

Allelopathic effects of *Amaranthus viridis* L. on germination and growth of *Eruca sativa* L.

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Abstract

A pot experiment was conducted at Alzaiem Alazhari University during 2020/2021 to study the effect of *Amaranthus viridis* powder incorporated into the soil on germination and growth of garden rocket (*Eruca sativa*). The experiment was arranged in completely randomized design (CRD) with four replicates. Five concentrations (0, 0.5, 1.0, 1.5 and 2.0% w/w) on basis of *Amaranthus viridis* powder incorporated in the soil. Results indicated that *Amaranthus viridis* powder decreased germination, shoot length, leaf area, shoot and root fresh and dry weight as well as chlorophyll content and some chemical elements (P, Ca, Mg, Fe).

Keywords: Amaranthus; Garden rocket; Germination; Allelopathy; Chlorophyll content

1. Introduction

Weeds are one of the worst biological constraints to increase crop production and if left uncontrolled cause massive yield losses in field crops. Weeds growing with crops interact with each other and exert inhibitory effects on each other through releasing compounds known as allelochemicals. These allelochemicals affect other plants at their germination and seedling growth. Allelopathic effects of weeds on emergence and growth of crops have been documented [1,2].

Garden rocket (*Eruca sativa*) is a leafy vegetable predominantly eaten raw. It is rich in vitamin C and important powerful antioxidant and it is cancer-fighting food [3]. Garden rocket is cultivated in large areas in Khartoum, Sudan and is one of the daily food consumed by most of Sudanese people. However, the production of garden rocket is not stable as weeds compete with it and reduce the yield.

Amaranthus viridis is an annual weed distributed throughout the world especially tropical countries. It has been reported as a principal and troublesome weed of corn (*Zea mays* L.), sugarcane (*Saccharum officinarum* L.), sorghum (*Sorghum bicolor* L.) and vegetables [4]. *Amaranthus viridis* is one of the most noxious weeds that imposed the garden rocket production. It is found grown in cultivated lands, canal banks and the bank of the Blue Nile and White Nile in Khartoum. Therefore the present work was conducted to evaluate the negative effect of *Amaranthus viridis* on the germination and growth of garden rocket.

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2. Material and methods

2.1. Plant material

Amaranthus viridis plants were collected from Shambat area, Faculty of Agriculture, University of Khartoum. The plants were uprooted, washed with distilled water, then dried at room temperature (25°C) for 96 hours, plants then chopped and ground into powder. The garden rocket seeds were obtained from local market (local cultivar).

2.2. Pot experiment

A pot experiment was set in plastic pots (18 × 35 cm) and arranged in completely randomized design (CRD) with four replicates. Five treatments were used, the first one T₁ represented the control, where the pot was free from *Amaranthus* powder (0), the other four treatments represented by T₂, T₃, T₄ and T₅, the soil in the pots were incorporated with *Amaranthus viridis* powder 10, 20, 30 and 40g per pot representing 0.5, 1.0, 1.5 and 2.0% (w/w) respectively. Ten seeds of garden rocket were sown in each pot and later thinned to two seedlings. Pots were irrigated daily with tap water. During the experiment plant height, number of leaves, leaf area, shoot and root fresh and dry weight were recorded and chlorophyll content (a, b) and some elements (P, Ca, Mg, Fe) were determined. The data of the experiment were subjected to analysis of variance (ANOVA) according to [5].

3. Results and discussion

The germination percentage showed a significant decrease (P= 0.05) in all treatments as compared to control (Table 1). The germination percentage decreased from 96.67% (control) to 60, 20, 16 and 3.33% at treatments T₂, T₃, T₄ and T₅ respectively. These results were supported by the result of [2] who found that *Amaranthus* species extract concentrations inhibited the germination of Lettuce seeds. Similar results were reported by Kalinova *et al.* [6] who reported that *Amaranthus hybridus* extract inhibited the germination of soybean, pea and Vetch. In this respect [7] reported that allelopathic effects of *Amaranthus viridis* decreased germination percentage of rye grass compared to control.

The inhibition of germination of garden rocket may be attributed to the presence of phenolic compounds in *Amaranthus viridis* which affected and inhibited the garden rocket germination.

Table 1 Allelopathic effect of *Amaranthus viridis* powder on germination, plant height, number of leaves and leaf area of garden rocket (*Eruca sativa*)

Treatments	Germination (%)	Plant height (cm)	Number of leaves	Leaf area (cm ²)
T ₁ (control)	96.67	11.00	3.90	8.29
T ₂ (0.5% w/w)	60.00	10.00	3.80	8.20
T ₃ (1.0% w/w)	20.00	8.00	3.60	8.16
T ₄ (1.5% w/w)	16.67	8.00	3.43	8.14
T ₅ (2.0% w/w)	3.33	6.00	3.40	0.18
LSD	4.94	0.78	0.05	0.08

The plant height decreased from 11cm at control to 10.00, 8.00, 8.00 and 6.00cm at treatments T₂, T₃, T₄ and T₅ respectively. In this respect [8] found that *Amaranthus viridis* incorporated powder significantly decreased plant height of sorghum, millet, maize and wheat.

The number of leaves and leaf area of garden rocket exhibited significant difference (P= 0.05) between treatments as compared with control (Table 1). These results are in agreement with the findings of [2] who found that *Amaranthus* species significantly reduced the seedlings development of lettuce. These results were supported by the results of [8] who found that *Amaranthus viridis* powder decreased the number of leaves of some poaceous crops.

The shoot fresh and dry weight of garden rocket expressed significant decrease in treatments as compared with control (Table 2). These results were supported by the results of [6] who reported that *Amaranthus* hybrids when added as dry ground material decreased the dry weight of the shoot and root of red clover and root of alfalfa. In this respect [9] reported that a production in dry mass of *Chenopodium album*, *Melilotus alba* and *Nicotiana plumbaginifolia* treated with *Cassia sophera*.

The root length, root fresh and dry weight showed significant decrease in treatments as compared with control (Table 2). Similar results were reported by [8] who found a decrease in root length as well as root fresh and dry weight of sorghum, millet, maize and wheat when *Amaranthus viridis* powder incorporated into the soil.

The chlorophyll a and b decreased as the concentration of *Amaranthus* increased (Table 3). In this respect [10] showed that total chlorophyll content of maize and kidney bean were reduced due to the application of Eucalyptus leaf leachates. Similar results were reported by [11] who found a reduction in chlorophyll a content of corn treated with *Eucalyptus rostrata* leaf residue.

Table 2 Allelopathic effect of *Amaranthus viridis* powder on shoot fresh and dry weight, root length, root fresh and dry weight of garden rocket (*Eruca sativa*)

Treatments	Shoot fresh weight (g)	Shoot dry weight (g)	Root length (cm)	Root fresh weight (g)	Root dry weight (g)
T ₁ (control)	4.55	1.27	5.70	0.37	0.05
T ₂ (0.5% w/w)	3.60	0.95	4.60	0.30	0.04
T ₃ (1.0% w/w)	3.40	0.82	4.40	0.28	0.03
T ₄ (1.5% w/w)	3.33	0.80	4.20	0.20	0.02
T ₅ (2.0% w/w)	3.30	0.73	3.80	0.18	0.01
LSD	0.00	0.00	0.10	0.00	0.00

Table 3 Allelopathic effect of *Amaranthus visridis* powder on chlorophyll content and some chemical elements of garden rocket (*Eruca sativa*)

Treatments	Chlorophyll		P (mg/kg)	Ca (mg/kg)	Mg (mg/kg)	Fe (mg/kg)
	a (mg/g)	b (mg/g)				
T ₁ (control)	554.80	275.39	118	3800	1200	1443
T ₂ (0.5% w/w)	483.20	227.02	105	3000	1200	1338
T ₃ (1.0% w/w)	509.11	269.36	115	3000	1160	1361
T ₄ (1.5% w/w)	508.61	182.45	113	3000	240	1107
T ₅ (2.0% w/w)	445.57	256.59	112	3000	1146	1218
LSD	4.79	4.99	3.80	9.24	3.23	3.80

The content of phosphorous P, calcium Ca, magnesium Mg and iron Fe decreased significantly as the garden rocket growing in soil incorporated with *Amaranthus viridis* powder. Similar results were reported by [11] who found that Eucalyptus allelochemicals reduced the amount of P and N. The results were in agreement with the results of [12] who observed that root exudates of cucumber inhibited the uptake of K⁺, Ca²⁺, Mg²⁺ and Fe²⁺ by cucumber seedlings. Also the work of [13] who showed that excretion of roots can inhibit the roots of absorbs ions.

It is worth mentioning that the suppression in the growth of garden rocket may be attributed to the decrease in shoot and root length of the seedlings which was induced by the allelochemicals found in *Amaranthus virids*. These phytochemicals may decrease water and nutrient absorption and consequently affect the whole growth.

4. Conclusion

From this study it was concluded that *Amaranthus viridis* affected the germination and growth of garden rocket negatively and reduced the yield, large scale experiments are required to evaluate the negative effect of *Amaranthus viridis* under field conditions.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors have declared that no competing interests exist.

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