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Full Length Research Paper

Allelopathic potential of *Polypogon monspeliensis* L. against two cultivars of wheat

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Polypogon monspeliensis **L. Desf., (Rabbitfoot grass, Family Poaceae) an annual grass, is native to Europe, temperate Asia (Middle East, China, Japan and Russia), tropical Asia (India, Pakistan, Nepal and Sri Lanka) and Africa. Allelopathic studies conducted by using aqueous extracts from various parts including shoots, inflorescences, litter and mulch in various experiments, invariably affected the germination, plumule growth, radical growth, number of seminal roots, fresh and dry weight of two wheat varieties viz. Uqab and Ghaznavi used as the test species. Phytotoxicity of extracts depended upon amount and soaking duration. Generally, shoots were more toxic than inflorescence, but 48 h extracts from inflorescence was more inhibitory at 48 h than 24 h extracts. Hot water extract was more inhibitory than aqueous extract obtained at room temperature. Added litter and mulch also proved to be inhibitory to the test species in pots. It is suggested that various assayed parts of *P. monopelinsis* had strong allelopathic potential at least against the present test species. Further study is required to show its allelopathic behavior under field condition against its associated species and to identify the toxic principle.**

Key words: *Polypogon monspeliensis*, inflorescence, extracts, allelopathy, phytotoxicity.

INTRODUCTION

The idea that plants affect neighboring plants by releasing chemicals in the environment has been well documented (Willis, 2004; Bais et al., 2003; Ferguson and Rathinasabapathi, 2009). Allelopathy by many species including grasses operates in nature through water soluble toxins that reach the immediate habitat by various mechanisms (Kadioglu and Yanar, 2004; Ko et al., 2005; Iman et al., 2006; Batlang and Shushu, 2007; Lannucci, 2007; Thapaliyal et al., 2007; Hisashhi et al., 2009; Dangwal et al., 2010). Allelopathy is also considered to be one of the possible alternatives for achieving sustainable weed management (Singh et al., 2003; Cheema, 1988). There are innumerable reports on the inhibitory effects of weeds on crop plants (Bhowmik and Doll, 1992; Javaid and Shafique, 2007). Many members of Poaceae family have been reported to have allelopathic activity (Sánchez-Moreiras et al., 2004), such as *Cenchrus ciliaris* and *Bothriochloa pertusa* (Hussain et al., 2010, 2011), *Cymbopogon citratus* (Li et al., 2005), *Imperata cylindrica* and *Desmotachya bipinnata* (Anjum et al., 2005; Javaid and Shafique, 2007). This study was, therefore, undertaken to investigate the effect of *Polypogon monspeliensis* on growth and yield of two commonly cultivated wheat varieties viz., Uqab and Ghaznavi which grows vigorously in wheat fields with moisture.

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MATERIALS AND METHODS

P. monspeliensis was collected from wheat fields of Azakhail Botanical Garden, Nowshehra. It was dried at room temperature (25 to 30°C) and inflorescence and shoots were separately powdered and stored. Certified seed of two wheat varieties viz; Uqab and Ghaznavi were obtained from the Agriculture University, Peshawer. Glassware was thoroughly washed with tap water and sterilized at 160°C for 72 h. All the results were statistically analyzed using one way ANOVA followed by LSD test at 5 or 1% significance level.

Effect of aqueous extracts

5 g of powdered parts were separately soaked in 100 ml distilled water at 25°C for 24 and 48 h and filtered to get aqueous extracts. These extracts were tested against two varieties of wheat viz Uqab and Ghaznavi on 3-folds of filter paper in Petri dishes. The filter papers were moistened with the respective extracts, while distilled water was used as the control. For each treatment, five replicates, each with 10 seeds were made. The Petri dishes were incubated at 25°C. After 72 h, germination, growth of plumule and radical, and number of seminal roots were noted. 20 seedlings were randomly taken out for fresh and dry weight determination. Seedlings were dried at 65°C for 72 h. The concentration of the aqueous extract was reduced to 2.5 and 1.25 g/100 ml of distilled water, in the case where no germination occurred at 5 g/100 ml extract. In another experiment, 5 g dried plant parts were separately boiled in 100 ml of water for 5 min and filtered to get hot water extracts. These room cooled extracts were applied against the same test species as earlier mentioned.

Effect of litter

5 g crushed litter from shoots and inflorescence were placed in Petri dish and topped with a single sheet of filter paper. Seeds of test species were placed on it. The dishes were moistened with 5 ml water. In control treatments, fine pieces of filter paper were used. The bioassay was run as earlier mentioned.

Effect of mulching

5 g crushed dried shoots and inflorescences were mixed in plastic glasses containing sterilized moist sand. For each treatment, five replicates, each with 10 seeds were made. The control consisted of fine pieces of filter paper. After seven days incubation at 25°C, germination, growth of plumule and radical were measured. 20 seedlings were randomly taken out for fresh and dry weight and moisture contents. Moisture contents were determined on oven dried base (Hussain et al., 1982).

RESULTS AND DISCUSSION

Effect of aqueous extract

Aqueous extracts from shoots and inflorescence soaked for 24 and 48 h significantly reduced the germination, plumule growth and radical length growth in both wheat varieties viz: Ghaznavi and Uqab. However, the plumule growth was stimulated in Uqab in shoot extracts (Table 2). 5 g shoot extract after 24 h soaking was more inhibitory than 48 h extract. This might be due to denaturation of some phytotoxic principles with the passage of time while 5 g inflorescence extract after 48 h was more inhibitory than 24 h extract against both test species. Ghaznavi variety was completely inhibited when treated with 5 g inflorescence extract (Table 1) at both soaking durations (24 and 48 h). The result agrees with those of Mehmood et al. (2010) who reported similar phytoxicity of sorghum + sunflower. Therefore, the extracts were further diluted to 50 and 25% of the original strength. Significant inhibition was observed at all the tested concentrations of all the parameters. Increase in soaking duration and concentration generally enhanced inhibition. Elizabeth et al. (2008), Barkatullah et al. (2010) and Hussain et al. (2011) also reported similar increased phytotoxicity with increase in soaking duration or concentration for other plant species, and thus agree with the present results. The findings are in line with those of Samreen et al. (2009) who also observed that the toxicity of aqueous extracts of *Calotropis* depended upon the soaking duration and amount of material soaked.

Fresh and dry weight of both test cultivars also reduced (Tables 1 and 2). Maciel et al. (2003) also got similar results in their studies. However, the moisture contents was increased in the treated plants as compared to the untreated plants which is in contradiction to the findings of Hussain and Ilahi (2009) and Barkatullah et al. (2010) who stated that allelopathy reduced shoot moisture contents of susceptible test species. This could be due to excessive absorption of water by the cells in order to acquire an isotonic atmosphere, and to reduce the toxic effects.

Hot water extract of shoots completely inhibited the germination and seedling growth of both test varieties. While hot water extract from inflorescence significantly retarded the germination and seedling growth of both the test species. It was observed that hot water extracts were more inhibitory than cold water extracts (Table 3). Chung et al. (2007) and Barkatullah et al. (2010) also reported that hot water extracts were strongly inhibitory against test species. Hussain et al. (2010, 2011) showed that hot water extracts of rain leachates of *Cenchrus Bothriochloa*, were strongly inhibitory to test the species. Fresh weight, dry weight and moisture contents of tested plant seedlings generally reduced in various treatments. However, the inhibition was related to test varieties. The use of hot water extracts is unnatural but it reduces the time period for extraction of allelochemicals.

Effect of litter and mulching

It was observed that litter from shoots and inflorescence, significantly reduced the germination, radical, plumule growth and number of seminal roots of both test varieties. Fresh weight, dry weight and moisture contents of both test species were also retarded (Table 4).

Maciel et al. (2003) also reported similar results. Litter from *Cenchrus ciliaris* and *Bothriochloa pertusa* (Hussain and Ilahi, 2009) proved to be inhibitory to test species. Similar trend was achieved when litter was used as mulch in pots. Allelopathic substances released by the plants accumulate in the soil to physiological activity level (Hussain and Ilahi, 2009; Samreen et al., 2009).

Inderjit and Duke (2003) stated that plants release phytochemicals from litter, and their incorporation to the soil might facilitate their harmful effects in the field. This aspect when tested by using *P. monspeliensis* shoots and inflorescence mulch in experiments showed that there was significant inhibition of test species. Shoot

Table 1. Effect of aqueous extract of *P. monspeliensis* on germination (%), plumule and radical growth (mm), number of seminal roots, fresh and dry weight (mg), and moisture contents (%) of Ghaznavi wheat varieties. Each value is a mean of five replicates, each with 10 seedlings.

Soaking duration and concentration	5 g and 24 h shoot	5 g and 48 h shoot	5 g and 24 h inflorescence	2.5 g and 24 h inflorescence	1.25 g and 24 h inflorescence	5 g and 48 h inflorescence	2.5 g and 48 h inflorescence	1.25 g and 48 h inflorescence
Germination (%)								
Control	100	100	100	100	100	100	100	100
Extract	74**	76**	0	84	86	0	30**	40**
Plumule growth (mm)								
Control	32.76	32.76	32.76	32.76	32.76	32.76	32.76	32.76
Extract	13.76*	29.4	0	16.76**	22.28**	0	7	13.59
Radical growth (mm)								
Control	29.46	29.46	29.46	29.46	29.46	29.46	29.46	29.46
Extract	17.56	27.06	0	19.43*	28.09	0	6.55	11.26
Mean seminal roots (% of control)								
Control	3.52	3.52	3.52	3.52	3.52	3.52	3.52	3.52
Extract	2.5**	3.25	0	3.26	3.04	0	2.52	2.86
Fresh weight (% of control)	28.57	45.98	0	25.44	29.01	0	25.44	29.01
Dry weight (% of control)	24.29	60.74	0	28.03	32.71	0	28.03	32.71
Moisture content (% of control)	133.66	53.46	0	82.31	78.39	0	82.31	78.39

*Significantly different from control at alpha 0.050 according to LSD test using one way ANOVA; **highly significantly different from control at alpha 0.010 according to LSD using one way ANOVA

mulch completely inhibited germination of Ghaznavi variety. Except for seminal roots number, all other parameters including germination, plumule and radical growth, fresh and dry weight, and moisture contents of both test species also reduced (Table 4). These findings agree with those of Rebaz et al. (2001) who also observed similar phytotoxicity by other plants. The reduction in seedling root and shoot length might be attributed to the reduced rate of cell division and cell elongation due to the presence of the allelochemicals (Javaid and Anjum, 2006). In pot culture, the aqueous leaf extracts (0, 1 and 2% concentrations) of *Ageratum conyzoides*, *Anagallis arvensis, Chenopodium album, Parthenium hysterophorus* and *Rumex dentatus* significantly reduced root length, shoot length, leaf area, root biomass, shoot biomass, total biomass, pod number and seed weight of *Vigna radiata* var. K 851. The effects of weed extracts were concentration dependant (Dongre et al., 2010) and thus agree with this study.

This study suggest the presence of various allelo-chemicals in hot water and cold water aqueous extracts, litter and mulch of *P. monspeliensis* that exhibited allelopathic stress against the germination, seedling growth, fresh and dry weight and number of seminal roots of tested wheat varieties. It was also shown that different parts of the same plant had differential toxicity not only against the different test varieties but also against the various growth parameters. The toxicity depended upon the physiological

Table 2. Effect of aqueous extract of *P. monspeliensis* on germination (%), plumule and radical growth (mm), number of seminal roots, fresh and dry weight (mg), and moisture contents (%) of Uqab wheat variety. Each value is a mean of five replicates, each with 10 seedlings.

Concentration	5 g shoot	5 g shoot	5 g Inflorescence	5 g Inflorescence
Soaking duration	24	48	24	48
Germination (%)				
Control	100	100	100	100
Extract	48*	74	30**	26**
Plumule growth (mm)				
Control	27	27	27	27
Extract	32.26	29.4	12.13*	19.96
Radical growth(mm)				
Control	53	53	53	53
Extract	7.57**	27.06**	13.22**	32.39**
Mean number of seminal roots (% of control)				
Control	1.9	1.9	1.9	1.9
Extract	4.11	2.55	2.32	3.4
Fresh weight (% of control)	32	36	10	9.5
Dry weight (% of control)	26	18	10	4.0
Moisture content (% of control)	14.61	30	10	37.5

*Significantly different from control at alpha 0.050 according to LSD using one way ANOVA; **highly significantly different from control at alpha 0.010 according to LSD using one way ANOVA.

Table 3. Effect of mulch of *P. monspeliensis* on germination (%), plumule and radical growth (mm), number of seminal roots, fresh and dry weight (mg), and moisture contents (%) of Ghaznavi and Uqab wheat variety. Each value is a mean of five replicates, each with 10 seedlings.

Soaking duration and concentration	Ghaznavi		Uqab	
	Inflorescence	Shoot	Inflorescence	Shoot
Germination (%)				
Control	82	82	88	88
Intoxicated	16**	0	42**	84
Plumule growth (mm)				
Control	150.74	32.76	80.72	80.72
Intoxicated	132.5	00	97.3	137.3
Radical growth (mm)				
Control	61.60	29.46	73.42	73.42
Intoxicated	33.63	0	63.2	34.90
Mean number Of seminal roots				
Control	3.66	3.52	2.64	2.64
Intoxicated	4.99	0	3.13	3.92**

Table 3. Continue.

Fresh weight (% of control)				
Intoxicated	53.12	0	8.47	9.60
Dry weight (% of control)				
Intoxicated	23.80	0	2.30	1.53
Moisture content (% of control)				
Intoxicated	3.53	0	207.46	110.65

*Significantly different from control at alpha 0.050 according to LSD using one way ANOVA; **highly significantly different from control at alpha 0.010 according to LSD using one way ANOVA

Table 4. Effect of hot water extract and litter of *P. monspeliensis* on germination (%), plumule and radical growth (mm), no. of seminal roots, fresh and dry weight (mg), and moisture contents (%) of Ghaznavi and Uqab wheat variety. Each value is a mean of five replicates, each with 10 seedlings.

Treatment	Litter				Hot water extract			
	Ghaznavi		Uqab		Ghaznavi		Uqab	
	Inflorescence	Shoot	Inflorescence	Shoot	Inflorescence	Shoot	Inflorescence	Shoot
Germination (%)								
Control	100	100	100	100	100	100	100	100
Test	74**	74**	72*	48**	72**	0	80	0
Plumule growth (mm)								
Control	32.76	32.76	47.18	47.18	32.76	32.76	47.18	47.18
Test	5.6**	22.44	21.58	4.96**	10.59**	0	3.84**	0
Radical growth (mm)								
Control	29.46	29.46	48.70	48.70	29.48	29.48	48.70	48.70
Test	16.90*	8.65**	16.91*	9.2**	17.54	0	13.07**	0
Number of seminal roots								
Control	3.52	3.52	3.76	3.76	3.52	3.52	3.76	3.76
Test	1.88**	1.5**	1.7**	2.4**	3.26	0	2.28	0
Fresh weight (% of control)								
Test	5.35	6.69	8.5	29	27.23	0	11.53	0
Dry weight (% of control)								
Test	1.21	2.80	4	35	31.77	0	16.66	0
Moisture content (% of control)								
Test	110	40	32.5	65.71	72.62	0	26.31	0

process involved as germination and growth were independently affected. Although, the present results are laboratory based, yet they indicate the capability of *P. monspeliensis* to release water soluble allelopathic substances. In nature, it is quite possible that the *P. monspeliensis* might be one of the possible causes of reduction of wheat yields due to its allelopathy. However, further study is needed to explain allelopathic mechanism and to identify the allelopathic principle. It may also be investigated to test its efficacy as a weed, pest and disease control agent.

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