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Research Article

The allelopathic influence of *Anethum graveolens* seed powder in controlling *Orobanche crenata* infesting *Vicia faba* and its effect on the crop growth and yield

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Abstract: Two pot experiments were performed in the wire greenhouse of the National Research Centre, Dokki, Giza, Egypt during two successive winter seasons of 2020/2021 and 2021/2022 to study the allelopathic efficiency of *Anethum graveolens* seed powder (AGSP) in comparison to the herbicidal effect of glyphosate treatment (0.375 ml/l) in controlling the parasitic weed broomrape infected faba bean as well as their effect on growth and yield of the crop. Treatments were applied by incorporating different AGSP concentrations (5, 10, 15, 20, 25, 30, 35 and 40 g/kg soil) into the soil. Broomrape seeds were obtained from the Weed Control Section, Ministry of Agriculture, Giza, Egypt. All pots, except healthy control, were infected with broomrape seeds (0.2 g/pot) at 5 cm depth from the soil surface. All AGSP concentrations used and herbicide treatment decreased all broomrape parameters i.e. number, fresh and dry weight of tubercles/pot at 90 days after sowing (DAS) and at harvest as well as tubercles length at harvest only. The best treatments for controlling broomrape were recorded with 40 and 35 g/kg soil AGSP concentrations compared to the herbicide glyphosate treatment at harvest. AGSP treatments at 35 and 30 g/kg soil concentrations achieved the maximum significant increases, exceeding their corresponding healthy control and glyphosate treatment. Therefore, the allelopathic effect of AGSP due to the presence of allelochemicals, mainly phenolic compounds and flavonoid contents, could play an essential role as a natural selective bioherbicide in controlling parasitic weed broomrape infesting faba bean plant and increasing the plant growth and yield.

Keywords: Allelopathy, Anethum graveolens, Vicia faba, Orobanche crenata, phenolic contents, flavonoids contents

Introduction

Faba bean is an important food and feed legume because of its high nutritional value of the seeds. It is considered one of the most major legumes in Egypt and also one of the strategic crops due to its income to the farmers, soil fertility and human nutrition as a good source of vegetable protein and industry purposes. Increasing faba bean production and improving yield quality are

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the senior targets to meet the demand of the increasing population, since it constitutes a large part of the people's diet (Zeidan, 2002).

Broomrape is a parasitic weed that is restricted to the Mediterranean region, Southern Europe, and the Middle East and is a dangerous pest in grain and forage legumes such as faba bean, lentil, pea and common vetch (Rubiales *et al*., 2009b; Kandil *et al*., 2015). Sever yield losses of legume crops due to broomrape depend on the severity of infestation sowing date, crop sensitivity and different prevailing environmental factors (El-Desoki *et al*., 2003; Messiha *et al*., 2004; Rubiales *et al*., 2009a; Kandil *et al*., 2015). Control of the parasitic weed broomrape has been proven to be very difficult in field crops due to its underground location, close association with the host plant roots, and complex mechanisms of seed dispersal, germination and longevity (Linke and Saxena, 1991). Therefore, several strategies to control parasitic weeds have been developed, including cultural practices and biological and chemical controls (Rubiales *et al*., 2009a; Fernandez-Aparicio *et al*., 2011).

Due to various problems of using chemical herbicides, such as weed resistance, herbicide residues, environmental pollution and adverse effects on human and animal health (Macias *et al*., 2003; Singh *et al*., 2003), using natural or synthetic allelopathic materials has been started as a way to control weeds. Weed management with allelopathic plant materials can be achieved by different methods, such as water extracts and surface mulch, incorporated in the soil as cover crops in crop rotation (Reigosa *et al*., 2001; Singh *et al*., 2003). Among these allelopathic plants, medicinal and aromatic plants have been increasingly explored for their potential use as allelopathically active plants (Dikic, 2005a; Dhima *et al*., 2009).

Dill (Anethum graveolens) is an annual aromatic herb belonging to the family Apiaceae that originated from the Mediterranean and West Asia and is widely cultivated in Pakistan, India, Afghanistan, Middle East, Russia, Iran, Egypt, Africa, China, USA, Canada, Bulgaria, Turkey and Uzbekistan (Chadha,1995). Different parts of the dill plant showed several biological activities such as antimicrobial, antihyperlipidemic, antihypercholesterolemic, antibacterial, antispasmolic and antioxidant (Yazdanpanparast and Alavi, 2001; Delaquis *et al*., 2002; Singh *et al*., 2005; Nair and Chanda, 2007; Al-Ma, adhedi, 2012). It is also used as a spice for flavoring of various foods such as salads, sauces, soups and seafood (Słupski *et al*., 2005). The phytochemical analysis of the dill plant revealed the presence of alkaloids, terpenoids, flavonoids, saponins, glucosides, tannins and phenolic compounds (Dahiya and Purkayastha, 2012; Ahmed *et al*., 2021).

The aim of this study was to determine the allelopathic potentiality of Anethum graveolens seed powder as one of the Apiaceae family in controlling the parasitic weed broomrape infesting faba bean as well as its effect on the growth and yield of the plant. It is worthy to mention that few medicinal plants have been examined for their biological or herbicidal activity. Many researchers are now showing interest in medicinal plants for searching new natural plant products (Valcheva and Popov, 2013; Ahmed *et al*., 2020)

Materials and Methods

Two pot experiments were carried out during two successive winter seasons of 2020/2021, and 2021/2022 at the wire greenhouse of the National Research Centre, Dokki, Giza, Egypt. Faba bean *Vicia faba* L. seeds (cultivar Wadi 1) and dill *Anethum graveolens* seeds were obtained from the Agricultural Research Centre, Giza, while the broomrape *Orobanche crenata* seeds were obtained from the Weed Control Section, Ministry of Agric., Giza, Egypt. Clean seeds of dill were ground to a fine powder and immediately incorporated to the soil surface before sowing at the rate of 0, 5, 10, 15, 20, 25, 30, 35 and 40 g/kg soil. The experiment consisted of 11 treatments as follows:

1- Faba bean alone (healthy control)
2- Faba bean + broomrape (infected control)

3- Faba bean + broomrape + Glyphosate at 0.375ml/liter
4- Faba bean + broomrape + *A. graveolens* at 5 g/kg soil
5- Faba bean + broomrape + *A. graveolens* at 10 g/kg soil
6- Faba bean + broomrape + *A. graveolens* at 15 g/kg soil
7- Faba bean + broomrape + *A. graveolens* at2 0 g/kg soil
8- Faba bean + broomrape + *A. graveolens* at 25 g/kg soil
9- Faba bean + broomrape + *A. graveolens* at30 g/kg soil
10- Faba bean + broomrape + *A. graveolens* at 35 g/kg soil
11- Faba bean + broomrape + *A. graveolens* l at 40 g/kg soil

All pots, except healthy control, were infected with broomrape seeds (0.2 g/pot) at 5cm depth from the soil surface. The experiment also includes herbicidal treatment with glyphosate (Isopropyl amine salt of N-phosphonomethyl glycine) for comparison with the allelopathic effect of AGSP treatments. Glyphosate was sprayed at the rate of 0.375 ml/liter twice times. The first spray was applied before the faba bean flowering stage (60 DAS), while the second spray was applied 14 days after the first one. Faba bean seeds (8 seeds/pot) were sown on November 13 and 16 in the first and second seasons, respectively, 3 cm deep in pots with 30cm diameter (0.07 m^2) filled with 5 kg clay and sandy soil (2: 1). Two weeks later, the faba bean plants were thinned to 4 plants/pot. Each treatment consists of nine replicates (A total of 99 pots). All treatments were distributed in a completely randomized design. Three replicates were collected from each treatment at 60 and 90 days after sowing (DAS) and at harvest. During soil preparation, a single super phosphate was applied (15.5% P_2O_5) at the rate of 200 kg/fed for all experimental treatments, and ammonium nitrate (33.5% N) at a rate of 150 kg/fed was divided into two equal parts and applied 35 and 50 DAS. During the growth stages, plants were watered weekly. All treatments were kept under wire greenhouse settings, and cultural practices for growing faba bean plants were followed.

Characters studied

Weed growth parameters

In each season, three replicates were collected from each treatment at 90 days after sowing (DAS) and at harvest 120 (DAS). The numbers, as well as fresh and dry weight of broomrape tubercles/pot (g) were recorded at the two growth stages, while broomrape tubercle length (cm) was recorded at harvest only.

Crop growth

In both seasons, samples of faba bean plants were collected from each treatment at 60 and 90 DAS to determine the shoot height (cm), root length (cm), leaf number /plant, branch number/plant as well as fresh and dry weight of plant (g).

Yield and yield components

At harvest, samples of faba bean plants were taken from each treatment to determine the number of pods/pot, pod length (cm), pods biomass/ pot (g), seed number /pod, weight of seeds/ 10 pods (g) and 100 seeds weight (g).

Anethum graveolens seeds were ground into fine powder. Total phenol and total flavonoid contents were determined in seed powder according to Srisawat *et al.* (2010). The analysis proved the detection of total phenols (11.18 mg/g dry weight) and total flavonoids (4.11 mg/g dry weight) in *A. graveolens* seed powder.

Statistical analysis

All data were statistically analyzed according to Snedecor and Cochran (1980) and the treatment means were compared by using LSD at 5% level of probability.

Results

Weed growth parameters

The results in Table 1 revealed that all applied AGSP concentrations and herbicidal glyphosate treatment significantly suppressed broomrape infestation and decreased the number, fresh and dry weight of tubercles/pot (g) at the two growth ages (90 DAS and at harvest) as well as the tubercles length at harvest only comparing to their corresponding infected control. The efficiency of controlling broomrape infestation increased significantly by increasing the applied AGSP concentration. Maximum reduction in number, fresh and dry weight of broomrape tubercles/pot and their length (cm) at harvest were recorded with the highest AGSP concentration (40 g/kg soil), which reached respectively 84.65, 87.53, 87.36 and 75.00% as compared to their corresponding infected control. It is evident from the results in Table 1 that AGSP treatments at 35 and 40 g/kg soil concentrations achieved better results in controlling broomrape-infected faba bean plants than that recorded by the herbicide glyphosate treatment., this treatment (glyphosate treatment) caused a reduction in broomrape tubercles parameters as number, fresh and dry weight/pot (g) and their length (cm) at harvest reached respectively 60.58, 70.62, 68.96 and 54.03% when compared to corresponding infected control.

Faba bean growth

The results in (Table 2) illustrated that all faba bean growth parameters were significantly increased with all AGSP concentrations (5 to 40g/kg soil), except the branches number /plant and dry weight of plant (g) at the lowest concentration (5 g/kg soil) at the first growth age (60DAS) as compared to the corresponding infected control. The rate of plant growth parameters increased by increasing the AGSP concentration used, and the highest significant increases in most plant growth parameters were recorded with AGSP at 40 g/kg soil concentration compared to the corresponding healthy control and glyphosate treatment (Table 2). While, at the second growth age (90 DAS), all faba bean growth parameters represented in (Table 3), showed significant increases with different AGSP concentrations used (5 to 40 g/kg soil) as well as herbicide glyphosate treatment, except the branches number/plant at the lowest concentration when compared to the corresponding infected control. The highest significant increases in different growth parameters were recorded with 35g/kg soil AGSP concentration compared to their corresponding healthy control and herbicide glyphosate treatment. It is worth mentioning that treatments with 25, 30 and 35g/kg soil AGSP concentrations not only alleviated the harmful effect of broomrape infestation but also induced high significant increases in all faba bean growth parameters, except the branches number /plant with 25 and 30 g/kg soil AGSP concentrations as compared to their healthy control. Maximum increases in the shoot height, root length, leaf number /plant, and fresh and dry weight of plant were recorded by 35 g/kg soil AGSP treatment reached respectively 9.14, 20.2, 41.95, 44.94 and 43.15%, while, with 30 g/kg soil AGSP treatment reached respectively to 5.16, 17.45, 27.05, 32.24 and 29.27% and also reached to 2.68, 7.02, 22.80, 27.93 and 15.48% with 25 g/kg soil AGSP treatments over than their corresponding healthy control. Moreover, the middle AGSP concentration (20 g/kg soil) recorded nonsignificant increases over their corresponding healthy control in all growth parameters except the fresh weight of the plant, which was significant (Table 3).

Faba bean yield

The results of yield and yield components parameters of faba bean plants were recorded in Table 4, revealing that all above-mentioned yield parameters in infected control were significantly decreased respectively to 54.56, 43.48, 57.97, 45.95, 64.43 and 56.10% compared to their corresponding healthy control. All applied AGSP treatments (5 to 40 g/kg soil) used as well as glyphosate treatment (0.375 ml/liter), significantly increased all plant yield components, except the number of pods/pot and their length (cm) at the lowest concentration (5 g/kg soil) as compared to the corresponding infected control. In addition, AGSP treatment at 35 followed by 30g/kg soil concentrations achieved the best results in all faba bean yield components. These treatments not only alleviated the harmful effect of broomrape infestation but also caused higher increases in all plant yield components over the corresponding healthy control. Maximum increases in the number of pods/pot, pod length (cm), pods biomass/pot (g), seeds number of /pod, weight of seeds/ 10 pods (g) and 100 seeds weight (g) of faba bean reached respectively to 56.98, 23.19, 16.05, 29.73, 39.39 and 42.84% with 35 g/kg soil AGSP treatment, while, with 30 g/kg soil AGSP treatment reached respectively to 40.04, 11.59, 14.12, 21.62, 31.02 and 31.81% over their corresponding healthy control. In this respect, AGSP treatments at 25 and 20g/kg soil concentrations recorded good results in all faba bean yield components when compared to the corresponding healthy control since these treatments showed increases ranging from nonsignificant to significant increases over the corresponding healthy control.

Table 1 Mean comparison of broomrape traits affected by different concentrations of Anethum graveolens seed powder and Glyphosate herbicide in faba bean pots at 90 DAS and at harvest stage (combined analysis of two seasons).

Treatments	No. of broomrape tubercles/pot		Broomrape tubercles/pot (g. f. w)		Broomrape tubercles/pot (g. d. w)		Length of broomrape tubercles (cm)
	at 90 DAS	at harvest	at 90 DAS	at harvest	at 90 DAS	at harvest	at harvest
Faba bean alone (F) (Healthy control)	0.0	0.0	0.00	0.00	0.00	0.00	0.0
(F) + Broomrape (B) (Infected control)	27.9	48.2	43.82	62.93	9.32	14.95	12.4
(F) + (B) + Glyphosate at 0.375 ml/liter	17.6	19.0	15.87	18.49	3.35	4.64	5.7
(F) + (B) + Anethum graveolens (A) at 5 g/kg soil	24.2	38.5	25.59	54.57	5.47	12.67	10.1
(F) + (B) + (A) at 10 g/kg soil	23.6	28.8	22.74	48.63	4.84	11.41	9.2
(F) + (B) + (A) at 15 g/kg soil	21.9	26.3	18.54	40.28	3.93	9.63	7.6
(F) + (B) + (A) at 20 g/kg soil	19.1	24.0	17.06	35.60	3.60	8.53	7.0
(F) + (B) + (A) at 25 g/kg soil	14.4	22.8	13.55	32.73	2.91	7.86	6.4
(F) + (B) + (A) at 30 g/kg soil	11.2	19.5	12.08	19.93	2.63	4.71	6.0
(F) + (B) + (A) at 35 g/kg soil	9.7	11.5	9.30	14.61	2.05	3.52	5.2
(F) + (B) + (A) at 40 g/kg soil	5.8	7.4	4.93	7.85	1.12	1.89	3.1
LSD at 5%	1.6	1.3	1.58	1.53	0.95	1.16	1.2
F-value	174.7	666.56	391.95	1185.80	48.61	113.23	40.64
df	9	9	9	9	9	9	9
Significance	**	**	**	**	**	**	**

F = Faba bean, B = Broomrape, A = *Anethum graveolens,* ** Significant at P < 0.01.

Table 2 Mean comparison of faba bean parameters at 60 DAS influenced by concentrations of Anethum graveolens seed powder and Glyphosate herbicide under broomrape infection (combined analysis of two seasons).

Treatments	Growth parameters					
	Shoot height (cm)	Root length (cm)	Leaf number/plant	Branches number/plant	Weight/plant (g. f. w)	Weight/plant (g. d. w)
Faba bean alone (F) (Healthy control)	81.1	37.5	28.8	2.45	53.24	8.76
(F) + Broomrape (B) (Infected control)	60.7	25.9	16.7	1.43	28.89	4.83
(F) + (B) + Glyphosate at 0.375ml/liter	73.1	32.0	25.7	2.34	42.41	6.98
(F) + (B)+ Anethum graveolens (A) at 5 g/kg soil	69.6	28.5	21.6	1.71	31.98	5.27
(F) + (B) + (A) at 10 g/kg soil	71.0	29.0	22.3	1.85	37.95	6.25
(F) + (B) + (A) at 15 g/kg soil	71.9	30.5	24.0	1.96	38.54	6.34
(F) + (B) +(A) at 20 g/kg soil	72.7	31.3	24.5	2.07	38.67	6.37
(F) + (B) + (A) at 25 g/kg soil	74.5	32.3	26.1	2.37	43.77	7.21
(F) + (B) + (A) at 30 g/kg soil	76.4	35.1	26.9	2.39	44.76	7.36
(F) + (B) + (A) at 35 g/kg soil	80.1	36.8	27.4	2.41	45.19	7.53
(F) + (B) + (A) at 40 g/kg soil	84.2	38.6	29.3	2.47	55.31	9.12
LSD at 5%	1.7	1.3	1.5	0.32	1.37	0.95
F-value	124.15	76.42	52.33	10.35	282.49	14.25
df	10	10	10	10	10	10
p-value	**	**	**	**	**	**

F = Faba bean, B = Broomrape, A = *Anethum graveolens,* ** Significant at P < 0.01.

Table 3 Mean comparison of faba bean parameters at 90 DAS influenced by concentrations of Anethum graveolens seed powder and Glyphosate herbicide under broomrape infection (combined analysis of two seasons).

Treatments	Growth parameters					
	Shoot height (cm)	Root length (cm)	Leaf number /plant	Branches number /plant	Weight/plant (g. f. w)	Weight/plant (g. d. w)
Faba bean alone (F) Healthy control)	100.7	47.0	32.9	2.95	55.67	10.66
(F) + Broomrape (B) (Infected control)	71.8	29.8	19.1	1.84	33.74	5.85
(F) + (B)+ Glyphosate at 0.375 ml/liter	98.6	41.7	32.1	2.73	51.95	10.07
(F) + (B) + Anethum graveolens (A) at 5 g/kg soil	91.6	32.8	22.7	2.06	39.06	7.64
(F) + (B) + (A) at 10 g/kg soil	94.7	38.3	26.8	2.47	44.83	7.83
(F) + (B) + (A) at 15 g/kg soil	96.3	39.0	29.0	2.60	48.14	8.87
(F) + (B) + (A) at 20 g/kg soil	101.5	48.2	33.7	3.12	60.09	11.22
(F) + (B) + (A) at 25 g/kg soil	103.4	50.3	40.4	3.23	71.22	12.31
(F) + (B) + (A) at 30 g/kg soil	105.9	55.2	41.8	3.34	73.62	13.78
(F) + (B) + (A) at 35 g/kg soil	109.9	56.5	46.7	3.52	80.69	15.26
(F) + (B) + (A) at 40 g/kg soil	98.1	40.3	31.3	2.66	49.21	9.56
LSD at 5%	1.9	1.6	1.8	0.45	2.06	1.46
F-value	233.55	128.67	178.08	11.48	431.16	30.32
df	10	10	10	10	10	10
p-value	**	**	**	**	**	**

F = Faba bean, B = Broomrape, A = *Anethum graveolens,* ** Significant at P < 0.01.

Table 4 Yield and yield components of faba bean at harvest affected by concentrations of Anethum graveolens seed powder and Glyphosate herbicide under broomrape infection (combined analysis of two seasons).

Treatments	Yield and yield components					
	No. of pods/ pot	Pod length (cm)	Pods biomass/pot (g)	Seed number /pod	Wt. of seeds/10 pods (g)	100 seeds Wt. (g)
Faba bean alone (F) (Healthy control)	5.37	6.9	8.85	3.7	13.86	62.49
(F) + Broomrape (B) (Infected control)	2.44	3.9	3.72	2.0	4.93	27.43
(F) + (B) + Glyphosate at 0.375 ml/liter	5.01	6.3	7.96	3.6	12.83	58.61
F)+ (B) + Anethum graveolens (A) at 5 g/kg soil	3.35	4.7	5.61	2.9	7.12	35.18
(F) + (B) + (A) at 10 g/kg soil	4.16	5.0	6.34	3.1	9.96	43.50
(F) + (B) + (A) at 15 g/kg soil	4.72	5.2	7.09	3.2	10.45	49.33
(F) + (B) + (A) at 20 g/kg soil	5.99	7.0	9.26	3.9	15.91	70.50
(F) + (B) + (A) at 25 g/kg soil	7.15	7.3	9.64	4.2	16.85	78.36
(F) + (B) +(A) at 30 g/kg soil	7.52	7.7	10.10	4.5	18.16	82.37
(F) + (B) + (A) at 35 g/kg soil	8.43	8.5	10.27	4.8	19.32	89.26
(F) + (B) + (A) at 40 g/kg soil	4.96	5.9	7.66	3.4	11.94	53.62
LSD at 5%	1.02	1.0	0.86	0.8	1.25	1.80
F-value	26.00	15.17	47.45	9.28	111.27	1011.36
df	10	10	10	10	10	10
p-value	**	**	**	**	**	**

F = Faba bean, B = Broomrape, A = *Anethum graveolens,* ** Significant at P < 0.01.

It is worth mentioning that AGSP treatments starting from 20 up to 35 g/kg soil concentrations achieved good results in controlling the parasitic weed broomrape infected faba bean and also improving the plant growth parameters and increasing its yield components till it reached the maximum significant increases in all plant growth parameters and yield components with 35 g/kg soil AGSP treatment over the corresponding healthy control.

Discussion

According to Dikic (2005 b), the inhibitory effect *A. graveolens* plant has been approved against hoary cress(Lepidium draba). Also, this treatment has a stimulatory effect on quack grass *Elymus repens* germination. Dhima *et al*. (2009) found that the green manure of *A. graveolens* plant significantly suppressed the emergence and growth of barnyard grass. (Echinochloa crus-galli

L), while essential oil extracted from the plant caused a reduction of germination percentage, root length and total fresh weight of barnyard grass (Dhima *et al*., 2010). On the other side, the allelopathic potentiality of AGSP-reducing effect in controlling the parasitic weed broomrape-infested faba bean could be attributed to its natural allelochemicals, mainly total phenols and total flavonoid contents. Ahmed *et al*. (2021) recorded the presence of total phenols and flavonoid contents in *A. graveolens* plant. It is worth mentioning that the results of this work are in agreement with our previous works at the Botany Department in the National Research Centre that which showed clearly the efficiency of other allelopathic crop plants such as Eruca sativa and Sinapis alba seed powder (family Brassicaceae) in controlling *Orobanche* spp. infesting *Vicia faba*, Pisum sativum and Lycopersicon esculentum plants (Messiha *et al*., 2018; El-Dabaa *et al*., 2019; El-Masry *et al*., 2019a; Ahmed *et al*., 2020; Telib, 2023).

However, the results of this work illustrated that the allelopathic potentiality of AGSP is not only restricted in controlling broomrape infesting faba bean plant but also significantly improved most parameters in the two growth ages and consequently increased yield as well as yield components of the host plant (Tables 2-4). The superior treatments were recorded with 30 and 35g/kg soil AGSP concentrations that achieved significant increases in most growth parameters (Tables 2 and 4) as well as yield components (Table 4) over the corresponding healthy control as well as glyphosate treatment. In this respect, some researchers studied the allelopathic influence of *Anethum graveolens* plant on other crop plants. So, Xing (2009) noticed a significant effect of *A. graveolens* plant extracted oil on tuber sprout number and weight of potatoes. Maulood and Amin (2012) also found that different concentrations of *A. graveolens* plant residues significantly affected most vegetative growth characteristics and chemical composition of leaves and grains of two barley (Hordeum vulgare L.) cultivars (Tedmor and Barbara). While Ali *et al*. (2013) demonstrated that the inhibitory effect of aqueous extracts of shoot parts of *A. graveolens* plant on germination and growth characteristics of bread wheat (Triticum aestivum L.) grains were directly related to the concentration coefficient. Another study carried out by Valcheva *et al*. (2019) recorded stimulation in tomato roots with 0.1% *A. graveolens* extract while inhibitory effect with 0.3 and 1.0% extract. Bonea (2019) also reported that *A. graveolens* plants had strong allelopathic potential on maize (*Zea mays* L.). Co-germination of *A. graveolens* seeds significantly decreased the root length of maize, while the aqueous plant extracts had stimulatory or inhibitory effects on maize seedlings, depending on the concentration.

It is worth mentioning that improving faba bean growth and consequently increasing its yield and yield components is not only due to controlling the weed growth by chemical or biological means that lead to increase the competitive ability of the plant (El-Rokiek *et al*., 2015; Ahmed *et al*.2018; El-Masry *et al*., 2019b; Messiha *et al*., 2013, 2018, 2021; Telib, 2023), but also, due to selectivity of the allelochemicals in their action and the plants in their responses (Einhellig, 1995). Since the allelochemicals that inhibit the growth of some species at specific concentrations may stimulate the development of some or different species at different concentrations (El-Awady *et al*., 2017; El-Rokiek *et al*., 2017; El-Masry *et al*., 2019 a & b; Messiha *et al*., 2021 & 2023; Ahmed *et al*., 2022; El-Wakeel *et al*., 2023).

Conclusion

The results of this study clearly indicate the efficiency of using the allelopathic potential of Anethum graveolens seed powder as a natural selective bio-herbicide in controlling the parasitic weed broomrape infesting faba bean plants and increasing significantly the plant growth as well as its yield components.

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Statement of Conflicting Interests

The Authors state that there is no conflict of interest.

References

Ahmed, F. A., Baraka, D., Abdel-Mawgoud, M., Essawy, H. and Elbadawy, H. 2021. Phenolic Compounds, Antioxidant and Antimicrobial Activities of Some Plants Belonging to Family Apiaceae. Benha Journal of Applied Sciences, 6(6): 299-308.

Ahmed, S. A. A., El-Masry, R. R., Messiha, N. K. and El-Rokiek, K. G. 2018. Evaluating the allelopathic efficiency of the seed powder of *Raphanus sativus L.* in controlling some weeds associating Phaseolus vulgaris L. *International Journal of Environmental Research*, 7(3): 87-94.

Ahmed, S. A. A., El-Wakeel, M. A., Mohamed, S. A. E. R. and Messiha, N. K. 2022. Impact of Phenolic Compounds and Glucosinolates of Two Brassicaceae Seed Powders in Controlling Two Annual Weeds Associating Lupinus albus Plants. Egyptian Journal of Chemistry, 65(9): 5-6.

Ahmed, S. A. A., Messiha, N. K., Mohamed, S. A., El-Masry, R. R. and Kowthar, G. 2020. Allelopathic properties of the seed powder of either Petroselinum crispum or Coriandrum sativum on the growth and yield of Glycine max and associated weeds. Middle East Journal of Applied Sciences, 10(3), 535-544.

Ali, K. A., Maulood, P. M. and Amin, S. A. 2013. The Allelopathic Effect of Aqueous Extracts of Dill (*Anethum graveolens* L.) on Soft Wheat's Some Germination and Growth Characteristics. In 2nd International Scientific Conference for Agriculture Researches.

Al-Ma'adhedi, S. H. F. 2012. Phytochemical Screening, Estimation of Some Heavy Metals Concentrations, and Specific Extraction of Bioactive Components from Iraqi *Anethum graveolens L.* Seeds and Studying their Antibacterial Activity. Anbar Journal for Veterinary Sciences, 5(2): p.30.

Bonea, D. 2019. Allelopathic potential of dill on germination and growth parameters of maize seedlings. Annals of the University of Craiova-Agriculture, Montanology, Cadastre Series, 49(2): 50-54.

Chadha, K. L. 1995. Advances in horticulture. 11. Medicinal and Aromatic Plants. Malhotra Publishing House.Kandil, E. E. E., Kordy, A. M. and Abou Zied, A. A. 2015. New approach for controlling broomrape plants in faba bean. Alexandria Science Exchange Journal, 36(JULY-SEPTEMBER): 282-291.

Dahiya, P. and Purkayastha, S. 2012. Phytochemical analysis and antibacterial efficacy of dill seed oil against multi-drug resistant clinical isolates. Asian Journal of Pharmaceutical and Clinical Research, 5(2): 62-64.

Delaquis, P. J., Stanich, K., Girard, B. and Mazza, G. 2002. Antimicrobial activity of individual and mixed fractions of dill, cilantro, coriander and eucalyptus essential oils. International journal of food microbiology, 74(1-2): 101-109.

Dhima, K. V., Vasilakoglou, I. B., Gatsis, T. D., Panou-Philotheou, E. and Eleftherohorinos, I. G. 2009. Effects of aromatic plants incorporated as green manure on weed and maize development. Field Crops Research, 110(3): 235-241.

Dhima, K., Vasilakoglou, I., Garane, V., Ritzoulis, C., Lianopoulou, V. and Panou-Philotheou, E. 2010. Competitiveness and essential oil phytotoxicity of seven annual aromatic plants. Weed Science, 58(4): 457-465.

Đikić, M. 2005a. Allelopathic effect of cogermination of aromatic and medicinal plants and weed seeds. Herbologia, 6(1): 15-24.

Đikić, M. 2005b. Allelopathic effect of aromatic and medicinal plants on the seed germination of Galinsoga parviflora, Echinochloa crus-galli and Galium molugo. Herbologia, 6(3): 51-57.

Einhellig, F. A. 1995. Mechanism of action of allelochemical in allelopathy. In: Inderjit, K., Dakshini, M. M. and Enhilelling, F. A. (Eds.), Allelopathy Organisms, Processes and

Application. American Chemical Society, Washington, USA, pp: 96-116.

El-Awadi, M. E., Dawood, M. G., Abdel-Baky Y. R. and El-Rokiek K. G. 2017. Investigations of growth promoting activity of some phenolic acids. CIGR Journal, 53-60.

El-Dabaa, M. A. T., Ahmed, S. A. E., Messiha, N. K. and El-Masry, R. R. 2019. The allelopathic efficiency of Eruca sativa seed powder in controlling Orobanche crenata infected Vicia faba cultivars. Bulletin of the National Research Centre, 43: 1-8.

El-Desoki, E. R., Messiha, N. K. and El-Masry, R. R. 2003. Sensitivity of some faba bean (*Vicia faba L.*) cultivars to *Orobanche crenata* infection. Egyptian Journal of Appleid Science, 18(7): 101-113.

El-Masry, R. R., Ahmed, S. A. A., El-Rokiek, K. G., Messiha, N. K. and Mohamed, S. A. 2019b. Allelopathic activity of the leaf powder of *Ficus nitida* on the growth and yield of Vicia faba and associated weeds. Bulletin of the National Research Centre, 43: 1-7.

El-Masry, R. R., El-Desoki, E. R., El-Dabaa, M. A. T., Messiha, N. K. and Ahmed, S. A. A. 2019a. Evaluating the allelopathic potentiality of seed powder of two Brassicaceae plants in controlling Orobanche ramosa parasitizing *Lycopersicon esculentum* Mill. plants. Bulletin of the National Research Centre, 43: 1-8.

El-Rekiek, K. G., Ahmed, S. A. A., Messiha, N. K., Mohamed, S. A. and El-Masry, R. R. 2017. Controlling the grassy weed *Avena fatua* associating wheat plants with the seed powder of two Brassicacea plants *Brassica rapa* and *Sinapis alba*. Middle East Journal, 6940: 1014-1020.

El-Rekiek, K. G., El-Metwally, I. M., Messiha, N. K. and Saad El-Din, S. 2015. Controlling *Orobanche crenata* in faba bean using the herbicides Glyphosate and Imazapic with some additives. International journal of Chem. Tech Research, 8: 18-26.

El–Wakeel, M. A., Ahmed, S. A. A. and Messiha, N. K. 2023. Evaluation of *Ficus nitida* Allelopathic Potential and the Most Efficient Application Method for Controlling Weeds Associated with Sunflower Plant. Gesunde Pflanzen: 1-11. doi.org/10.1007 /s10343-023-00830-7.

Fernández-Aparicio, M., Westwood, J. H. and Rubiales, D. 2011. Agronomic, breeding, and biotechnological approaches to parasitic plant management through manipulation of germination stimulant levels in agricultural soils. Botany, 89(12): 813-826. https:// doi.org/https://doi.org/10.1139/b11-075.

Linke, K. H. and Saxena, M. C. 1991. Study on viability and longevity of Orobanche seed under laboratory conditions. Progress in Orobanche Research: 110-114.

Macías, F. A., Marín, D., Oliveros-Bastidas, A., Varela, R. M., Simonet, A. M., Carrera, C. and Molinillo, J. M. 2003. Allelopathy as a new strategy for sustainable ecosystems development. Biological sciences in Space, 17(1): 18-23.

Maulood, P. M. and Amin A. S. 2012.The allelopathic effect of Dill plant (*Anethum graveolens* L.) residues on the growth and chemical content of two types of Barley (*Hordeum vulgare* L.) Rafidain Journal of Science, 23(5): 1-12.

Messiha, N. K., Ahmed, S. A. A., Mohamed, S. A., El-Masry, R. R. and El-Rokiek, K. G 2021. The allelopathic activity of the seed powder of two *Lupinus albus* species on growth and yield of *Vicia faba* plant and its associated *Malva parviflora* weed. Middle East Journal of Applied Sciences, 11 (4): 823-831.

Messiha, N. K., Ahmed, S. A., El-Rokiek, K. G., Dawood, M. G. and El-Masry, R. R. 2013. The physiological influence of allelochemicals in two Brassicaceae plant seeds on the growth and propagative capacity of *Cyperus rotundus* and *Zea mays* L. World Applied Sciences Journal, 26(9): 1142-1149.

Messiha, N. K., El-Dabaa, M. A. T., El-Masry, R. R. and Ahmed, S. A. A. 2018. The allelopathic influence of Sinapis alba seed powder (white mustard) on the growth and yield of Vicia faba (faba bean) infected with *Orobanche crenata* (broomrape).

Middle East Journal of Appleid Science, *8*(2): 418-425.

Messiha, N. K., El-Rokiek, K. G., Abel Rahman, S. M., El-Mary, R. R. and Ahmed, S. A. 2023. The Dual Allelopathic Efficiency of *Bougainvillea Glabra* Leaf Powder on the Growth and Yield of *Vigna unguiculata* L. Walp. Plant and the Associated perennial Weed *Cyperus rotundus* L. Journal of Material Environtal Science, 14(2): 161-172.

Messiha, N. K., Sharara, F. A. and Elgayar, S. H. 2004. Effect of glyphosate, fosamine ammonium and their mixture for controlling *Orobanche crenata* in pea (*Pisum sativum* L.). Journal of Plant Production, 29 (7): 3979-3991.

Nair, R. and Chanda, S. 2007. Antibacterial activities of some medicinal plants of the western region of India. Turkish Journal of Biology, 31(4): 231-236.

Reigosa, M. J., Sanches-Moreiras, A., Duran, B., Puime, D., Fernandez, D. A. and Bolano, J. C. 2001. Comparison of physiological effects of allelochemicals nad commercial herbicides. Allelopathy Journal, 8(2): 211-220.

Rubiales, D., Fernandez-Aparicio, M. and Haddad, A. 2009a. Parasitic weeds. The Lentil Botany, Production and Uses. Edited by William Erskine, Fred Muehlbauer, Ashutosh Sarker and Balram Sharma. CAB International: 343-349.

Rubiales, D., Fernández-Aparicio, M., Wegmann, K. and Joel, D. M. 2009b. Revisiting strategies for reducing the seedbank of Orobanche and Phelipanche spp. *Weed Research*, *49*: 23-33.

Singh, G., Maurya, S., De Lampasona, M. P. and Catalan, C. 2005. Chemical constituents, antimicrobial investigations, and antioxidative potentials of Anethum graveolens L. essential oil and acetone extract: Part 52. Journal of Food Science, 70(4): M208-M215.

Singh, H. P., Batish, D. R. and Kohli, R. K. 2003. Allelopathic interactions and allelochemicals: new possibilities for sustainable weed management. Critical Reviews in Plant Sciences, 22(3-4): 239-311.

Słupski, J., Lisiewska, Z. and Kmiecik, W. 2005. Contents of macro and microelements in fresh and frozen dill (Anethum graveolens L.). Food Chemistry, 91(4): 737-743.

Snedecor, G. W. and Cochran W. G. 1980. Statistical Methods. 7th Ed. The Iowa State University PRESS, Ames, Iowa.

Srisawat, U., Panunto, W., Kaendee, N., Tanuchit, S., Itharat, A., Lerdvuthisopon, N. and Hansakul, P. 2010. Determination of phenolic compounds, flavonoids, and antioxidant activities in water extracts of Thai red and white rice cultivars. Journal of the Medical Association of Thailand, *93*: S83-91.

Telib, S. T. S. 2023. Using some practices for managing broomrape in faba bean. M.Sc. Thesis Faculty of Agriculture, Ain Shams Univ., Cairo.

Valcheva, E. and Popov, V. 2013. Role of the allelopathy in mixed vegetable crops in the organic farming. Scientific Papers Series A. Agronomy, 56: 422-425.

Valcheva, E., Popov, V., Marinov-Serafimov, P., Golubinova, I., Nikolov, B., Velcheva, I. and Petrova, S. 2019. A Case Study of Allelopathic Effect of Parsley, Dill, Onion and Carrots on the Germination and Initial Development of Tomato Plants. Ecologia Balkanica, 11(1).

Xing, S. 2009. The impact of dill weed, spearmint and clove essential oils on sprout suppression in potato tubers. M.Sc. Thesis. Saskatchewan University.

Yazdanparast, R. and Alavi, M. 2001. Antihyperlipidaemic and antihyper-cholesterolaemic effects of Anethum graveolens leaves after the removal of furocoumarins. Cytobios, *105*(410): 185-191.

Zeidan, M. S. 2002. Effect of sowing dates and urea foliar application on growth and seed yield of determinate faba bean (*Vicia faba* L.) under Egyptian conditions. Egyptian Journal of Agronomy, 24: 93-102.

تأثیر آللوپاتیک پودر بذر شوید *Anethum graveolens* در کنترل گل جالیز *Orobanche crenata* آلوده به باقلا *Vicia faba* و تأثیر آن بر رشد و عملکرد محصول

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چکیده: دو آزمایش گلدانی در گلخانه مرکز تحقیقات ملی، دوکی، جیزه، مصر در دو فصل زمستانی متوالی ۲۰۲۰/۲۰۲۱ و ۲۰۲۱/۲۰۲۲ برای بررسی کارایی آللوپاتیک پودر بذر گیاه شوید *Anethum graveolens* (AGSP) در مقایسه با اثر علف‌کشی تیمار گلایفوسیت (۰/۳۷۵ میلی‌لیتر در لیتر) در کنترل باقلای آلوده به گل جالیز و همچنین تأثیر آن بر رشد و عملکرد محصول. تیمارها با ترکیب غلظت‌های مختلف AGSP (۵، ۱۰، ۱۵، ۲۰، ۲۵، ۳۰، ۳۵ و ۴۰ گرم بر کیلوگرم خاک) در خاک اعمال شدند. بذر گل جالیز از بخش کنترل علف‌های هرز، وزارت کشاورزی، جیزه، مصر تهیه شد. تمامی گلدان‌ها به‌جز شاهد سالم با بذر گل جالیز (۰/۲ گرم در گلدان) در عمق ۵ سانتی‌متری سطح خاک آلوده شدند. تمام غلظت‌های AGSP استفاده‌شده و تیمار علفکش تمام پارامترهای گل جالیز یعنی تعداد، وزن تازه و خشک غده/گلدان را در ۹۰ روز پس از کاشت (DAS) و در هنگام برداشت و همچنین طول غده را فقط در زمان برداشت کاهش داد. بهترین تیمارها برای کنترل گل جالیز با غلظت‌های ۴۰ و ۳۵ گرم بر کیلوگرم AGSP خاک در مقایسه با تیمار علفکش گلایفوسیت در زمان برداشت ثبت شد. تیمارهای AGSP در غلظت‌های ۳۵ و ۳۰ گرم بر کیلوگرم خاک، حداکثر افزایش قابل‌توجهی را به‌دست آوردند که از کنترل سالم و تیمار گلایفوسیت فراتر رفت. بنابراین، اثر آللوپاتیک AGSP به‌دلیل وجود مواد آللوشیمیایی، عمدتاً ترکیبات فنلی و محتویات فلاونوئیدی، می‌تواند به‌عنوان یک بیوعلفکش انتخابی طبیعی در کنترل گل جالیز آلوده به گیاه باقلا و افزایش رشد و عملکرد گیاه نقش اساسی داشته باشد.

واژگان کلیدی: آللوپاتی، باقلا، شوید، گل جالیز، محتوای فنلی، محتوای فلاونوئیدها