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Allelopathic effects of red pepper (*Capsicum annuum* L.) and coriander (*Coriandrum sativum* L.) on early seedling growth of wheat (*Triticum aestivum* L.)

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Abstract. A pot experiment was conducted to assess the effects of red pepper (*Capsicum annuum*) and coriander (*Coriandrum sativum*) on seedling growth of wheat (*Triticum aestivum*). The aqueous extracts treatment of red pepper and coriander showed a significant ($p < 0.05$) reduction in root, shoot and seedling length, number of leaves and seedling dry weight of wheat (*T. aestivum*) as compared to control. The inhibitory different effect on growth of wheat (*T. aestivum*) was directly proportional to the increasing concentration (1, 2, 3, 4 and 5%) of aqueous extracts of red pepper and coriander as compared to control treatment (0%). The root, shoot, seedling length and number of leaves of *T. aestivum* significantly $p < 0.05$ decreased at 5% concentration of red pepper as compared to control. The root, shoot and seedling growth of *T. aestivum* was also significantly reduced at 1, 2, 3, 4 and 5% concentration of coriander as compared to control. The root, shoot and leaves dry weight of *T. aestivum* at 5% coriander extract treatment concentration decreased as compared to control. The tolerance in seedlings of *T. aestivum* to red pepper and coriander extract treatment was dose dependent as compared to control. The seedlings of *T. aestivum* showed low percentage of tolerance to pepper extract treatment than coriander extract treatment.

Keywords: red pepper; coriander; plant extracts; allelopathy; phytotoxicity; seedling growth; wheat

1. Introduction

The releases of phytotoxic substances from plant species are commonly reported by researchers. Influence of leaf leachets of certain woody species on agriculture crops and allelopathic effects of *Eucalyptus tereticornis* on *Phaseolus vulgaris* seedlings was observed by Melkania (1984), and Puri and Khara (1991). Allelopathic effects of *Anastatica hiertochuntica* on five desert plants

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(*Rumex cyprius*, *Trigonella stellata*, *Diplotaxis harra*, *Cleome droserifolia* and *Farsetia aegyptia*) were observed by Hegazy *et al*. (1990). Seed germination, seedling growth and cell division of all desert species *R*. *cyprius*, *T*. *stellata*, *D*. *harra*, *C*. *droserifolia*, and *F*. *aegyptia* tested were inhibited by the shoot aqueous extract of *A*. *hierochuntica* (Hegazy *et al*. 1990). Indoor and outdoor experiments demonstrated that allelopathy is an important factor explaining seed regeneration failures of Scots pine (*Pinus silvestris*) in forest floor vegetation dominated by the dwarf shrub *Empetrum hermaphroditum*. Scanning electron micrograph views of the leaf surfaces of *E*. *hermaphroditum* reveal secretory glands that are shown to be involved in the release of water soluble phytotoxic substances. Bioassays indicated that low doses and short exposure times of seeds to leachates have strong negative effects on germination and early root development. This technique demonstrates the occurrence of allelopathic interference by *E*. *hermaphroditum* on seed germination of both Scots pine and aspen (Zackrisson and Nilsson 1992).

Several secondary metabolites have been isolated from *Bothriochloa laguroides* var. *laguroides* (DC) Herter, such as sesquitepenes, monoterpenes, esters and hydrocarbons (Scrivanti *et al*. 2009). *B*. *laguroides*, a native blue stem of America, has been shown to produce many biologically active compounds. The allelopathic potential of aqueous extracts from roots, stems and leaves was examined. Lettuce seeds (*Lactuca sativa*) and corn (*Zea mays*), the common allelopathy bioassay systems, as well as seeds from two native species, winter green paspalum (*Paspalum guenoarum*) and love grass (*Eragrostis curvula*) were germinated in the presence of aqueous extracts. The root, stem and leaf extracts caused inhibition of root and shoot elongation in all four species tested (Scrivanti 2010). The aqueous leaf extracts of *Jatropha curcas* showed inhibitory effects on seed germination, shoot length and root length in green pepper (*Capsicum annum*). The inhibitory effect of the crop plant was directly proportional to the increasing concentration (5, 10, 15, 20%) of aqueous leaf extracts of *J*. *curcas*. *J*. *curcas* leaf extract showed stimulatory effects on seed germination and shoot length in sesame (*Sesamum indicum*). The stimulatory effect was directly proportional to the increasing concentration (5, 10, 15, 20%), but the root growth was inhibited in all treatment when compared to the control. The result of bioassay studies revealed that the inhibitory and stimulatory effect may be due to the presence of water soluble allelochemicals like phenols and tannins (Rejila and Vijayakumar 2011). Foliage of *Coriandrum sativum* is a rich source of natural folates amenable for enhancement through salicylic acid-mediated elicitation, thereby holding a great promise for natural-mode alleviation of vitamin (B_9) deficiency (Puthusseri *et al*. 2013). Allelopathy may also play an eminent role in the intraspecific and interspecific competition and may determine the type of interspecific association. In nature plants have to face various biotic and abiotic stresses (Das *et al*. 2012).

Capsicum annuum L. is reported to be the most widely cultivated species. The waste of vegetable processing, like seeds, has been considered the subject of many studies as an attempt to find new, alternative and cheap sources of bioactive compounds with application in several industries. *C*. *annuum* seeds are a potential source of valuable bioactive compounds that can be used in food industry (Silva *et al*. 2013). Pepper, *Capsicum* sp. is a member of the Solanaceae family and commonly divided into two groups, pungent and non-pungent, which also called hot and sweet pepper. Sweet pepper includes different cultivars and the most commonly used ones in greenhouse production, are hybrids that are bell-shaped (Zayed *et al*. 2013). The chemical composition and *in vitro* antimicrobial, antifungal and antioxidant properties of essential oils obtained from some aromatic herbs (*Coriandrum sativum*), celery (*Apium graveolens*) and bush-basil (*Ocimum minimum*) are widely used in Portugal. Coriander, bush basil and celery are a source of bioactive compounds and essential oils. Their antioxidant and antibacterial properties are appreciated in the food industry (Alves-Silva *et al*. 2013). Large amounts of *Flaveria bidentis* root culturing solution were obtained by using DFT (deep flow technique) equipment and the solution which was vacuum concentrated (10, 20 mg mL^{-1}) can have a certain inhibition on *Triticum aestivum*, *Cucumis sativus*, *Raphanus sativus*, *Amaranthus retroflexus*, *Setaria viridis*, *Chenopodium album*, *Echinochloa crusgalli* and *Chloris virgata* suggesting that some active compounds in the root exudates of *F. bidentis* can inhibit the germination, seedling elongation and root length (Yang *et al*. 2014). Under natural conditions plants are often subjected to multiple stress factors (Kovács *et al*. 2014). Foliage of coriander crop is a rich source of pro-vitamin-A carotenoids and phenolics of relevance to human health. The observations indicate that the precise use of plant growth regulators is a simple method for naturally augmenting the nutritionally important compounds in coriander crop (Divya *et al*. 2014).

Plants vary in their chemical composition and each plant species have some kind of effects on the other. In present study the allelopathic effects of randomly selected two plant species (red pepper and coriander) were investigated on the seedling growth of wheat (*T. aestivum*).

2. Materials and methods

The experiment was conducted to evaluate the effects of red pepper (*Capsicum annuum* L.) and coriander (*Coriandrum sativum*) on seedling growth performances of wheat (*Triticum aestivum* L.). *C. annuum* belongs to Solanaceae family and is commonly known as red pepper. Red peppers also belong to the group of foods bearing the Latin name of Capsicum. These peppers are usually red or green in color. *C. sativum* L. belongs to Apiaceae family with common name as coriander. The seeds of coriander are an excellent source of minerals like iron, copper, calcium, potassium, manganese, zinc and magnesium. Coriander leaves have been used as a food flavorant in various cuisines since ancient times (Ahmed *et al*. 2004). Both red pepper and coriander are used in cooking on daily basis. Wheat is recognized as the most ancient crop and it is also a major source of carbohydrate around the world. Wheat is the most agriculturally important cereal crop plant (Wu *et al*. 2012).

Different concentrations (1%, 2%, 3%, 4% and 5%) of powder extract were prepared by weighing both the spices (*C. annum* and *C. sativum*) and were suspending in distilled water. Like for 1% solution of red pepper or coriander powder 1 g of spice powder was suspended in 99 ml of distilled water by making the volume 100 ml, given the boiling so that red pepper powder and coriander powder extract into solution completely. pH of red pepper and coriander extract was recorded by pH meter. The seeds of wheat were purchased from the local market. Seedling growth performances of wheat were evaluated in pots in response to different concentration of red pepper and coriander powder extracts.

Experiment was conducted in garden soil by mixing one part of manure and three parts of garden soil. Seeds of wheat were soaked in distilled water for 24 hours then dried in air and were sterilized with 1% sodium hypochlorite (NaOCl) solution for 3 minutes then washed with distilled water. Ten seeds of wheat were placed in pots. There were five replicates of each treatment and the experiment was completely randomized. One centimeter deep holes were dug in soil from above surface of pots, (5 holes/pot and 10 seeds per pot with 2 seeds per hole) and buried into each hole. The surface of holes was covered by soil after placing the seeds inside the pots. Pots were irrigated daily with tap water. The pots were placed under sunlight for the seed germination and were moistened daily with water so as seeds germinated after two weeks with equal heights. The seedling was transplanted to pots growing one seedling in each pot and pots were irrigated daily. Germinated seedlings were then treated with different concentration (0, 1, 2, 3, 4, 5%) of red pepper and coriander extract. Control pots were provided with tap water. Ten milliliter of red pepper and coriander extract with the different concentration of 1, 2, 3, 4 and 5% were provided into the respective pots for the treatment. Leaf area was determined by leaf length X leaf breadth X 2 / 3. After 5 weeks of observations the seedlings were harvested. All the seedlings were carefully removed from the pots and washed thoroughly with water and root length, shoot length, and numbers of leaves were recorded. Harvested seedlings were placed in oven at 80°C for 24 hours for the complete dryness. Root dry weight, leaf dry weight, shoot dry weight and total plant dry weight were recorded. The experimental design was a randomized complete block with five replicates for each treatment and control. Pots were reshuffled weekly to avoid light/shade or any other environmental effect.

Root / shoot ratio, leaf weight, specific leaf area and leaf area ratio were determined by Rehman and Iqbal (2009).

Root / Shoot ratio = Root dry weight / Shoot dry weight
Leaf weight ratio = Leaf dry weight / Total plant dry weight
Specific leaf area (cm^2 g^{-1}) = Leaf area / Leaf dry weight
Leaf area ratio (cm^2 g^{-1}) = Leaf area / Total plant dry weight

Reduction in percentage of all growth data was determined using the following formula:
Reduction in growth (%) = Growth in control soil – Growth in treated soil / Growth in control soil × 100.

2.1 Soil analysis

Experimental soil containing one part of the manure and three parts of the garden soil was brought into the laboratory for the physical and chemical analysis. The soil samples were sieved so that the fine particles of soil were collected. The soil was analyzed to determine the maximum water holding capacity, soil organic matter, bulk density, total porosity, electrical conductivity and soil texture. All the data was statistically analyzed by ANOVA (Analysis of Variance) and DMRT (Duncan Multiple Range Test) at probability level of ($p < 0.05$) using personal software packages SPSS version 14.0.

3. Results

3.1 Growth of wheat supplied with red pepper and coriander powder extract

The allelopathic effects of extracts of red pepper and coriander on seedling growth of wheat as compared to control were observed (Tables 1-3; Figs. 1-5). The inhibitory effect on root, shoot, leaves and total dry weight (g) of *T. aestivum* was brought about by red pepper and coriander extract treatment at 1 to 5% as compared to control (Fig. 1). There was maximum number of leaves (5.8), leaf area (15.72 cm^2), root (24.77 cm), shoot (32.16 cm) and seedling length (56.93 cm) of *T. aestivum*. The number of leaves, leaf area, root, shoot and seedling length of *T. aestivum* was significantly decreased at 1% red pepper extract treatment as compared to control. The significant ($p < 0.05$) reduction in number of leaves, leaf area, root, shoot and seedling length of *T.*

aestivum was observed with the increase in red pepper extract treatment at 5% concentration as compared to control. The inhibitory effect in root, shoot, leaves and total dry weight (0.09 g) was brought about by red pepper extract treatment at 5% concentration as compared to root, shoot, leaves and total dry weight of *T. aestivum* in control treatment (Fig. 2). The root / shoot ratio, leaf weight ratio, specific leaf area $cm^2\ g^{-1}$, leaf area ratio $cm^2\ g^{-1}$ of *T. aestivum* was also affected by 5% of aqueous extract treatment of red pepper and coriander extract as compared to control. The root / shoot ratio, leaf weight ratio, specific leaf area $cm^2\ g^{-1}$, leaf area ratio $cm^2\ g^{-1}$ of *T. aestivum* was also affected by 5% of aqueous extract treatment of red pepper and coriander extract as compared to control (Table 1). Similarly, there was maximum number of leaves (4.60), leaf area

Table 1 Bioassay studies of aqueous extract of red pepper on root / shoot ratio, leaf weight ratio, specific leaf area ($cm^2\ g^{-1}$), leaf area (cm^2) and leaf area ratio ($cm^2\ g^{-1}$) of wheat (*Triticum aestivum*) as compared to control

Concentration (%)	Root / shoot ratio	Leaf weight ratio	Specific leaf area $cm^2\ g^{-1}$	Leaf area cm^2	Leaf area ratio $cm^2\ g^{-1}$
0	0.931 c ± 0.001	0.20 b ± 0.009	349.3 f ± 1.016	15.72 e ± 0.018	72.7 f ± 0.064
1	0.470 b ± 0.007	0.21 ab ± 0.003	175.8 e ± 2.71	7.21d ± 0.024	24.52 ± 0.022
2	0.480 b ± 0.007	0.21 b ± 0.006	115.25 a ± 0.240	4.61 c ± 0.015	22.12 a ± 0.090
3	0.460 ab ± 0.012	0.19 a ± 0.006	141.2 b ± 0.988	4.38 b ± 0.015	26.22 b ± 0.146
4	0.470 b ± 0.006	0.18 a ± 0.004	123.6 c ± 0.409	3.09 b ± 0.006	23.23 ± 0.073
5	0.430 a ± 0.021	0.21 c ± 0.018	157.8 d ± 3.017	3.0 a ± 0.0	33.33 e ± 0.041

Symbol used: ± = Standard Error
Number followed by the same letters on the same column are not significantly different ($p < 0.05$) according to Duncan's Multiple Range Test

Table 2 Bioassay studies of aqueous extract of coriander on root / shoot ratio, leaf weight ratio, specific leaf area ($cm^2\ g^{-1}$), leaf area (cm^2) and leaf area ratio ($cm^2\ g^{-1}$) of wheat (*Triticum aestivum*) as compared to control

Concentration (%)	Root / shoot ratio	Leaf weight ratio	Specific leaf area $cm^2\ g^{-1}$	Leaf area cm^2	Leaf area ratio $cm^2\ g^{-1}$
0	0.931 a ± 0.005	0.20 a ± 0.031	349.3 a ± 78.01	15.72 c ± 0.212	72.7 b ± 0.064
1	0.810 b ± 0.045	0.143 a ± 0.003	251.50 a ± 1.718	8.05 b ± 0.026	0.143a ± 0.022
2	1.03 a ± 0.001	0.19 a ± 0.005	200.0 a ± 45.33	8.0 b ± 0.064	0.197 a ± 0.001
3	0.660 a ± 0.018	0.124 a ± 0.02	251.50 a ± 1.08	7.83 b ± 0.061	0.124 a ± 0.001
4	0.750 a ± 0.026	0.170 a ± 0.008	250.0 a ± 7.07	7.0 a ± 0.006	0.112a ± 0.001
5	0.590 a ± 0.008	0.138 a ± 0.001	310.0 a ± 0.930	6.51 a ± 0.40	0.138a ± 0.002

Symbol used: ± = Standard Error
Number followed by the same letters on the same column are not significantly different ($p < 0.05$) according to Duncan's Multiple Range Test

Table 3 Percentage reduction in seedling growth of wheat (*Triticum aestivum*) in aqueous extract of red pepper (*) and coriander (**) treatment on root, shoot, seedling length (cm), number of leaves, leaf area (cm^2), root dry weight, shoot, leaf dry weight and total plant dry weight (g) as compared to control

Growth parameter	Concentration (%)				
	1	2	3	4	5
Root length (cm)	*51.67 **32.74	53.1 4.32	56.27 37.02	60.19 29.35	63.26 58.57
Shoot length (cm)	0.06 28.48	6.72 15.45	9.26 8.24	23.10 7.27	25.27 28.17
Seedling length (cm)	25.69 30.33	26.89 10.61	29.72 20.76	39.24 16.88	41.85 41.40
Number of leaves	13.79 8.10	13.79 13.79	17.24 17.24	24.13 18.62	31.03 20.68
Leaf area (cm^2)	54.13 48.79	70.67 49.10	72.13 50.19	80.34 55.47	80.91 58.58
Root dry weight (g)	6.45 45.16^+	9.67 29.03^+	16.1 25.81^+	35.40 0	41.93 3.22
Shoot dry weight (g)	10.7 4.28^+	14.28 12.14	21.42 28.57^+	37.14 25	62.14 27.85
Leaves dry weight (g)	8.89 28.89	11.11 11.11	31.11 31.11	44.44 37.78	57.58 53.30
Total plant dry weight (g)	9.72 3.24^+	12.96 6.01	22.68 15.70^+	38.42 24.07	58.33 29.62

* = Red pepper powder extract treatment
** = Coriander powder extract treatment
\+ = Percent increase over control

(6.51 cm^2), root (10.26 cm), shoot (33.36 cm) and seedling length (10.26 cm) of *T. aestivum* was observed with 5 % coriander extract treatment (Fig. 3). 1% treatment of coriander extract significantly ($p < 0.05$) produced inhibitory effect on root, shoot, leaves and total dry weight of *T. aestivum* as compared responded differently to seedling growth performance of *T. aestivum* as compared to co to control (Fig. 4). The significantly ($p < 0.05$) inhibitory effect on root, shoot, leaves and total dry weight of *T. aestivum* was brought about by coriander extract treatment at 5% as compared to control (Fig. 4). The root / shoot ratio, leaf weight ratio, specific leaf area cm^2 g^{-1}, leaf area ratio cm^2 g^{-1} of *T. aestivum* was also affected by 5% of aqueous extract treatment of coriander extract treatment as compared to control (Table 2). Aqueous extract treatment of red pepper and coriander at higher concentration ntrol. High percentage of decrease in root length (63.26%), seedling length (25.27%), number of leaves (31.03) and leaf area (80.91) of *T. aestivum* was observed at 5% treatment of red pepper as compared to control. Seedling dry weight of *T aestivum* also predominantly decreased at 5% concentration of red pepper treatment as compared to control (Table 3).

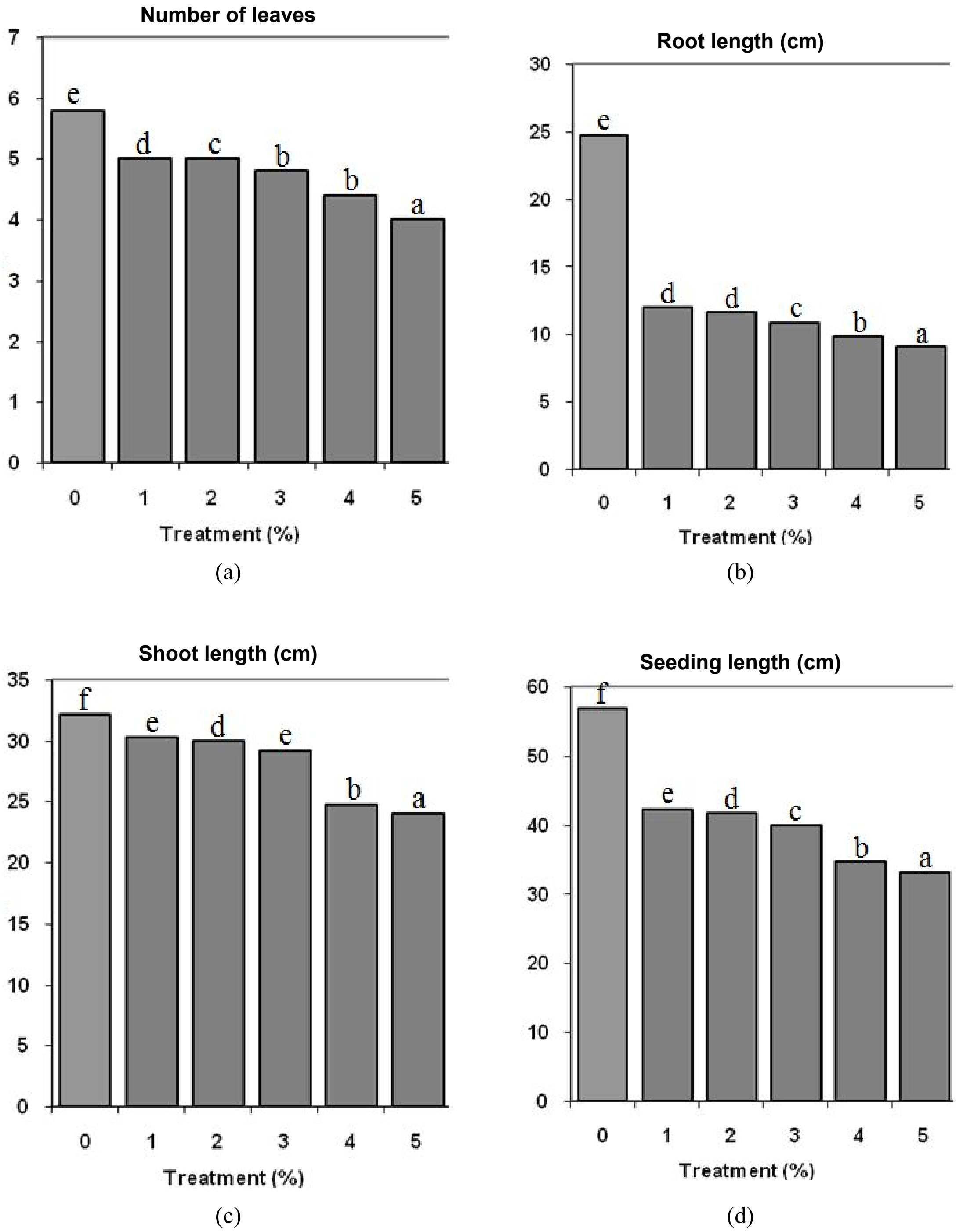
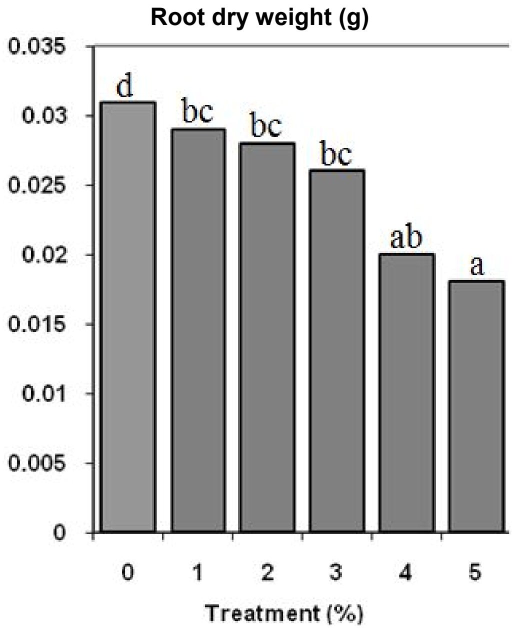


Fig. 1 Effects of different concentration (0, 1, 2, 3, 4, 5%) of red pepper (*Capsicum annuum*) powder extract treatment on number of leaves, root length (cm), shoot length (cm) and seedling length (cm) of wheat (*Triticum aestivum*) as compared to control (0%). Number followed by the same letters on the same bar are not significantly different ($p < 0.05$) according to Duncan's Multiple Range Test



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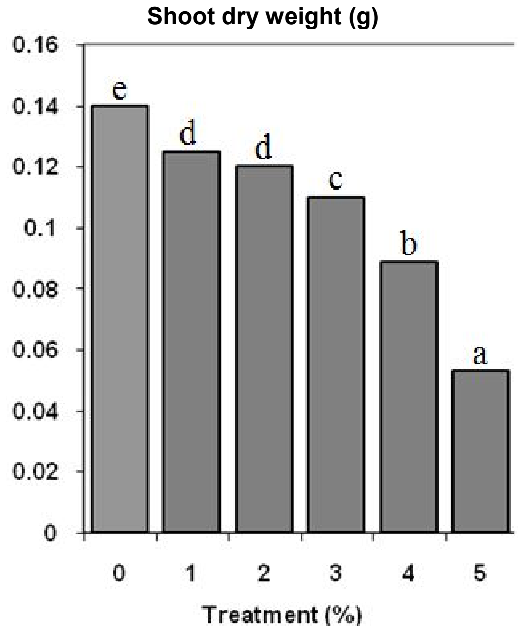

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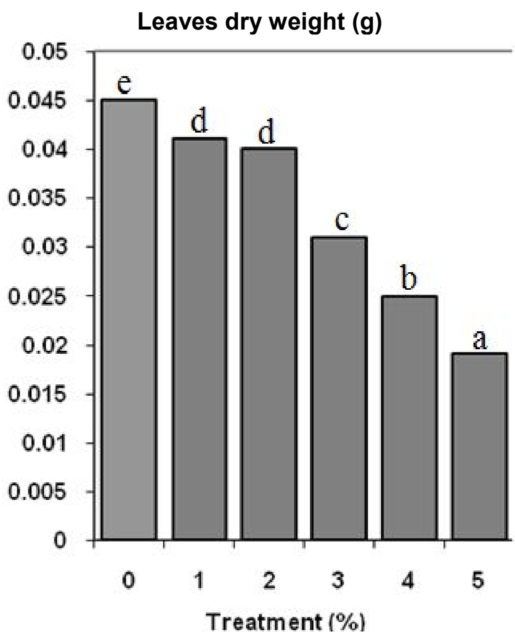

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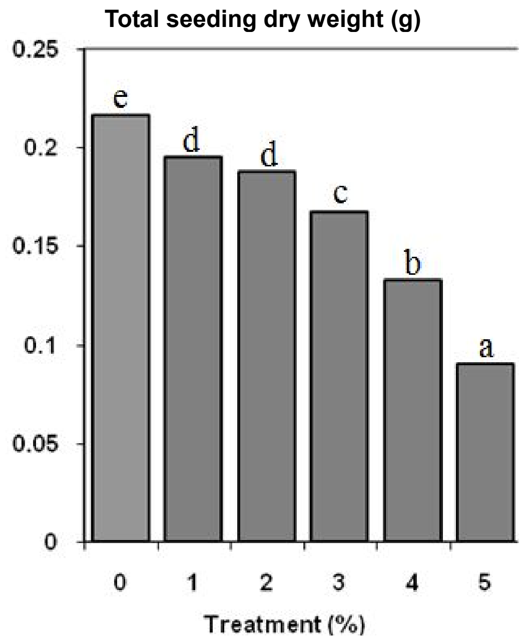

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Fig. 2 Effects of different concentration (0, 1, 2, 3, 4, 5%) of red pepper (*Capsicum annuum*) powder extract treatment on root, shoot, leaves and seedling dry weight (g) of wheat (*Triticum aestivum*) as compared to control (0%). Number followed by the same letters on the same bar are not significantly different ($p < 0.05$) according to Duncan's Multiple Range Test

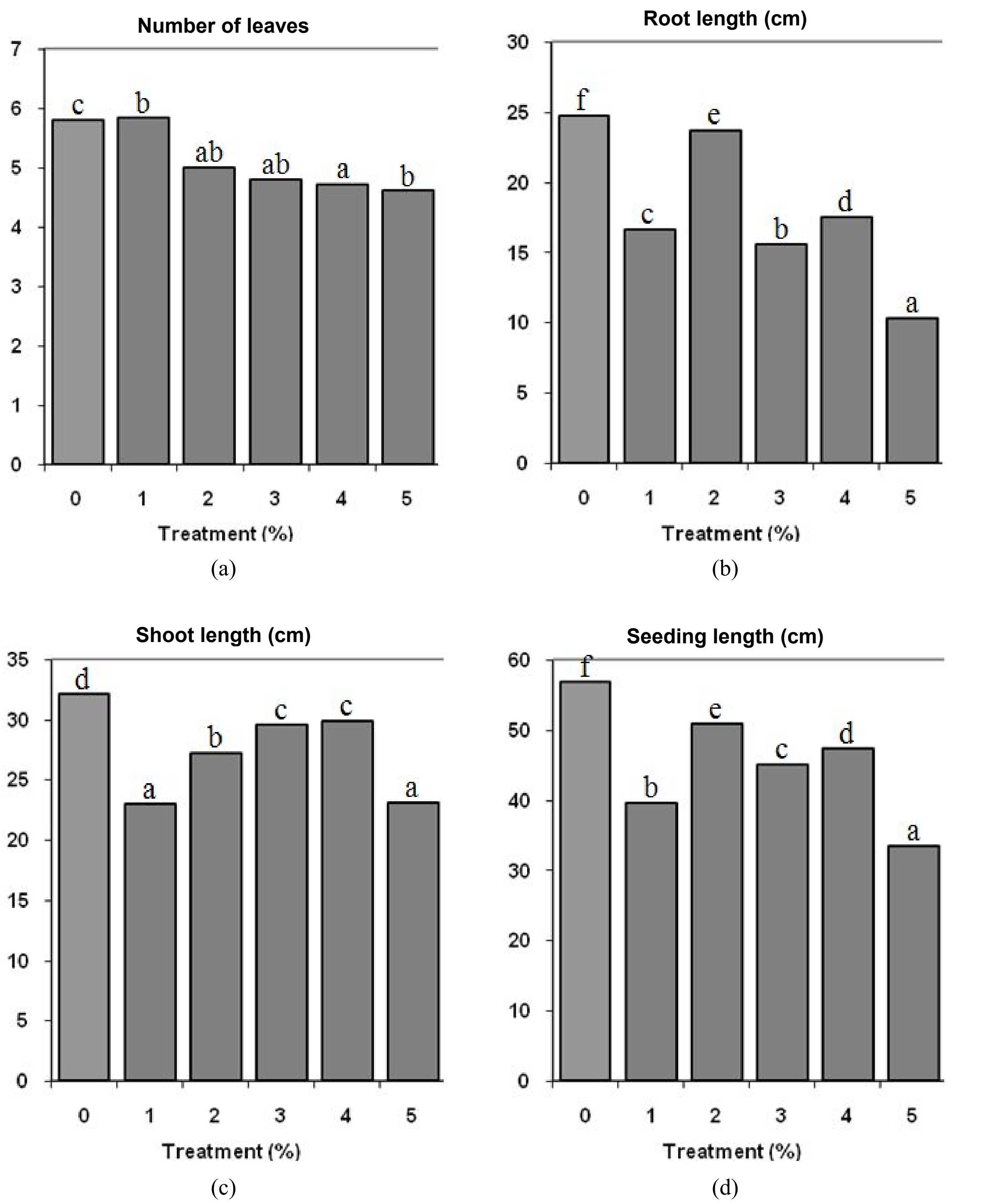
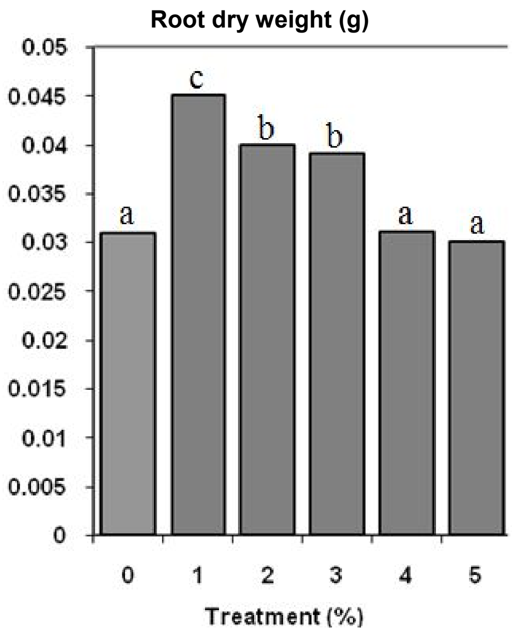


Fig. 3 Effects of different concentration (0, 1, 2, 3, 4, 5%) of coriander (*Coriandrum sativum*) powder extract treatment on number of leaves, root, shoot and seedling length (cm) of wheat (*Triticum aestivum*) as compared to control (0%). Number followed by the same letters on the same bar are not significantly different ($p < 0.05$) according to Duncan's Multiple Range Test



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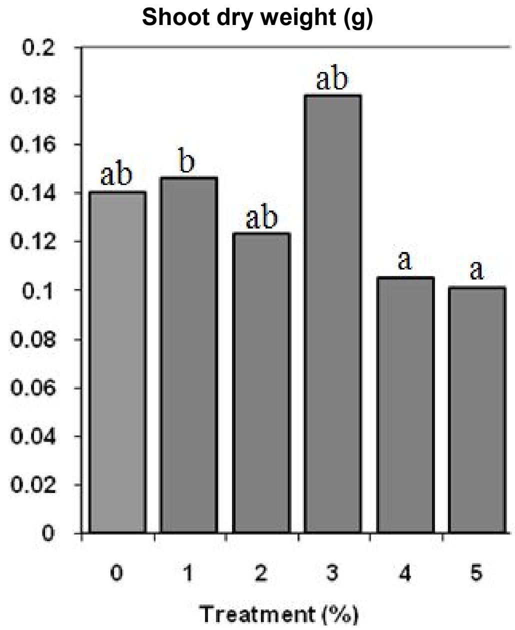

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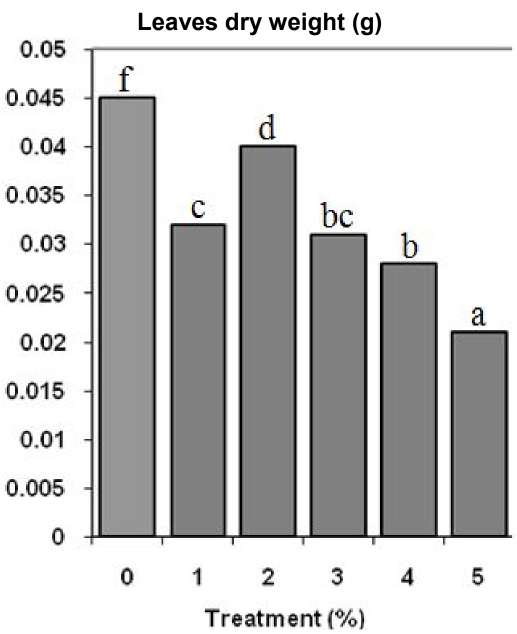

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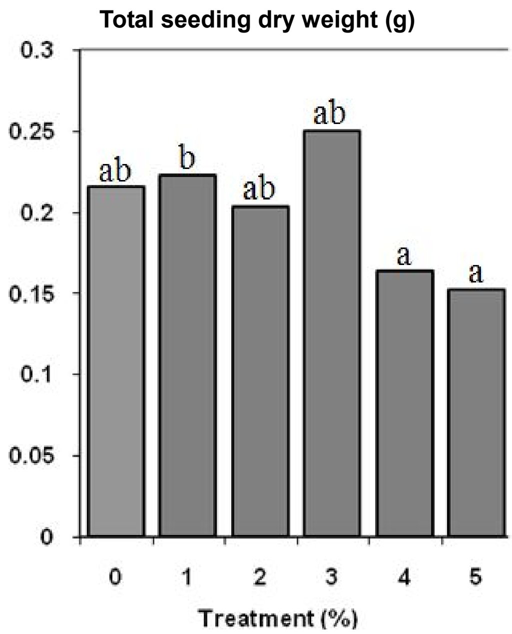

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Fig. 4 Effects of different concentration (0, 1, 2, 3, 4, 5%) of coriander (*Coriandrum sativum*) powder extract treatment on root, shoot, leaves and seedling dry weight (g) of wheat (*Triticum aestivum*) as compared to control (0%). Number followed by the same letters on the same bar are not significantly different ($p < 0.05$) according to Duncan's Multiple Range Test

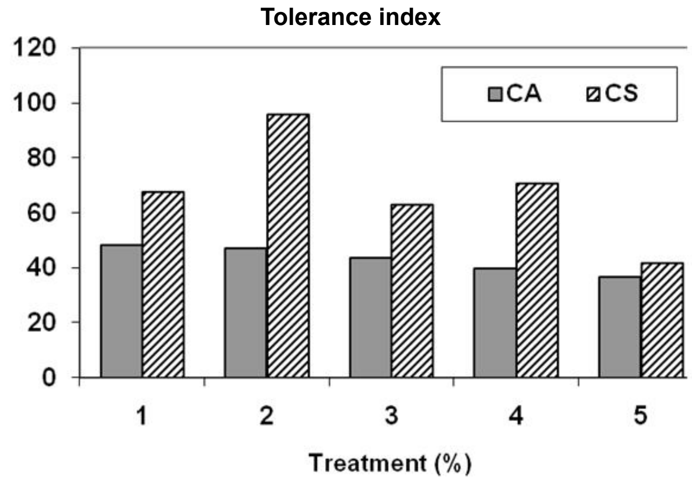

Fig. 5 Percentage of tolerance in wheat (*Triticum aestivum*) seedlings against different concentration (1, 2, 3, 4, 5%) of red pepper (CA = *Capsicum annum*) and coriander (CS = *Coriandrum sativum*) powder extract (1-5%) as compared to control

Table 4 pH of red pepper and coriander extracts powder

pH	Concentration (%)				
	1	2	3	4	5
Red pepper	7.29	7.16	6	6.03	6.05
Coriander	7.46	7.32	7.42	7.91	8.06

In present study the tolerance by red pepper and coriander powder extract to the seedlings of *T. aestivum* was observed with the help of tolerance indices (Fig. 5). In tolerance studies, the aqueous extract of red pepper and coriander showed a gradual decreased the percentage of tolerance index of *T. aestivum* seedlings. The reduction in percentage of tolerance in seedlings of *T. aestivum* was found concentration dependent of red pepper and coriander. Bioassays indicated that increase in concentration of red pepper and coriander treatments have strong effects on the tolerance indices of *T. aestivum* seedlings as compared to control. Red pepper extract treatment at 2, 3, 4 and 5% showed tolerance indices by 46.91, 43.72, 39.80 and 36.73 in seedlings of *T. aestivum*) as compared to control. Maximum tolerance in seedling growth of *T. aestivum* was recorded at 1% concentration of red pepper. Similarly different concentrations of coriander treatment affected tolerance indices of *T. aestivum* seedlings at 1, 2, 3, 4% and 5%. Lowest tolerance in seedling growth of *T. aestivum* was recorded at 5% concentration of coriander. Coriander extract treatment at 5% showed more tolerance than red pepper extract at same concentration of 5%.

3.2 pH of red pepper and coriander powder extracts

pH values of red pepper and coriander powders were recorded by pH meter. pH of different concentrations of red pepper powder extracts showed neutral to acidic pH values while pH of coriander extracts showed neutral to basic pH values (Table 4).

Table 5 Physical and chemical characteristics of garden soil

Soil type	E.C. dS^{-}	$CaCO_3$ (%)	O.M (%)	M.W.H.C. (%)	B.D. g^{-cc}
Loam	0.80	0.89	0.16	40.24	1.21

E.C. = Electrical Conductivity, $CaCO_3$ = Calcium Carbonate, B.D. Bulk Density
M.W.H.C. = Maximum water holding capacity of soil

3.3 Physical and chemical characteristics of garden soil

Textural class of garden soil was loam. Garden soil was chemically analysed. Electrical conductivity of soil was low (0.80 dS^{-1} cm) due to the absence of excessive salts. Low concentration of calcium carbonate (0.89%) was found in soil. Organic matter (0.16%), maximum water holding capacity of soil (40.24%), bulk density (1.21 g^{-cc}) was recorded (Table 5).

4. Discussion

In present study the phytotoxic effects of red pepper and coriander on seedling growth of *T. aestivum* were observed. Extracts of red pepper and coriander on *T. aestivum* were applied singly at 1, 2, 3, 4 and 5% concentration. Seedling growth performance of *T. aestivum* in response to red pepper and coriander extract treatment was found different as compared to control treatment. This variation in seedling growth seems attributable to a differential concentration of red pepper powder extract as compared to control treatment, which ranged from 0 to 5%. Allelopathy, classically defined as the inhibition of the growth or germination of one plant by another through the release into the environment of selectively toxic metabolic by-products, is one of the less studied interactions that may occur among plant species growing together, when it comes to account for the maintenance of high plant diversity (Mongelli *et al*. 1997).

Effects of leachates from plants, plant extracts and decomposing plant residues have been the focus of several investigators concerned with the role of allelopathy in agriculture (Das *et al*. 2012). The potent phytotoxic compounds occur naturally in plant (Kuti *et al*. 1990) and respond differently to nature of toxicity. The aqueous extracts concentrations of red pepper and coriander at 1% decreased the seedling growth of *T. aestivum* as compared to control. The inhibitory substances from spices (red pepper and coriander) are apparently released in the substrate were responsible for reduction in seedling growth performances of *T. aestivum*. The allelopathic effect of different concentration of water extract of *Prosopsis juliflora* leaf on seed germination and radicle length of wheat (*T. aestivum* Var-Lok-1) was reported (Siddiqui *et al*. 2009). Ells and McSay (1991) reported allelopathic effects of alfalfa plant residues on emergence and growth of cucumber seedlings. In another investigation the aqueous extracts of *Miscanthus transmorrisonensis* plant parts showed significant phytotoxic effects on radicle growth of rye grass, lettuce, and two varieties of chinese cabbage (Chou and Lee 1991). In an investigation the allelopathic effect of sweet potato (*Ipomoea batatas*) cultivars on certain weed and vegetable species was also reported (Reinhardt *et al*. 1993). Red pepper and coriander treatment at 1 and 2% produced more inhibition in root and shoot growth of *T. aestivum* when compared to control using distilled water. Similarly inhibition of root and shoot growth in rice, ground nut and corn due to allelopathic potential of *Rhizophora apiculata*, bamboo and *Eucalyptus* was recorded by Eyini *et al*. (1989), Jayakumar *et al*. (1990) and Rajangam (1984). Coriander powder extract treatment at low concentration 1% slightly increased the seedling dry weight of *T. aestivum* as compared to control. The allelopathic effects of wormwood plants (*Artemisia princeps* var. orientalis) and their possible phytotoxicity on receptor species were investigated. The aqueous extracts of mature leaf, stem, and root of wormwood plants caused significant inhibition in germination and decreased seedling elongation of receptor plants, whereas germination of some species was not inhibited by extracts of stems and roots. Dry weight growth was slightly increased at lower concentrations of the extract, whereas it was proportionally inhibited at higher concentrations (Kil and Yun 1992). Much attention has been paid in the last few years to the influence of toxicants both on the growth of one population and on the competition of two species for a critical nutrient (Fergolaa *et al*. 2007). Interference of allelochemicals presents in some multipurpose trees on growth and development of adjoining crops necessitate the evaluation of the compatibility of the tree with various crops before integration into an agroforestry system (Amoo *et al*. 2008). The allelopathic potential of *Tetrapleura tetraptera*, a multipurpose tree, using aqueous leaf extracts at different concentrations in laboratory bioassays has been reported. The extracts stimulated production of lateral roots in tomato *Lycopersicon esculentum* but inhibited it in okra (*Abelmoschus esculentum*). The extract significantly reduced shoot length at 25% concentration and above in *Amaranthus spinosus*. However, both shoot and root lengths of *Capsicum annum* were significantly inhibited at all extract concentrations up to 79 and 73% respectively. Significant inhibition of root length at almost all concentrations in all the bioassay species showed that root length is a more sensitive indicator of phytotoxic activity.

5. Conclusions

The detailed study revealed that red pepper and coriander aqueous extract treatment affected seedling growth performance of wheat as compared to control. The release of toxic compounds from red pepper and coriander extract showed strong allelopathic potential activity and characterized from reduction in seedling growth performance of wheat. Similar observation on the phytotoxic effect of invasive weed, *Ageratum conyzoides* on chickpea (*Cicer arietinum*) was observed. Weed residues amended in the soil significantly reduced the chickpea growth. Root length, plant height and biomass of chickpea were lower in the soils amended with below- or above-ground weed residues and concluded that reduction in chickpea growth was due to the presence of phytotoxic phenolics in the residues (Batish *et al*. 2006). Each plant species has potential of release of different chemical compounds in immediate environment and produced different kinds of effects on neighboring plants. Leachates from plants have been shown to suppress seed germination and early seedling growth (Alagesaboopathi 2011, Sidiqui *et al*. 2009). The results of this study will be helpful in increasing the knowledge on the allelopathic potential of red pepper and coriander on wheat. The plants growing in the surrounding areas have different capacity of tolerance to these chemical compounds. It is concluded that the wheat seedling showed greater tolerance to randomly selected species of red pepper than coriander extract treatment. It was also concluded that that seedling growth of wheat was found sensitive to higher concentrations of extract of red pepper and coriander showing its inhibitory allelopathic effect.

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