Journal of Materials and Environmental Science
ISSN : 2028-2508
e-ISSN : 2737-890X
CODEN : JMESCN

J. Mater. Environ. Sci., 2024, Volume 15, Issue 10, Page 1491-1502

http://www.jmaterenvironsci.com

The allelopathic efficiency of *Petroselinum crispum* seed powder and Glyphosate herbicide in controlling *Orobanche crenata* infected *Vicia faba* plants

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Received *29 Sept 2024,*
Revised *27 Oct 2024,*
Accepted *28 Oct 2024*

Keywords:
- ✓ *Allelopathy;*
- ✓ *Petroselinum crispum;*
- ✓ *Vicia faba;*
- ✓ *Orobanche crenata;*
- ✓ *Phenolic contents*
- ✓ *Flavonoids contents*

Citation: El-Dabaa M.A.T., El-Masry, R.R., Ahmed S.A.A. and Messiha N. K. (2024) The allelopathic efficiency of Petroselinum crispum seed powder and Glyphosate herbicide in controlling Orobanche crenata infected Vicia faba plants, J. Mater. Environ. Sci., 15(10), 1491-1502

Abstract: Two pot experiments were conducted in the greenhouse of the National Research Centre, Dokki, Giza, Egypt, during two successive winter seasons of 2021/2022 and 2022/2023 to investigate the allelopathic influence of *Petroselinum crispum* seed powder (PCSP) in controlling the parasitic weed *Orobanche crenata* infected *Vicia faba* and its effect on growth and yield of the plant in comparison to the effect of herbicidal glyphosate treatment (0.375 ml/Liter). Treatments were applied by incorporating different PCSP concentrations (0,5, 10, 15, 20, 25, 30, 35 and 40g/kg soil) to the soil. The use of PCSP concentrations and herbicidal glyphosate treatment significantly reduced all O. crenata parameters at 100 days after sowing and harvest. The best treatments for controlling *O. crenata* were recorded with 40 and 35g/kg soil PCSP concentrations compared to the herbicidal glyphosate treatment 100 DAS and at harvest. On the other side, most *V. faba* growth parameters at two growth ages (75 and 100 DAS) as well as its yield and yield components were significantly increased by all PCSP concentrations used and the herbicidal glyphosate treatment as compared to their corresponding infected control. PCSP treatments at 30 and 25g/kg soil concentrations achieved maximum significant increases in all growth parameters at (100 DAS) and yield components over their corresponding healthy control and glyphosate treatment. *P. crispum* seed powder's allelopathic efficiency may be due to its phenolic and flavonoid contents, which could serve as a natural bioherbicide for controlling O. crenata in *V. faba* plants and increasing its growth and yield.

1. Introduction

Vicia faba L. (faba bean) is an important multi - purpose crop. Since it has a beneficial role in life for human, animals and even for microorganisms. It is used as a source of protein in humans' diets, as fodder for animals and for its excellent ability to fix atmospheric nitrogen. *V. faba* seed has been regarded as a meat extender or substitute due to its high protein content ranging from 20 to 41 % with valuable mineral micronutrients (Crepona *et al.*, 2010; Alhammad *et al.*, 2023 Ghorbi et al., 2023). It is relatively high in lysine, which is an essential amino acid in human and monogastric diets (Khazaei *et al.*, 2019). *V. faba* cultivation increases the sustainability of cropping systems by adding nitrogen to the soil and therefore reducing the consumption of fossil fuel energy required for manufacturing nitrogen fertilizers (Jensen *et al.*, 2010) with improving soil fertility. Also, faba bean plays a crucial

role in crop rotation by breaking the disease cycles of various pathogens and pets **(**Nebiyu *et al.*, 2016 and Rose *et al.*, 2016).

Orobanche crenata, or Broomrape, is a parasitic weed that affects various crops and legumes, including peas, chickpea, faba beans, lentils and common vetch **(**Messiha *et al.*, 2004 &2018; Hershenhorn *et al.*, 2009 and Ahmed *et al.*, 2020a). It is primarily found in the Mediterranean region, Southern Europe and the Middle East. According to Rubiales *et al.*, 2009b and Kandil *et al.*, 2015, it is also regarded as a significant pest of grains and forage legumes. Depending on the extent of the infestation and the planting date, considerable yield losses of leguminous plants have been observed as a result of O. crenata infestation (Sauerborn, 1991; Rubiales *et al.*, 2009a and Kandil *et al.*, 2015). Because of its underground location, intimate relationship to the roots of host plants and intricate mechanisms of seed distribution, germination and longevity, Orobanche spp. are difficult to control in leguminous plants (Linke and Saxena, 1991). Various strategies have been developed to control Orobanche spp., a parasitic weed, chemically or biologically, alongside cultural practices (Rubiales *et al.*, 2009a; Fernandez-Aparicio *et al.*, 2011; Messiha *et al.*, 2018; El-Dabaa *et al.*, 2019; El-Masry *et al.*, 2019 a and Ahmed *et al.*, 2020 a).

Many allelopathic plants that have strong allelopathic potential are used as safety and effective methods in controlling weeds, insects, pests and diseases (El-Rokiek *et al.*, 2024). Among these allelopathic plants medicinal and aromatic plants have been increasingly explored for their potential use as allelopathically active crops **(**Dikic, 2005 and Dhima et al., 2009).

Petroselinum crispum Mill. (Parsley) is a biannual herb plant belonging to the Apiaceae family that has several biological activities. It is cultivated as a medicinal and vegetable plant in tropical, sub-tropical and temperate regions, Soliman et al., 2015. *P. crispum* is now planted throughout the world due to its usage in food industry, perfume, manufacturing, soaps and creams Its main constituents subsume coumarins, furanocoumarins (bergapten, imperatorial), ascorbic acid, carotenoids, flavonoids, apiole, various terpenoid compounds, phenyl propanoids, phathalides and tocopherol **(**Rodino *et al.*, 2016). *P. crispum* is a rich source of flavonoid and antioxidants, especially luteolin, apigenin, folic acid, vitamin K, vitamin C and vitamin A (Galazka, 2006; Meyer *et al.*, 2006 and Mahmood *et al.*, 2014). *P. crispum* is grown for roots, leaves and used as a vegetable and spice **(**Parađiković, 2009). The plant possesses small and dark seeds wić volatile oil content. *P. crispum* seed extract showed allelopathic potential against *Fusarium oxyporum* **(**Jia *et al.*, 2011), while *P. crispum* vegetative biomass extract showed the allelopathic effect on pepper seedlings growth **(**Valcheva and Popov, 2013). Dhima *et al.* (2009) reported inhibitory effect of *P. crispum* extracts and as green manure on various weed species.

This study aimed to investigate the allelopathic effect of *P. crispum* seed powder and herbicide glyphosate on controlling *O. crenata* infesting *V. faba*, as well as their impact on plant growth and yield.

2. Methodology

Two pot experiments were carried out during the winter seasons of 2021/2022 and 2022/2023 at the greenhouse of the National Research Centre, Dokki, Giza, Egypt. *Vicia faba* L. (Faba bean) seeds (Nobaria 3) and *Petroselinum crispum* (Parsley) seeds were obtained from the Agricultural Research Centre, Giza, while the parasitic weed seeds of *Orobanche crenata* (broomrape) were obtained from the Weed Control Section, Ministry of Agric., Giza, Egypt. Clean seeds of *P. crispum* were grinded 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 40g/kg soil The experiment consisted of 11 treatments, including two controls

(healthy and infected), 8 treatments of different concentrations of *P. crispum* seed powder (PCSP) and a treatment with herbicide glyphosate (Isopropyl amine salt of N- phosphonomethyl glycine) for comparison with the allelopathic effect of PCSP treatments. All pots, except healthy control, were infested with *O. crenata* seeds (0.2 g/pot) at 5cm depth from the soil surface. The herbicide glyphosate was sprayed at the rate of 0.375ml/liter twice times, the first spray was applied before the flowering stage (55 DAS), while the second spray was applied 14 days after the first one. *V. faba* seeds (8 seeds/pot) were sown on November 14 and 13 in the first and second seasons, respectively, 3 cm deep in pots with 30 cm diameter (0.07 m^2) filled with 5 kg clay and sandy soil (2:1). Two weeks later, the *V. faba* plants were thinned to 4 plants/pot. Each treatment consists of 9 replicates. All treatments were distributed in a complete randomized design. All treatments were kept under greenhouse settings and cultural practices of growing *V. faba* plants were followed especially fertilization and irrigation.

2.1 Characters studied

2.1.1 Weed growth parameters

In each season, three replicates were collected from each treatment at 100 days after sowing (DAS) and at harvest. The numbers as well as fresh and dry weight of *O. crenata* tubercles/pot (g) were recorded at the two growth ages, while *O. crenata* tubercles length (cm) was recorded at harvest only.

2.1.2 Plant growth

In both seasons, samples of *V. faba* plants were collected from each treatment at 75 and 100 DAS to determine the shoot height (cm), root length (cm), number of leaves/plant, number of branches/plant as well as fresh and dry weight of plant (g).

2.1.3 Yield and yield components

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

2.2 Chemical analysis

2.2.1 Determination of Total phenol and Total flavonoid contents in *P. crispum* seed powder (mg/g DW)

Total phenol and Total flavonoid contents were determined in *P. crispum* seed powder according to Srisawat *et al.* (2010); Salhi et al., (2019) Haddou *et al.*, (2023).

2.3 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.

3. Results and Discussion

3.1 Results

3.1.1 Weed growth parameters

The results in Table (1) showed the efficiency of different *Petroselinum crispum* seed powder (PCSP) concentrations (5 to 40g/kg soil) as well as the herbicidal glyphosate treatment (0.375ml/liter) in controlling *O. crenata* infested *Vicia faba* plants. The results in Table (1) revealed that all applied PCSP concentrations and herbicidal glyphosate treatment recorded a significant decrease in all *O. crenata* parameters infested *V. faba* plants at the two growth ages (100 DAS and at harvest) compared

to their corresponding infected control. The efficiency of controlling *O. crenata* parasitic weed was enhanced with an increase in PCSP concentration, resulting in maximum reduction in number, fresh and dry weight of *O. crenata* tubercles/pot as well as their length (cm) at harvest was recorded with PCSP at 40g, followed by PCSP at 35g/kg soil and glyphosate treatment, respectively. The previous parameters reached respectively to 84.16, 89.18, 89.46 and 78.50%, with 40 g/kg soil PCSP concentration, while with the herbicidal treatment glyphosate (0.375ml/liter) reached to 61.63, 73.06, 68.32 and 49.53%, respectively comparison is made to their corresponding infected control. It is obvious from these results that the treatment with the highest PCSP concentration (40g/kg soil) achieved better results in controlling *O. crenata* infected *V. faba* plants than that recorded by the herbicidal glyphosate treatment.

Table (1): The impact of different concentrations of *Petroselinum crispum* seed powder and Glyphosate herbicide on *Orobanche crenata* infesting in *Vicia faba* L. at 100 days after sowing and at harvest (combined analysis of two seasons)

Treatments	No. of *O. crenata* tubercles/pot		Fresh weight of *O. crenata* tubercles/pot (g)		Dry weight of *O. crenata* tubercles/pot (g)		Length of *O. crenata* tubercles (cm)
	At 100 DAS	At harvest	At 100 DAS	At harvest	At 100 DAS	At harvest	At harvest
Vicia faba alone (*V*) (Healthy control)	00.0	00.0	0.00	00.00	0.00	00.00	00.0
(*V*) + *Orobanche crenata* (*O*) (Infected control)	25.6	40.4	36.54	60.24	8.29	14.52	10.7
(*V*) + (*O*)+ Glyphosate at 0.375ml/liter	14.7	15.5	14.88	16.23	3.24	4.60	5.4
(*V*) + (*O*) + *Petroselinum crispum* (*P*) at 5g/kg soil	22.5	28.9	24.68	48.75	5.57	10.50	9.6
(*V*) + (*O*)+ (*P*) *at* 10g/kg soil	20.4	23.0	21.79	42.69	4.90	9.10	8.7
(*V*) + (*O*)+ (*P*) *at* 15g/kg soil	20.0	22.3	17.97	39.38	4.03	8.75	7.2
(*V*) + (*O*)+ (*P*) *at* 20g/kg soil	18.5	21.9	15.86	32.27	3.53	7.26	6.5
(*V*) + (*O*)+ (*P*) *at* 25g/kg soil	14.0	19.6	12.96	30.39	2.86	6.91	6.1
(*V*) + (*O*)+ (*P*) at 30g/kg soil	11.9	16.1	10.93	28.61	2.38	6.29	5.7
(*V*) + (*O*)+ (*P*) at 35g/kg soil	9.4	10.9	8.78	12.95	1.91	3.70	4.9
(*V*) + (*O*)+ (*P*) at 40g/kg soil	5.5	6.4	4.75	6.52	1.03	1.53	2.3
LSD at 5%	1.7	1.4	1.53	1.78	0.86	0.98	0.8

V= Vicia faba *O= Orobanche crenata* *P = Petroselinum crispum*

3.1.2 Vicia faba growth

The results in (Table 2) showed that all growth parameters of *V. faba* plants, represented by shoot height (cm), root length (cm), number of leaves/plant, number of branches/plant, fresh and dry weight of plant (g) were significantly increased by different PCSP concentrations (5 to 40g/kg soil) used, except the number of branches/plant and dry weight of plant (g) with the lowest concentration (5 g/kg soil) at the first growth age (75 DAS) as compared to the corresponding infected control. The maximum increases in these mentioned growth parameters were recorded with PCSP treatments at 30, 35 and 40 g/kg soil concentrations, except the number of branches/plants, over their corresponding healthy control and glyphosate treatment.

Also, PCSP treatments at 20 and 25 g/kg soil concentration at 75 DAS achieved good results in all *V. faba* growth parameters which recorded range from non-significant to significant increases over their corresponding healthy control (Table 2). At the second *V. faba* plant growth age (100 DAS) all growth parameters were significantly increased with different PCSP concentrations used (5 to 40g/kg

soil) used, except the number of branches /plant with the two lower concentrations (5 and 10 g/kg soil) as compared to the corresponding infected control (Table 3). The study found that treatments containing 25 and 30g/kg soil PCSP showed the most effective results in reducing V. faba growth parameters compared to the healthy control. Maximum significant increases of shoot height (cm), root length(cm), number of leaves/plant, fresh and dry weight of plant (g) reached respectively to 2.47, 12.5, 6.70, 8.72 and 11.97% with 25g/kg soil PCSP treatment, while with 30g/kg soil PCSP treatment reached respectively to 5.46, 23.51, 18.13, 15.51 and 20.10% over their corresponding healthy control. It is worthy to mentioned that both PCSP treatments at 20 and 25g/kg soil concentrations recorded approximately equal increases in all *V. faba* plant growth parameters. These increases range d from non- significant to significant increases compared to the corresponding herbicidal glyphosate treatment, but all still less than those recorded by the corresponding healthy control. So, economically we must prefer using 20g/kg soil PCSP treatment instead of 35 9g/kg soil PCSP treatment (Table 3).

Table (2): The impact of different concentrations of Petroselinum crispum seed powder and Glyphosate herbicide on growth parameters of Vicia faba L. at 75 days after sowing (combined analysis of two seasons)

Treatments	Growth parameters					
	Shoot height (cm)	Root length (cm)	No. of leaves /plant	No. of branches /plant	F.W. of plant (g)	D.W. of plant (g)
Vicia faba alone (*V*) (Healthy control)	82.0	37.7	29.3	2.25	44.85	7.39
(*V*) + *Orobanche crenata (O)* (Infected control)	61.2	28.4	20.0	1.50	31.23	5.03
(*V*) + *(O)*+ Glyphosate at 0.375ml/liter	75.9	34.8	25.5	2.05	39.53	6.51
(*V*) + *(O)* + *Petroselinum crispum* (*P*) at 5g/kg soil	69.6	31.2	23.3	1.79	34.56	5.50
(*V*) + *(O)*+ *(P) at* 10g/kg soil	71.7	33.0	24.8	1.99	37.58	6.19
(*V*) + *(O)*+ *(P) at* 15g/kg soil	80.4	35.0	27.0	2.15	41.88	6.91
(*V*) + *(O)*+ *(P) at* 20g/kg soil	83.5	38.5	29.9	2.26	46.49	7.66
(*V*) + *(O)*+ *(P) at* 25g/kg soil	86.1	40.9	30.5	2.32	48.07	7.91
(*V*) + *(O)*+ *(P)* at 30g/kg soil	87.3	41.3	31.0	2.37	50.28	8.36
(*V*) + *(O)*+ *(P)* at 35g/kg soil	88.1	41.8	31.8	2.41	51.11	8.41
(*V*) + *(O)*+ *(P)* at 40g/kg soil	90.8	42.0	32.3	2.63	51.76	8.55
LSD at 5%	1.80	1.50	1.40	0.48	1.37	0.84

V= Vicia faba *O= Orobanche crenata* *P = Petroselinum crispum*

Table (3): The impact of different concentrations of Petroselinum crispum seed powder and Glyphosate herbicide on growth parameters of Vicia faba L. at 100 days after sowing (combined analysis of two seasons)

Treatments	Growth parameters					
	Shoot height (cm)	Root length (cm)	No. of leaves /plant	No. of branches /plant	F.W. of plant (g)	D.W. of plant (g)
Vicia faba alone (*V*) (Healthy control)	113.5	53.6	42.80	3.41	74.42	13.53
(*V*) + *Orobanche crenata (O)* (Infected control)	81.2	31.9	25.10	1.89	33.98	6.00
(*V*) + *(O)*+ Glyphosate at 0.375ml/liter	104.3	44.9	38.80	3.03	59.35	11.51
(*V*) + *(O)* + *Petroselinum crispum* (*P*) at 5g/kg soil	90.8	37.7	33.40	2.53	40.38	7.90
(*V*) + *(O)*+ *(P) at* 10g/kg soil	95.3	40.9	35.00	2.72	46.73	8.83
(*V*) + *(O)*+ *(P) at* 15g/kg soil	101.0	43.4	37.50	2.99	55.65	10.61
(*V*) + *(O)*+ *(P) at* 20g/kg soil	112.6	49.5	40.60	3.34	68.09	12.70
(*V*) + *(O)*+ *(P) at* 25g/kg soil	116.3	60.3	45.40	3.62	80.91	15.15
(*V*) + *(O)*+ *(P)* at 30g/kg soil	119.7	66.2	50.56	3.65	85.96	16.25
(*V*) + *(O)*+ *(P)* at 35g/kg soil	110.3	47.8	39.30	3.27	62.74	12.02
(*V*) + *(O)*+ *(P)* at 40g/kg soil	99.5	43.2	36.90	2.95	53.77	10.42
LSD at 5%	2.20	2.00	1.81	0.74	1.98	1.42

V= Vicia faba *O= Orobanche crenata* *P = Petroselinum crispum*

3.1.3 Vicia faba yield

The study analyzed the yield and yield components of *V. faba* as number of pods/pot, pod length (cm), weight of pods/ pot (g), number of seeds/pod, weight of seeds/ 10 pods (g) and weight of 100 seeds (g) recorded in Table (4) showed that, *O. crenata* infestation in *V. faba* plant caused sever decrease in all above mentioned *V. faba* yield parameters that reached respectively to 65.33, 46.25, 64.87, 56.82, 72.11 and 63.14 % comparing to their corresponding healthy control. While, all applied PCSP treatments used (5 to 40g/kg soil) concentrations recorded significant increases in all *V. faba* yield parameters, except pod length (cm) at the lowest PCSP concentration (5 g/kg soil) as compared to the corresponding infected control. Treatment of 30g/kg soil PCSP significantly improved *V. faba* yield components, alleviating O. crenata infestation effects and enhancing all plant yield parameters compared to the healthy control except weight of pods/pot (g) and number of seeds /pods that were non- significant. Maximum increases in number of pods/pot, pod length (cm), weight of pods/ pot (g), number of seeds/pod, weight of seeds/ 10 pods (g) as well as weight of 100 seeds (g), that were recorded by 30g/kg soil PCSP concentration, reached respectively to 17.54, 12.50, 11.30, 15.91, 23.33 and 12.10%, over their healthy control. In this respect, treatment with 25g/kg soil PCSP concentration also achieved non- significant increases over the corresponding healthy control with different *V. faba* yield parameters except, weight of seeds/10 pods(g) and weight of 100 seeds (g) that were significant. It is worthy to mentioned that both PCSP treatments at 20 and 35 g/kg soil concentration recorded also good results in all plant yield parameters better than that recorded with the herbicidal glyphosate treatment (Table 4). We could conclude that, PCSP treatments at 25 and 30g/kg soil concentration achieved good results in controlling *O. crenata* infestation (Table 1) and the study reveals significant increases in *V. faba* growth parameters and yield over the healthy control and glyphosate treatment (Tables 3 and 4).

Table (4): The impact of different concentrations of Petroselinum crispum seed powder and Glyphosate herbicide on yield and yield components of Vicia faba L. at harvest (combined analysis of two seasons)

Treatments	Yield and yield components parameters					
	No. of pods/ pot	Pod length (cm)	Wt. of pods/pot (g)	No. of seeds /pod	Wt. of seeds/10 pods(g)	Wt. of 100 seeds (g)
Vicia faba alone (*V*) (Healthy control)	7.24	8.0	9.82	4.4	18.00	80.39
(*V*) + *Orobanche crenata (O)* (Infected control)	2.51	4.3	3.45	1.9	5.02	29.63
(*V*) + *(O)*+ Glyphosate at 0.375ml/liter	5.34	6.7	7.89	3.5	15.30	62.62
(*V*) + *(O)* + *Petroselinum crispum* (*P*) at 5g/kg soil	3.52	5.0	5.41	3.0	7.70	36.26
(*V*) + *(O)*+ *(P) at* 10g/kg soil	4.38	5.7	6.25	3.1	10.60	45.22
(*V*) + *(O)*+ *(P) at* 15g/kg soil	5.03	6.3	7.50	3.4	14.50	56.74
(*V*) + *(O)*+ *(P) at* 20g/kg soil	6.15	7.8	8.96	3.9	16.10	73.43
(*V*) + *(O)*+ *(P) at* 25g/kg soil	7.66	8.3	10.54	4.7	20.60	84.66
(*V*) + *(O)*+ *(P) at* 30g/kg soil	8.51	9.0	10.93	5.1	22.20	90.12
(*V*) + *(O)*+ *(P) at* 35g/kg soil	5.65	7.5	8.89	3.7	15.70	67.55
(*V*) + *(O)*+ *(P) at* 40g/kg soil	4.96	6.0	6.94	3.2	11.94	51.36
LSD at 5%	1.01	1.0	1.25	0. 9	1.25	2.69

V= Vicia faba *O= Orobanche crenata* *P = Petroselinum crispum*

3.1.4 Total phenolic and flavonoid contents

Table (5) clears the quantity of total phenolic contents (20.34 mg/g dry weight) and total flavonoid contents (8.39 mg/g dry weight) in *P. crispum* seed powder

Table (5): Total phenols and flavonoids contents in the seed powder of *Petroselinum crispum*

Seed extract	Total phenols as mg/g dry weight	Total flavonoids as mg/g dry weight
Petroselinum crispum	20.340	8.387

3.2 Discussion

Allelopathy is a phenomenon where secondary metabolites (allelochemicals) produced by fungi, viruses, microorganisms and plant parts influence biological and agricultural systems, either stimulating or inhibiting them **(**Torres *et al.,* 1996**).** Allelochemicals, bioactive compounds, have the potential to function as natural pesticides **(**Macias *et al.*, 2007 and Dayan *et al.*, 2009**)** and the use of synthetic agrochemicals can lead to pest biotype resistance, health issues and soil and environmental pollution **(**Zhu and Li, 2002; Roeleveld and Bretveld, 2008 and Dayan *et al.*, 2009**).**

The study's findings indicated that PCSP concentrations (5 to 40 g/kg soil) possess to a great extent allelopathic reducing effect on all *O. crenata* tubercles infesting *V. faba* plants at 100 DAS and harvest (Table 1). The reducing effect of PCSP was concentration dependent, recording maximum inhibition in all *O. crenata* growth parameters with the highest concentration (40 g/kg soil) used the comparison is made to the corresponding infected control. These results are in agreement with those recorded by many researches who illustrated the allelopathic potential effect of different *P. crispum* plant parts (roots, aerial parts stems and leaves as well as seeds) in controlling different weeds**.** Rodino *et al.* (2016) found that the aqueous extracts of different *P. crispum* plant parts have an allelopathic inhibiting effects on germination and radical elongation of these weeds e.g. ragweed (*Ambrosia artemisiifolia* L.), knotweed (*Polygonum arviculare* L.) and Johnson grass (*Sorghum halepense* (L.) Pers.). Ahmed et al., (2020 b) also showed the efficiency of *P. crispum* and *Coriandrum sativum* seed powder in controlling *Corchorus olitorius* and *Portulaca oleracea* weeds associated with *Glycine max* crop. Moreover, some researchers studied the allelopathic effect of *Anethum graveolens* (Apiaceae family) on different weeds e.g. *Lepidium draba* (hoary cress), *Elymus repens* (quack grass), *Echinochloa crus- galli* L. (barnyard) **(**Dikic, 2005 and Dhima *et al.*, 2009 & 2010). In this connection the allelopathic potentiality of PCSP reducing effect in controlling the parasitic weed *O. crenata* infested *V. faba* plant could be attributed to the presence of natural allelochemicals mainly total phenolic and total flavonoid contents (Table 5). Ahmed *et al.,* (2020a) and Ahmed *et al.,* (2021) confirmed these results. It is worthy to mention that, the study aligns with previous research conducted at the Botany department of the National Research Centre, which demonstrated the effectiveness of other allelopathic plants as *Eruca sativa*, *Sinapis alba* seed powder (family Brassicaceae) in controlling *Orobanche spp.* Infesting *V. 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 a & 2024; Saudy, *et al.*, 2022 and Telib, 2023).

On the other side, improving the growth and increasing the yield and yield components of *V. faba* plant infested by *O. crenata* weed achieved by different PCSP concentrations used (Tables 2,3 and 4) recording the highest significant increases with 30 and 25 g/kg soil treatments over the corresponding healthy control and glyphosate treatment. In this respect, Ahmed *et al.*, (2020b) confirmed these results illustrated the allelopathic influence of *P. crispum* and *Coriandrum sativum* seed powder on the growth and yield of the *Glycine max* plant. Other researchers also studied the allelopathic efficiency of the *Anethum graveolens L.*, another member of Apiaceae family, on different crops e.g. potatoes (*Solanum tuberosum* L), barley (*Hordeum vulgare* L.), wheat (*Triticum aestivum* L.), tomato (*Lycopersicon esculentum* Mill.) and maize (*Zea mays* L.) **(**Xing 2009; Maulood and Amin 2012; Ali *et al.,* 2013;

Dorina 2019, Valcheva *et al.*, 2019 and Aourabi *et al.*, 2020). Improving *V. faba* growth and increasing yield is not only due to controlling weed growth **(**Ahmed *et al.*2018; El-Masry *et al*, 2019b; Messiha *et al.*, 2018 & 2021 and Telib,2023), but also to the selective action of allelochemicals and plants' responses to these chemicals **(**Einhellig, 1995). Allelochemicals that inhibit certain species' growth at specific concentrations can potentially stimulate the growth of the same or different species at different concentrations **(**El-Awadi *et al.*, 2017; El-Masry *et al.*, 2019 a & b; Messiha *et al.*, 2021 & 2023; Ahmed *et al.*,2022; El-Wakeel *et al.*, 2023 and Telib,2023).

Conclusion

The results of this study indicate clearly the capability of using *P. crispum* seed powder as safety and selective bio-herbicide in controlling the parasitic weed *O. crenata* infesting *V. faba* plants and improving its growth and yield.

Acknowledgement, Thanks are due to the National Research Centre for use of the green house and laboratory facilities

Disclosure statement: *Conflict of Interest:* The authors declare that there are no conflicts of interest.
Compliance with Ethical Standards: This article does not contain any studies involving human or animal subjects.

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