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Allelopathic effects of bermuda grass (*Cynodon dactylon* L. Pers.) extract on germination and seedling growth of basil (*Ocimum basilicum* L.) and common purslane (*Portulaca oleracea* L.)

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Abstract

Allelopathy is a natural phenomenon that refers to any direct or indirect positive or negative effect of one plant on another through the release of chemical compounds excreted into the environment. In order to evaluate the allelopathic effects of the Bermuda grass (*Cynodon dactylon* L.) extract on germination and early growth of Basil (*Ocimum basilicum* L.) and Common purslane (*Portulaca oleracea* L.), an experiment was conducted in Research station of Islamic Azad University, Isfahan (Khorasgan) branch in 2013. The experiment was arranged as a factorial in a completely randomized design with three replications. The experiment consisted of four stubble concentrations (control, 25, 50 and 100 g/L) along with Basil and Common purslane plants. The results obtained showed that the allelopathic effects of the Bermuda grass extract on coleoptile length, radicale length, coleoptile weight and radicale weight of Basil and Common purslane were significant but for germination percent was non-significant. The results of this research revealed that increasing in extract concentration lead to decrease seedling growth of Basil and Common purslane. Our results showed that Bermuda grass extract had strong allelopathic and inhibitory effects on different traits of Basil and Common purslane.

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Introduction

Allelochemicals are metabolic by-products of certain plants that, when introduced into the environment, cause growth inhibition by affecting physiological processes such as respiration, cell division, and water and nutrient uptake. Symptoms of allelopathic effects include leaf wilting and yellowing, or death of part or all of a plant (Willis, 1985). Bermuda grass (*Cynodon dactylon* L. Pers.) is one of the most important weed family Poaceae is a native to North and East Africa, Asia, Australia and Southern Europe. The blades are a grey-green colour and are short, usually 2–15 cm long with rough edges. Bermuda grass reproduces through seeds, runners, and rhizomes and 2n=36. Bermuda grass is a weed that widely dispersed throughout the world and is one of the most dangerous weed and is considered had the fourth most allelopathic compounds (Nelson, 2005).

Sweet basil (*Ocimum basilicum* L.), a member of the family Lamiaceae, is a tender summer and herbaceous annual plant, 20 to 70 cm in height, which originates from tropical and warm areas, such as India, Africa and southern Asia (Marotti *et al.,* 1996). Common purslane (*Portulaca oleracea* L.) is an annual succulent in the family Portulacaceae, which may reach 40 cm in height (Byrne and McAndrews, 1975). Bermuda grass extract decreased 71% and residual 81% of wheat yield (Yarnia 2000). Abdul- Rehman and Habib (2005) reported that Residues of Bermuda grass stopped seed germination and growth of (*Leptochloa fusca*). Czarnota *et al.*(2001) working with *Sorghum* spp. found that sorgoleone, a potent inhibitor of chlorophyll formation, was detected in root extracts. Besides, the Sorghumspecies, including Johnsongrass were found to produce and release cyanogenic glycosides and phenolic acids that can contribute to the suppression of plant growth (Sene *etal.*, 2001). In other studies, Bermuda grass residue reduced dry weight of several annual vegetable and agronomic crops (Meissner *et al.,* 1989). Bermuda grass residue also reduced radicle growth of barley (*Hordeum vulgare* L.), mustard (*Brassica juncea* L.) and wheat (*Triticum aestivum* L.) (Friedman and Horowitz, 1970).

Therefore, in this study, the allelopathic effects of Bermuda grass (*Cynodon dactylon* L.Pers.) extract on germination and seedling growth of Basil (*Ocimum basilicum* L.) and Common purslane (*Portulaca oleracea* L.) was studied under laboratory conditions.

Materials and methods

Laboratory experiments

In order to evaluate the allelopathic effects of Bermuda grass (*Cynodon dactylon* L. Pers.) extract on seed germination and seedling growth of Basil (*Ocimum basilicum* L.) and Common purslane (*Portulaca oleracea* L.) an experiment was conducted in germinator conditions in the laboratoryin Islamic Azad University of Isfahan (Khorasgan). In order to prepare an extract of Bermuda grass shoots and leaves were collected from field in Islamic Azad University of Isfahan (Khorasgan) in 2013end of growing season and were dried in open air, then ground into powder form. In a next stage the powder prepared from Bermuda grass was mixed with distilled water (1 portion of powder and 9 portions of distilled water). The 10% weight volume aquatic solution mixture was used to follow the tests after a pass time of 72 hours. The desired concentrations, namely: 25%, 50% and 100% were prepared through addition of distilled water. Petry dish and filter paper were employed for seeds to be grown on. Three hundred seeds Basil and three hundred seeds Common purslane were sowed in 24 petri dishes for each treatment and each petry dish contained 25 seeds. Basil and Common purslane seeds were first surface-sterilized in 2% sodium hypochlorite for 2 min, and then rinsed in sterile distilled water for three times. Germinator with 12 hours light per day, and a 20/10 °C day/night temperature regime. The number of germinated seeds were recorded during an 8 day duration. After 14 days, radical and coleoptile length and radicale and coleoptile fresh weights were measured.

Statistical analysis

The experiment was arranged as a factorial in a completely randomized block design with three replications. The data was statistically analyzed by Minitab15 software based on the statistical model of completely randomized design. Logarithmic transformation was employed for normalization the data. Means of the traits were compared by Duncan's multiple range test at P≤0.05 level. The graphs were drawn using EXCEL2007.

Results and discussion

Seed germination percent

The results of variance analysis showed that the allelopathic effects of the Bermuda grass extract on seed germination percent of Basil and Common purslane not was significantly (Table 1). However, germination percentage not was significantly reduced with concentration 100% (Fig. 1). According to Fig. 1, it can be seen that there is no significant difference observed in germination for control as well as for 25%, 50% and 100% treatment. There were no significant difference observed among 25%, 50% and 100% treatments as germination is concerned.

Coleoptile and radicale length

The results of variance analysis showed that the allelopathic effects Bermuda grass extract on coleoptile and radicale length of Basil and Common purslane were significantly (Table 1).

Table 1. The variance analysis results of allelopathic effects of the Bermuda grass extract on the growth parameters of Basil and Common purslane.

S.V	df	Seed germination	Coleoptile length	Radicale length	Radicale weight	Coleoptile weight
Concentrations (A)	3	16.43^{ns}	11.31**	21.14**	0.76**	0.21**
Plants (B)	1	13.54^{ns}	1.68**	15.91**	1.51**	0.78**
Interaction (A*B)	3	21.65^{ns}	0.24^{ns}	0.84^{ns}	0.041^{ns}	0.98**
Error	16	18.55	1.64	1.25	1.1531	0.009
CV(%)	-	21.70	21.08	20.3	33.8	27.2

$^{n.s}$, *, **: non-significant, Significant at 0.05 and 0.01 probability levels, respectively.

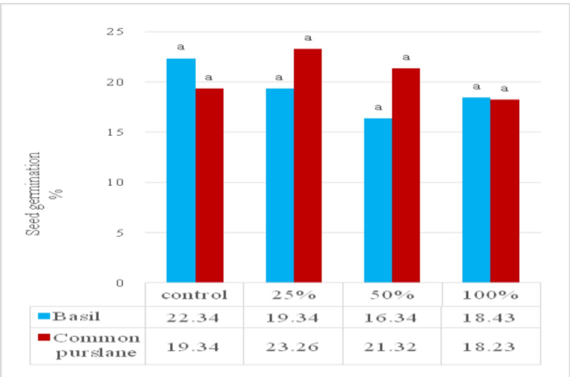

Fig. 1. Comparison of interaction effects of the Bermuda grass extract on seed germination of Basil and Common purslane.

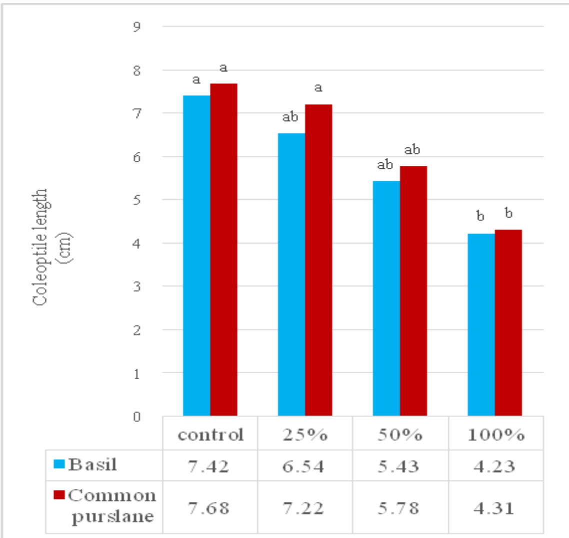

Fig. 2. Comparison of interaction effects of the Bermuda grass extract on coleoptile length of Basil and Common purslane.

Table 2 and Fig. 2 indicated that all extracts significantly reduced coleoptile length of Basil and Common purslane, In particular, highest inhibitory effect was found at a concentration of 100%.

Table 2. Comparison of inhibiting effect of the Bermuda grass extract on the growth parameters.

Concentrations	Seed germination (%)	Coleoptile length (cm)	Radicale length (cm)	Radicale weight (g)	Coleoptile weight (g)
Control	20.85a	7.37a	7.89a	0.56a	1.5a
25%	21.02a	6.71ab	5.8b	0.4a	1.32b
50%	17.85a	5.6bc	4.65bc	0.25a	0.94c
100%	18.41a	4.24c	3.5c	0.14a	0.75d

Means in each column followed by the same letter are not significantly different (*P* <0.05).

Table 2 and Fig. 3 indicated that all extracts significantly reduced radicalelength of Basil and Common purslane, In particular, highest inhibitory effect was found at a concentration of 100%.

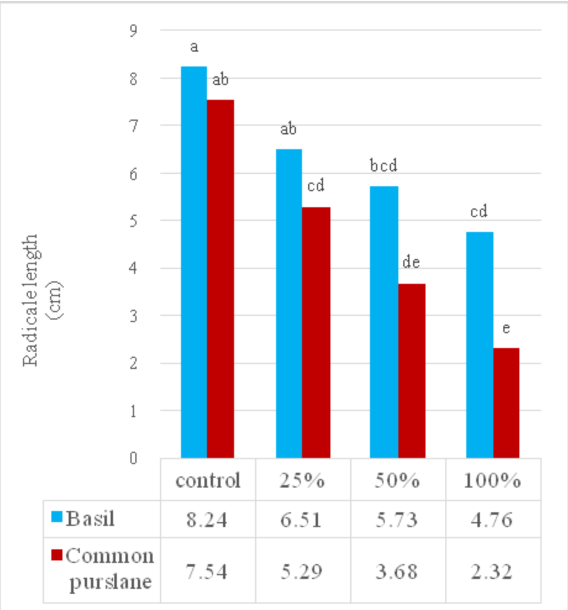

Fig. 3. Comparison of interaction effects of the Bermuda grass extract on radicale length of Basil and Common purslane.

Radicale and coleoptile fresh weights

The results of variance analysis showed that the effect of Bermuda grass extract on radicale and coleoptile fresh weights of Basil and Common purslane is significant at 1% level (p<0.01) (Table 1).

Table 2 and Fig. 4 indicated that all extracts significantly reduced radicale fresh weights of Basil and Common purslane, In particular, highest inhibitory effect was found at a concentration of 100%. Table 2 and Fig. 5 indicated that all extracts significantly reduced coleoptile fresh weights of Basil and Common purslane, In particular, highest inhibitory effect was found at a concentration of 100%. The comparision between the average traits proved that by increasing the concentration of extract (100 g/L), the coleoptile and radicale length and radicale and coleoptile fresh weights compared with the control of Basil and Common purslane. According to comparison of interaction effects Bermuda grass extract results, the lowest seed germination percent (18.23%)of Common purslane was obtained from concentration of extract (100 g/L) (Fig. 1), but the lowest germination percent (16.34%)of Basil was obtained from concentration (50 g/L) (Fig. 1). The lowest coleoptile length (4.31 cm)of Common purslane and lowest coleoptile length (4.23 cm) of Basil were obtained from concentration of extract (100 g/L) (Fig. 2).

The lowest radicale length (2.32 cm)of Common purslane and lowest radicale length (4.76 cm) of Basil were obtained from concentration of extract (100 g/L) (Fig. 3). The lowest radicale fresh weights (0.49 g) of Common purslane and lowest radicale fresh weights (1.01 g) of Basil were obtained from concentration of extract (100 g/L) (Fig. 4). The lowest coleoptile fresh weights (0.11 g) of Common purslane and lowest coleoptile fresh weights (0.18 g) of Basil were obtained from concentration of extract (100 g/L) (Fig. 5). This under laboratory conditions study suggests that higher amounts of extracts of Bermuda grass may decrease Common purslane yield,in comparison with Basil (Table 3).

Table 3. Comparison of Basil and Common purslane for the growth parameters.

	Seed germination (%)	Coleoptile length (cm)	Radicale length (cm)	Radicale weight (g)	Coleoptile weight (g)
Basil	18.79a	5.73b	6.3a	0.51b	0.38b
Common purslane	20.28a	6.26a	4.6b	0.16a	0.8a

Means in each column followed by the same letter are not significantly different (P <0.05).

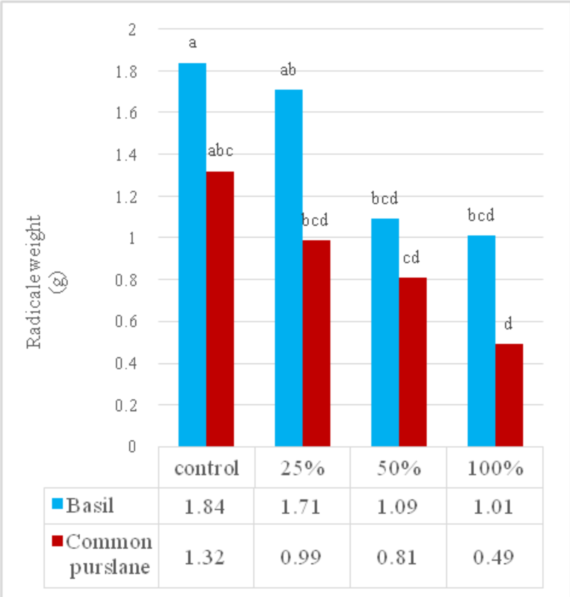

Fig. 4. Comparison of interaction effects of the Bermuda grass extract on radicale weight of Basil and Common purslane.

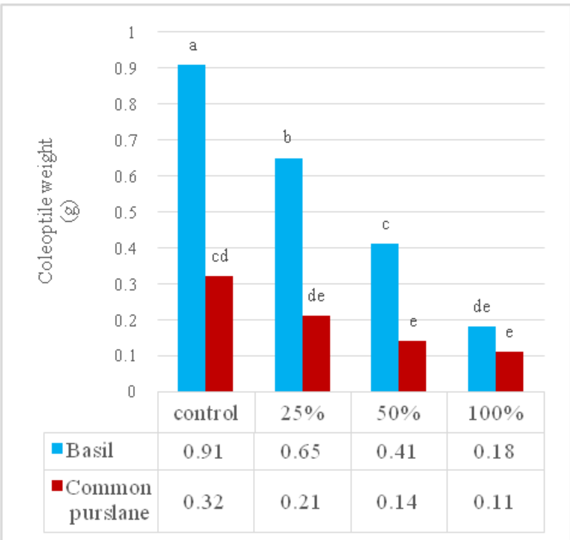

Fig. 5. Comparison of interaction effects of the Bermuda grass extract on coleoptile weight of Basil and Common purslane.

Allelopathy is in fact an interference mechanism in which live or dead plant materials release chemical substances, which inhibit or stimulate the associated plant growth. Several researchers have shown that allelopathy plays an important part in weed and weed interaction (Jabeen and Ahmed, 2009).The results showed that Bermuda grass extract had strong allelopathic effects and inhibited of Basil and Common purslane. Because allelopathic effects depend on several factors such as decaying, retention, transformation concentration and soil conditions. Processes such as retention, transformation and transport may affect the active concentration of allelochemicals and hence allelopathic effects in the soil (Cheng, 1995). Phenolic acids that the most important compounds in weeds can reduce the growth of roots, leading to reduction mineral absorption and transport of food to other parts of the plant (El-Khatib *et al.*, 2004). Root cells growth is done by apical meristem cells growth and division. Parameters which induced root apical cells growth, which primary meristems is located in, could severely affected by allelopathic compounds and almost stop its growth and resulted in reduction root longitudinal growth and dry mater accumulation in root. Some of allelopathic substances such as coumarinsby lowering cells mitosis division rate decreases roots longitudinal growth (El-Khawas and Shehata, 2005).

Bermuda grass extract in different concentration decreased germination, root and shoot growth of wheat 39%, 68% and 83%, respectively. Also, root and shoot residues of Bermuda grass and their extract decreased significantly germination, primary growth, biomass, moisture and chlorophyll content of wheat, barley and corn (Alam *et al.*, 2001). Bermuda grassextract also stopped seed germination, of foxtail, cotton, and barnyard grass. Under field conditions, growth of cotton is decreased 50% by Bermuda grass residues. The growth of barley, mustard, and wheat radicles was decreased by the residues of Bermuda grass (Vasilakoglou *et al.,* 2005).Research carried out in recent years proved that the Bermuda grass reduces peach trees (Smith *et al.*, 2001). Mokhtar hossein *et al.*(2012) also found that germination rate of bean is reduced by increasing of water extract concentration. Salam and Kato-Noguchi (2010) reported that extracts of allelopathic plants are more effective in inhibiting radicle growth than hypocotile growth because radicle is the first organ that absorbs the allelochemicals. Moreover, root tissue is more permeable to allelochemicals than aerial organs (Nishida *et al.,* 2005). Reduction in radicle length by allelochemicals is due to the effects of these substances on reduction of cell division, reduction in auxine which induces root development and disturbance of respiration (Maighany *et al.*, 2005; Gholami *et al.*, 2012).

Conclusion

In generally, it can be stated that Bermuda grass exerts allelopathic effects on coleoptiles and, radicale length, coleoptile and radicale weight of Basil and Common purslane. Also inorder to better realize and more accurately find out about the effect of Bermuda grass plant on Basil and Common purslane, different concentrations of the extract can be tested. It is also suggested to study the allelopathic effect of Bermuda grass (*Cynodon dactylon* L. Pers.) on other plant species of the region as well.

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