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Allelopathic effect of *Datura stramonium* on germination and some growth characters of purslane (*Portulaca oleracea L.)*

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Abstract

Pot experiments were conducted to study the allelopathic effect of *Datura stramonium* residue on germination and growth characters of purslane (*Portulaca oleracea* L). Experiments were set as completely randomized design with four treatments and three replications. Results indicated that the residue concentration affect germination negatively. The lower level of Datura residue induced a stimulatory effect on plant height, leaf area, shoot and root, fresh and dry weight of purslane. The higher level of Datura residue (1% and 1.5%) reduce the parameters mentioned above.

Keywords: Allelopathy; Purslane; Datura; Chlorophyll

1. Introduction

Plants have great significance due to their nutritive value and are also major source of medicines, food plants, including fruits, vegetable and spices are primary sources of naturally occurring nutrients essential for human health [1]. They contain valuable food ingredients which can be used as energy sources, body building, regulatory and protective material. In Sudan, as in most other tropical countries of Africa where the daily diet is dominated by starchy staple foods, vegetables are the cheapest and most readily available sources of important proteins, vitamins, minerals and essential amino acids [2].

Purslane is one of the vegetables which is consumed by most of the Sudanese people. Some purslane grows in many countries and known as a common trouble weed, but it can be eaten as a cooked vegetable and use in salads and is very rich in omega fatty acids. Plants growing together interact with each other through direct or indirect allelopathic interactions and exert inhibitory or stimulatory effects on growth of each other through releasing compounds known as allelochemicals [3,4]. Allelochemicals released from plants affect other plants mainly at their germination and seedling growth stages [5]. The present work was carried out to study the effect of *Datura stramonium* residue on the germination and some growth parameters of purslane.

2. Material and methods

2.1. Plant material

The Datura plant (*Datura stramonium*) was collected from Shambat Campus, University of Khartoum. The plants were uprooted at maturity, then washed thoroughly with distilled water and air dried at room temperature (25^{o}) for 96 hours.

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The plants then were chopped and ground into fine powder with mortar. The seeds of the experimental plant the Purslane plant were obtained from the market (local cultivar).

2.2. Soil material

The soil used in this experiment was river silt, moderately acid (PH 6.75), highly permeable.

2.3. Seed germination purslane

The seeds of plant were arranged in completely randomize design to four treatments.

The first treatment the soil was without Datura residue, representing the control. The second, third and fourth treatments, the soil was incorporated with 10, 20 and 30g of powdered *Datura stramonium* representing 0.5, 1 and 1.5% (w/w, residue/soil) respectively. Each treatment was replicated three times. Each pot (18cm in diameter, 27 in depth filled with silt soil) was planted with 5 seeds of purslane. After emergence, the seedlings were thinned to 3 seedlings per pot, plants were irrigated daily with tap water. During the experiment the following parameters were measured, plant height, number of leaves, leaf area, the shoot and root fresh and dry weight were taken at the end of the experiment. Part of the dried shoot of purslane was used for determination of P, K percentage. The data were analyzed using analysis of variance (ANOVA) using SPSS-version 21.

3. Results and discussion

Table (1) showed the germination percentage of purslane in the first and second experiment. It is clear that the residue concentration affect the germination negatively. The concentration 1% and 1.5% residue of Datura inhibited the purslane germination completely. The use of aqueous extracts of *Excoecaria agelloclia* leaves inhibited seed germination and plumule and radicle elongation of rice [6]. El Khawas and Shehata [7] found that with the increase in concentration of leaf extracts of *Eucalyputs globules,* there was concomitant decrease in germination of green gram, black gram, and cowpea; they also reported that aqueous leaf leachate of *Eucalyptus citriodora* inhibited the germination and seedling growth of *Vigna radiata, Vigna mungo* and *Arachis hypogaea*. Also [8] noticed phylotoxic suppressive action of water extract of *Chromolaena odorata* on germination and seedling growth of rice and barnyard grass. Skinner *et al*. [9]found that sunnhemp ground dried residues inhibit germination and seedling growth of various vegetables and cover crops.

Table 1 Allelopathic of *Datura stramonium* residue on germination of purslane (*Portulaca oleracea* L)

Treatments	Germination percentage	
	First experiment	Second experiment
T_1	85.00	68.33
T_2	61.67	55.00
T_3	00.00	0.00
T_4	00.00	0.00
LSD	8.25	8.27

Table (2) indicated a significant difference (P=0.05) between treatments in plant height at 15, 30 and 45 DAS (days after sowing). The lower level of Datura residue (0.5%, w/w) induced stimulatory effect on plant height, but the higher level (1, 1.5%, w/w) residue reduced plant height of purslane. In connection to this, Hegab *et al*.[10] found a stimulatory effect of Eucalyptus leaf residue in lower level (0.5%, w/w) on corn length. The results of this study was supported by the findings of [11] who observed an inhibitory allelopathic effect of soil incorporated residues of *Hordeum spontaneum* on seedling length and dry weight of *Triticum aestivum*. In this respect, [12] reported that litter amended in the soil have a negative effect on seedling length and weight of both *Triticum aestivum* and *L culinaris* and the length decreased with increasing amount of litter emended in the soil.

Similar results were reported by[13] who found that seedling length and weight of *Oryza sativa* was suppressed by residue of *Cyperus iria* in soil. As seen in Table (2) the number of leaves did not exhibit significant difference between treatments. However, the leaf area expressed a significant difference (P=0.05) between treatments at 15, 30 and 45 DAS

(Table 2). In this respect [14] demonstrated that the irrigation of groundnut and maize with 5, 10, 15 and 20% water extract of abscised *Eucalyptus globules* leaf greatly reduced plant height and leaf area.

Table 2 Allelopathic effect of *Datura stramonium* residue on germination of plant height, number of leaves and leaf area of purslane (*Portulaca oleracea*)

Treatment	Plant height (cm)			Number of leaves			Leaf area (cm^2)		
	Days after sowing			Days after sowing			Days after sowing		
	15	30	45	15	30	45	15	30	45
T_1	3.11	4.50	5.04	3.45	3.56	5.78	0.18	1.90	2.45
T_2	4.55	6.72	5.27	3.22	4.20	5.98	0.21	1.96	3.93
T_3	2.68	3.55	3.78	3.11	3.22	3.33	0.11	1.49	2.06
T_4	2.50	3.04	3.46	2.77	3.00	3.22	0.10	1.36	1.80
LSD	0.01	0.007	0.072	NS	NS	NS	0.03	0.003	0.009

The shoot fresh weight of purslane as indicated in Table (3) expressed a significant difference between treatments. The Datura residue in low rate (0.5%, w/w) induced stimulatory effect and the shoot fresh weight exceeded the control value. In this respect [10] found an increase in lower level of Eucalyputs residue in shoot growth parameters in corn. However, higher level of Datura residue (1 and 1.5%, w/w) reduced the shoot fresh weight. This result concurred with the results of [12] and [15]. The shoot dry weight also showed a significant difference between treatments (Table 3). In this respect, [11] observed the inhibitory allelopathic effect of soil incorporated residues of *Hordeum spontaneum* on seedling length and dry weight of *Triticum aestivum*.

Regarding the root length, root fresh and dry weight, Table (3) indicated a significant difference between treatments. The Datura residues with (1 and 1.5%, w/w) decreased the root length of purslane when compared with control. In contrast the (0.5%, w/w) residue level stimulated the length of the root. This result is in agreement with results of [6] who found that undiluted tuber extract of *Cyperus rotundus* impeded the radicle elongation of cucumber, radish, onion and tomato. In connection to this [16] reported that the extracts of *Eucalyptus camandulensis* inhibited the root elongation of tomato and [17] found that the root length of *Chenopodium album, Melilotus alba* and *Nicotiana plumbaginifolig* decreased as the concentration of *Cassia sophera* increased. In this respect [18, 19] assumed that the root length decreased as the concentration of extract increased, and the root membranes are a primary site of action for phenolics. The contact of phenolic acids with root cell membrane leads to depolarization an efflux of ions, and a reduction of hydrolic conductivity, water uptake and net nutrient uptake. Root growth is characterized by high metabolic rates and for this reason; roots are highly susceptible to environmental stresses such as allelochemical in soils [20]. In this respect [21, 22, 23,24] attributed the highly allelopathtic herbicidal potential in plant extracts to the presence of of allelopathic substances e.g. Coumarin, O-Coumaric acid, P-Coumaric acid, benzoic acid, P-hydroxy benzoic acid and ferrulic acid.

Table 3 Allelopathic effect of *Datura stramonium* residue on shoots and root fresh and dry weight of purslane (*Portulaca oleracea*)

Treatments	Shoot weight		Root		
	Fresh	Dry	Length	Fresh weight	Dry weight
T_1	0.29	0.11	1.93	0.15	0.013
T_2	0.43	0.23	3.64	0.27	0.015
T_3	0.27	0.017	1.72	0.14	0.0`0
T_4	0.25	0.017	1.63	0.106	0.010
LSD	0.001	0.003	0.003	0.005	0.000

The chlorophyll content (a, b) deceased significantly as the concentration of Datura residue (1 and 1.5%, w/w) increased (Table 4). However at low level (0.5%, w/w) of Datura residue a stimulatory was observed, similar results were obtained by [7] who showed that the total chlorophyll content and consequently the soluble sugar contents of maize and kidney-bean were reduced due to the application of Eucalyptus leaf leachates.

Table 4 Allelopathic effect of *Datura stramonium* residue on chlorophyll content and chemical elements of purslane

Treatments	Chlorophyll		Chemical element	
	a	b	P %	K %
T_1	6.52	2.22	0.2347	15.63
T_2	7.24	2.36	0.2756	19.71
T_3	5.44	1.93	0.1770	11.07
T_4	4.44	1.44	0.1262	9.26
LSD	0.001	0.001	0.000	0.001

Also[17] found a significant reduction in chlorophyll content of *Chenopodium album, Melilotus alba* and *Nicotiana plumbaginifolia* treated with different concentration of *Cassia sophera*. Hegab *et al.*[10] reported that a reduction was observed at higher level of the residue in chlorophyll a content of corn treated with *Eucalyptus rostrata* leaf residue on contrast the lower level of leaf residue (0.5, w/w) induced a stimulatory effect.

The reduction in chlorophyll content may be due to the inhibition of chlorophyll biosynthesis, the stimulation of chlorophyll degrading substances or both [25]. Another mechanism induced by alleloochemicals is the inhibition of photosynthesis and oxygen evaluation through interactions with components of photosystem II (PSII) [26] . On the other hand, recently [27] assumed that water content of leaves in plant initially induce stomatal closure, imposing a decrease in the supply of Co_2 to the mesophyll cells and consequently photosynthesis cells and consequently photosynthesis could be lowered resulting in the decrease of chlorophyll content.

Table (4) indicated a significant reduction (P=0.05) in K_2 and P content when treated with higher rate of Datura residue compared with control. However, the lower level of Datura residue (0.5%, w/w) stimulated the purslane and an increase in these elements was observed. Similar results were reported by [10] who found that the higher levels of Eucalyptus allelochemicals (1% and 2%) reduced the amount of all phosphorus fractions, and content of both soluble and insoluble nitrogen. Mersie and Singh [28] demonstrated that *Parthenium hysterophorus* extract and residue greatly reduced phosphorus content of treated 3 weeks old tomato plant. The allelopathic compounds are often observed to occur early in the life cycle causing inhibition of seed germination and/or seedling growth. These compounds exhibit a wide range of mechanisms of actions, from effects on DNA (alkaloids), photosynthetic and mitochondrial function (quinones), phyto-hormone activity, ion uptake and water balance (phenolic) [29].

4. Conclusion

The results of this study showed that Datura stramonium residue in low concentration can promote the growth parameters and yield of purslane, but higher concentration induced a reduction in growth parameters and yield. It is a great benefit to use natural methods and plants in increasing yield.

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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