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Phytotoxic activity of *Tecomella undulata* (Sm.) Seem extracts on some ornamental plants

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ABSTRACT

Tecomella undulata is an ecologically and economically important tree in arid areas of southwestern Asia. It has important ornamental and medicinal uses. In this study, aqueous extracts from roots, leaves, inner stem barks and flowers of *T. undulata* were studied for their allelopathic effects on seed germination and early seedling growth of four important monocotyledonous and dicotyledonous ornamental plants. The flower and root extracts of *T. undulata* significantly ($P < 0.05$) inhibited germination of tall fescue (*Festuca arundinacea* Schreb.) and perennial ryegrass (*Lolium perenne* L.) seeds, but leaf and inner stem bark extracts had no significant effects on either of these turf grasses. The allelopathic inhibition was greater for root extracts than flower extracts, and increased with higher root extract concentrations. The germination of cocks comb (*Celosia argentea*) and rose moss (*Portulaca grandiflora*) seeds were not inhibited by the application of *T. undulata* extracts. The results showed that the extracts of *T. undulata* have allelopathic effects on seed germination and seedling growth of the two monocotyledonous plants tested but not with the two dicotyledonous plants tested. *T. undulata* extracts may have selective potential for natural weed control.

1. Introduction

Tecomella undulata (Sm.) Seem, locally known as Semeng, is an ecologically and economically important tree in arid areas of southwestern Asia. It has important ornamental and medicinal uses. In Iran, its natural forests occur in the southwestern and southern parts of the country. At the time of flowering (April-May), it produces beautiful showy flowers in yellow and orange colors. Biochemical analysis indicated that *T. undulata* plant parts have lapachol, oleanolic, ursolic and betulinic acids, compounds (Karami and Salehi, 2010; Kalia et al., 2014). Approximately, in all of plants allelochemicals are present in their tissues such as leaves, roots, stems, bark, buds, flowers and seeds (Weston and Duke, 2003). The useful or hurtful allelopathy effects on one plant, crop and weeds species released from plant parts by residue decomposition, volatilization, leaching, root exudation and other processes in both natural and non-natural systems (Ferguson and Rathinasabapathi, 2009). Root derived compounds have the capability to normalize the soil microbial population and the soil chemical and physical characteristics, affecting the growth of neighboring plant species (Ens et al., 2009). The leaf aqueous extraction of *Prosopsis juliflora* contains water-soluble allelochemicals. This could inhibit the seed germination and reduce radical length of wheat (Siddiqui et al., 2009). Mutlu and Atici (2009) reported that aqueous extracts prepared of roots and leaves of *Nepeta meyeri* Benth. on seed germination and seedling growth of several crops (barley, wheat, canola, safflower, and sunflower). They concluded that the *N. meyeri* allelopathic activity related to the extraction methods. The variation in the allelopathic effects of the *Sapindus saponaria* root and mature leaf extracts may be depended on the different concentrations of chemical composition or allelochemicals among the extracts (Batish et al., 2007; Fateh et al., 2012). The aerial parts and root extracts effects of *Haloxylon aphyllum* (Minkw.) lljin. on germination, root and shoot length, fresh and dry weight of *Agropyron elongatum* (Host.) and *A. desertorum* (Fisch.) investigated by Moameri et al. (2011), which shown that the different levels of *H. aphyllum* extracts had allelopathic effect on seeds germination and seedlings growth of two *Agropyron* species. Additionally, root length was comparatively more susceptible to phytotoxic allelochemicals than shoot length. Raoof and Siddiqui (2012) found that the leaf and stem aqueous extracts of *Tinospora cordifolia* repressed root and shoot length and dry weights from some weed plants. Aqueous extract of leaves shows the allelopathic effects while stem shows the least effect on weeds. The roots and mature leaves aqueous extracts of *Sapindus saponaria* had inhibitory effects on the germination of diaspores and seedlings growth of lettuce and onion. They suggested that the inhibitory effects of mature leaves were concentration-dependent, while the root extracts showed no allelo-

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pathic effects on the germination process (Raoof and Siddiqui, 2012). The aim of this study was to investigate the allelopathic potential of aqueous extracts from different parts (roots, leaves, inner stem barks and flowers) of *T. undulata* (Sm.) Seem. on seed germination and seedling growth of four important monocotyledonous and dicotyledonous ornamental plants.

2. Materials and methods

2.1. Preparation of aqueous extracts from roots, leaves, inner stem barks and flowers of Tecomella undulata

Roots, leaves, inner stem barks and flowers of *Tecomella undulata* were collected during the flowering stage from Farashband city in Fars province located in the southern of Iran. The plant material was dried at home temperature. The aqueous extraction was prepared as described by Mutlu and Atici (2009). The dried samples were ground in a blender. A measure of 20 gr of dry powder was stirred (125 rpm) in 1000 ml of distilled water for 24 h at 20 °C. The resulting solution was filtered to remove debris, and centrifuged at 5,000×*g* for 30 min. The supernatant was filtered through one layer of filter paper (whatman No. 1). The filtered stock solutions were held for a short time at 4 °C until bioassay. The extracts used for bioassay were carried out by diluting the stock solution (2% w/v) at concentrations including 0, 5, 10, 15 and 20 gr of the dried powders per 1000 ml of distilled water.

2.2. Plant materials

Plant seeds of tall fescue (*Festuca arundinacea* Schreb), perennial ryegrass (*Lolium perenne* L.), cockscomb (*Celosia argentea* L.) and rose moss (*Portula cagrandiflora* Hook.) were purchased from Dashtyar seed company, Isfahan, Iran. Seeds were subjected to sodium chloride (1% v/v) for 5 min and after washing with distilled water, sterilization was done by ethanol (96% v/v) for one minute. At last, seeds were washed under running distilled water for 2 min and kept in a cool place for further assays. Seed samples of each plant were placed into 9 cm petri dishes lined with whatman No. 1 filter paper under laminar airflow cabinet for increasing controlled medium and lowering pollutants. The whatman No. 1 filter papers were sterilized under U.V. radiation for 15 min.

2.3. Bioassay

Germination tests were performed for each of the root, leaf, inner stem bark and flower extracts from *T. undulata* as follows: According to seed size, 25 or 50 of sterilized seeds were placed on two layers of filter paper in sterile petri dishes. 6 ml of the extract solutions from four concentrations of stock solution (0.5%, 1.0%, 1.5% and 2%) were included to each petri dish, and distilled water was used as the control. The petri dishes were placed in a growth chamber (25 °C, 70% humidity and continuously dark) for germination tests up to 10 days.

2.4. Statistical analysis

Treatments were arranged in a completely randomized design (CRD) with three replications. The number of germinated seeds was determined by counting seeds at 24 h intervals during a 5-d period. After that, root and shoot length, and dry matter weight of the plants were calculated. The normality test was done by using SAS statistical software. One-way analysis of variance (ANOVA) was used to determine the significant differences amongst the treatments. All data were analyzed using SAS software (version 9.0), and the means were compared using LSD test at 5% level.

Table 1
Effect of different concentration of aqueous extracts of flower (FE), leaf (LE), inner stem bark (SE) and root (RE) of *T. undulata* (Sm.) Seem. on seed germination of *F. arundinacea*, *L. perenne*, *P. grandiflora* and *C. argentea*.

Extract (%)	*Festuca arundinacea Schreb*			
	FE	LE	SE	RE
0	87.6a* ± 2.9	87.6a ± 2.9	87.6 a ± 2.9	87.6 a ± 2.9
0.5	77.3 a-j ± 6.8	76.0 a-k ± 5.0	75.0 a-k ± 4.1	73.0 b-k ± 6.2
1	71.0 d-k ± 4.7	67.6f-l ± 2.9	75.6 a-k ± 5.3	49.6 op ± 0.9
1.5	55.3l-p ± 5.8	71.3 d-k ± 5.0	74.3 a-k ± 2.9	53.3n-p ± 4.9
2	53.0n-p ± 7.2	75.3 a-k ± 4.6	75.0 a-k ± 4.6	31.6 qr ± 10.7
	Lolium pernne L.			
	FE	LE	SE	RE
0	88.7 a ± 2.6	88.7 a ± 2.6	88.7 a ± 2.6	88.7 a ± 2.6
0.5	79.3 a-g ± 6.4	74.3 a-k ± 6.4	74.3 a-k ± 3.9	64.3 i-n ± 9.8
1	65.3h-n ± 4.1	76.6 a-k ± 1.7	76.6 a-k ± 4.6	64.0 j-n ± 7.1
1.5	45.3 pq ± 9.6	24.0 r ± 12.2	80.6 a-f ± 1.3	45.6 p ± 2.3
2	63.6 j-n ± 1.8	53.6m-p ± 9.8	84.3 a-d ± 2.3	22.0 r ± 7.5
	Portulaca grandiflora			
	FE	LE	SE	RE
0	85.3 abc ± 6.7	85.3 abc ± 6.7	85.3 abc ± 6.7	85.3 abc ± 6.7
0.5	77.0 a-j ± 1.5	78.3 a-h ± 1.4	73.3 b-k ± 1.2	86.3 ab ± 3.3
1	68.0f-l ± 8.3	66.6g-n ± 1.6	68.3f-l ± 3.5	72.3c-k ± 5.5
1.5	75.3 a-k ± 3.2	77.0 a-j ± 1.5	76.6 a-k ± 8.2	84.3 a-d ± 4.6
2	69.0 e-l ± 6.5	78.6 a-h ± 2.7	79.3 a-g ± 3.7	80.3 a-g ± 3.9
	Celosia argentea			
	FE	LE	SE	RE
0	86.3 abc ± 1.2	86.3 abc ± 1.2	86.3 abc ± 1.2	86.3 abc ± 1.2
0.5	82.6 a-e ± 0.3	78.6 a-h ± 2.3	77.0 a-j ± 1.0	76.3 a-k ± 7.7
1	63.0 k-o ± 5.5	74.6 a-k ± 3.2	74.0 a-k ± 1.1	69.0 e-l ± 2.5
1.5	71.3 d-k ± 2.9	74.6 a-k ± 2.3	72.0c-k ± 3.4	75.3 a-k ± 1.4
2	70.3 e-k ± 2.3	74.3 a-k ± 4.7	78.0 a-i ± 1.0	67.3f-m ± 2.8

* Means with the same letter in each row and column are not significantly different, as indicated by the LSD test ($p < 0.05$). Data are means ± SE.

3. Result and discussion

The germination percentage of seeds was reduced significantly by application of all aqueous extracts compared to control (Table 1). In addition, flower and root extracts notably inhibited seed germination of *F. arundinacea* and *L. perenne*, although leaf and inner stem bark extracts did not show significant effects on both turf grasses. The determined inhibitions were higher for root extracts than other extracts, and were more obvious at increasing concentrations of the root extract in these plants (Table 1). Seed germination of *F. arundinacea* was exhibited 39.5% and 63.9% decline in comparison with the control by application of flower and root extracts at high concentration (2%). The most inhibition effect on seed germination of *L. perrene* was due to higher (1.5% and 2%) concentrations of leaf and root extracts (Table 1). Amongst the treatments, flower extract significantly ($p < 0.05$) decreased seed germination of *C. argentea* at higher concentrations in comparison with control. (Table 1). However, there were no significant different among concentration levels of different extracts on *P. grandiflora* (Table 1). Raoof and Siddiqui (2012) reported that the aqueous extracts *Tinospora cordifolia* from leaf and stem parts at 2% and 4% concentrations exhibited significant ($P < 0.05$) inhibition on germination and seedling growth *Chenopodium album* L., *Chenopodium murale* L., *Cassia tora* L. and *Cassia sophera* L. They found that among the different parts, leaf extract showed the most allelopathic potential followed by stems. In the present investigation, root extract exhibited the most allelopathic effect on germination percent, which depended on the concentration used.

The inhibition effect found to increase by enhancing the concentrations of different aqueous extracts (Sisodia and Siddiqui, 2008, 2009). It has been reported that the radicle and plumule length, as well as the dry weight of seedlings were reduced significantly in response to all the *Tinospora cordifolia* extracts. At 4% concentration of the leaf extract, in *Chenopodium album* L. the radicle and plumule length were reduced