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HERBICIDAL POTENTIAL OF AQUEOUS LEAF EXTRACT OF ALLELOPATHIC TREES AGAINST *PHALARIS MINOR*

Arshad Javaid[1], Sobiya Shafique[1] and Shazia Shafique[1]

ABSTRACT

Effect of 2, 4 and 8% (w/v) aqueous extracts of dry leaves of Alstonia scholaris (L.) R. Br., Azadirachta indica (L.) A. Juss., Eucalyptus citriodora Hook, Mangifera indica L. and Syzygium cumini (L.) Skeels was investigated against germination and seedling growth of one of the most serious weeds of wheat viz. Phalaris minor Retz. Aqueous extracts of all the employed concentrations of A. scholaris, A. indica and E. citiodora proved highly effective resulting in significant reduction of 43–100% in final germination of the target weed species. Aqueous extracts of M. indica and S. cumini proved less effective where only highest concentration of 8% exhibited significant negative impact against the germination of P. minor. Generally, not always, the higher concentrations of 4 and 8% significantly reduced the seedling root and shoot growth of the target weed species.

Key words: Allelopathic trees, aqueous leaf extracts, herbicidal effects, *Phalaris minor*.

INTRODUCTION

Littleseed canarygrass (*Phalaris minor* Retz.) is a native of Mediterranean Europe and western Asia and has been introduced and become naturalized in southern Africa, and Hawaii (Tselev, 1984; Chapman 1991; Arnold and de Wet, 1993). It is one of the most widespread grassy weeds in cultivated land in Greece, Mediterranean countries, California, Arizona, India and Pakistan (Afentouli and Eleftherohorinos, 1996; Bir and Sidhu, 1979, Damanakis, 1983; Shad and Siddiqui, 1996). Other weed seeds may be killed during the summer or by rainy season flooding under rice cultivation but *P. minor* remains unaffected due to an impermeable seed coat. Many researchers have reported that presence of *P. minor* severely decreases yield of wheat. Mehra and Gill (1988) found that competition of 50 and 250 *P. minor* plants m^{-2} reduced wheat yield by 8% and 44%, respectively. Dhaliwal *et al.*, (1997) found that 60–70 *P. minor* plants m^{-2} reduced wheat yield by 10%, while yield losses exceeded 50% when wheat was grown with 500 *P. minor* plants m^{-2}. According to Dhima and Eleftherohorinos (2003) grain yield of wheat was reduced 48% by season-long competition of 400 *P. minor* plants m^{-2}.

Chemical weed control has been proved to be efficient and economical in controlling *P. minor*. Many herbicides have been used to control *P. minor* including atrazine, diclofop-methyl, fenoxaprop-p-ethyl, triazine, fenoxaprop-p, flupyrsulfuron-methyl, isoproturon, metsulfuron, tralkoxydim, and triazine, (*Bibi et al.*, 2005; Kumar and Singh 1997, Mirkamali 1987, Marwat *et al.*, 2005, Qureshi *et al.*, 2002; Singh *et al.*, 1995a, Yaacoby *et al.*, 1986, Yadav *et al.*, 1984). However, the increased use of

[1] Department of Mycology and Plant Pathology, University of the Punjab, Quaid-e-Azam Campus Lahore, Pakistan E-mail: arshadjpk@yahoo.com

herbicides poses serious environmental and public health concerns (Balogh and Anderson, 1992). Furthermore, the evolution of resistance to several herbicides, including atrazine, fenoxaprop-p, flupyrsulfuron, isoproturon, and triazine, has been reported (Koeppe *et al.*, 1997; Malik and Singh, 1995; Singh *et al.*, 1995b; Tal *et al.*,1996).

In the past two decades, much work has been done on plant-derived compounds as environmentally safe alternatives to herbicides for weed control (Duke *et al.*, 2000, 2002). Cheema (1988) demonstrated that aqueous extracts of sorghum (*Sorghum bicolor* L.) significantly inhibited the germination and growth of field bind weed (*Convolvulus arvensis* L.) and crowfoot grass (*Dactyloctenium aegyptium* L.). Abdul-Rehman and Habib (1989) found that decomposing crop residue of alfalfa (*Medicago sativa* L.) reduced the germination of blady grass [*Imperata cylindrica* (L) Beauv.] by 52%. Recently Ko *et al.* (2005) have reported the inhibitory effects of husk extracts of seven rice varieties on growth of barnyard grass [*Echinochloa crusgalli* (L.) Beauv.]. Similar adverse effects of water extracts of different *Brassica* spp. against germination and growth of cutleaf ground-cherry weed (*Physalis angulata* L.) have been reported by Uremis *et al.* (2005). The present study was designed to evaluate the herbicidal effects of aqueous leaf extract of five allelopathic trees viz. *Alstonia scholaris, Azadirachta indica, Eucalyptus citriodora, Mangifera indica* and *Syzygium cumini* (Bajwa *et al.*, 1999; Bajwa and Naz, 2004; Hussain *et al.*, 1985; Javaid *et al.*, 2007) against germination and early growth of *Phalaris minor*, one of the most serious weeds of wheat in Pakistan.

MATERIALS AND METHODS

The present study was carried out in Mycology & Plant Pathology Department, University of the Punjab, Lahore, Pakistan during November 2005. Leaves of five test tree species viz. *A. scholaris, A. indica, E. citriodora, M. indica* and *S. cumini* were collected from Quaid-e-Azam Campus, University of the Punjab Lahore, Pakistan and were thoroughly washed with tap water. Leaves were dried in an electric oven at 40 °C, grind thoroughly and soaked in distilled water @ 8 g 100 ml^{-1} for 24 h at 25 °C. The extracts were filtered through a double layer of muslin cloth followed by a Whatman No. 1 filter paper. These 8% (w/v) leaf extracts were further diluted so as to get 4 and 2% extracts.

In a laboratory bioassay, the effect of different concentrations of the aqueous extracts on germination and early seedling growth of *P. minor* was studied. For this, 10 seeds of *P. minor* were placed in a 9-cm Petri dish lined with a Whatman No. 1 filter paper moistened with 3ml of different concentrations of aqueous extracts. Treatment in a similar manner, but with distilled water, served as the control. For each treatment, three replicates were maintained in a completely randomized design. Plates were incubated in a growth chamber at 25°C. Seed germination was monitored for 10 days. After 10 days, seedling root/shoot length and plant fresh biomass were determined. All the data were analyzed by one-way ANOVA and the means were separated by Duncan's Multiple Range Test (Steel and Torrie, 1980) at 5% level of significance.

RESULTS AND DISCUSSION

Effect of extracts on germination of *P. minor*

There was a significant ($P \leq 0.001$) effect of the five test allelopathic tree species on the seed germination of test weed species. Effect of extract concentration was also significant ($P \leq 0.001$). However, the interaction of test species and concentration was not significant for this studied parameter (Table 1). Aqueous extracts of *A. scholaris, A. indica* and *E. citriodora* proved more inhibitory than rest of the test species, where all the employed extract concentrations resulted in delayed and significantly reduced germination percentage of *P. minor* as compared to control (Table 2). Aqueous extracts of *E. citriodora* proved to be the most effective where 2 and 4% extracts significantly reduced the final germination by 43 and 94% over control, respectively and 8% extract completely arrested the germination of the target weed species (Table 2). Aqueous extract of *A. scholaris* was also proved highly effective against *P. minor* where different employed extracts reduced the final germination by 72–89% (Table 2). In a recent study Javaid *et al.* (2007) reported similar herbicidal effects of aqueous leaf extracts of *A. scholaris* against the germination of noxious alien weed *Parthenium hysterophorus* L. Aqueous extracts of *A. indica* also exhibited pronounced herbicidal activity against germination of target weed species where aqueous extracts of 2–8% significantly reduced the germination by 57–79% (Table 2) Similar phytotoxic effects of aqueous extracts of *A. indica* have also been reported against other weeds and crop plants (Hussain et al., 1985; Shafique et al., 2005). The bioactivity of neem extracts has been attributed to various compounds found in seeds and leaves such as nimbin, nimbidin, salannin, but the most important of these compounds is azadirachtin (Lale and Abdulrahman, 1999).

Aqueous extracts of *S. cumini* and *M. indica* did not prove much effective against the target weed where only the highest extract concentration of 8% exhibited significant adverse impact resulting 43 and 72% reduction in final germination, respectively (Table 2). In contrast to that Bajwa *et al.* (1999) reported the highly phytotoxicity of aqueosus extracts *of S. cumini* against other test plant species. Similarly Shafique *et al.* (2005) found that leaf extract of *M. indica* was highly suppressive against *P. hysterophorus*. It indicates that the allelochemicals are specific to the target species. The species specificity of allelochemicals has also been demonstrated for other allelopathic plants species (Shaukat *et al.*, 1983, Noor and Khan, 1994) Toxicity is assumed to be associated with the presence of strong electrophilic or nucleophilic systems. Action by such systems on specific positions of proteins or enzymes would alter their configuration and affect their activity (Macias *et al.*, 1992).

Effect of extracts on shoot and root length of *P. minor*

Effect of test species, extract concentration, and their interaction was significant ($P \leq 0.001$) against both seedling shoot and root length of target species (Table 1). Except *A. scholaris*, aqueous extract of lowest concentration (2%) of all the test species enhanced the shoot length of *P. minor*. Stimulatory effects of *S. cumini* and *E. citiodora* were significant as compared to control (Fig. 1A) Similar stimulatory effects of aqueous extracts of *Inula grantioides* Boiss. and *Capsicum annuum* L. on seedling growth of test weed species have also been reported by Shaukat *et al.* (1983) and Reigosa *et al.* (1999). Higher concentrations of 4 and 8% of *A. scholaris*, *A. indica* and *E. citiodora* significantly suppressed shoot length of *P. minor*. Conversely, none of the extract concentration of *M. indica* and *S. cumini* proved inhibitory against the shoot length of the target weed species (Fig 1A).

Root length in *P. minor* seedling was significantly reduced by aqueous extracts of all the employed concentrations of *A. scholaris* and *A. indica*. Aqueous extracts of rest of the test species were proved comparatively less inhibitory where only extracts of 4 and 8% exhibited significant negative impact on the studied parameter (Fig. 1B).

Effect of extracts on seedling biomass of *P. minor*

There was significant effect of test species, extract concentration (P≤0.001) and their interaction (P≤0.05) on the seedling biomass of *P. minor* (Table 1). Extracts of lower concentration of 2% of all the test species except *E. citriodora* enhanced plant biomass (Fig. 1C). Higher concentrations of 4 and 8% of *A. scholaris, A. indica* and *E. citriodora* significantly reduced the seedling biomass. Similarly 8% extract of *S. cumini* also exhibited significant negative impact. By contrast, none of the employed extract concentration of *M. indica* proved inhibitory against the studied parameter (Fig. 1C).

The present study reveals that the aqueous extracts of *A. scholaris, A. indica* and *E. citiodora* are highly effective against germination and growth of *P. minor*. Further studies regarding the efficacy of these crude extracts under field conditions, and isolation and identification of allelochemicals responsible for germination and growth reduction of *P. minor* are in progress. There is possibility of using these allelochemicals directly or as structural leads for the discovery and development of environment friendly herbicides to control one of the noxious weeds of wheat in Indo Pakistan subcontinent.

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Table-1. Significance levels for final germination percentage, root and shoot length, and plant biomass of *Phalaris minor* grown in different concentrations of aqueous leaf extracts of five allelopathic tree species.

Trait	Test species (T)	Extract conc. (C)	T×C
Germination	***	***	ns
Shoot length	***	***	***
Root length	***	***	***
Plant biomass	**	***	*

*, **, ***, Significant at P ≤ 0.05, 0.01 and 0.001, respectively
NS: non-significant

Table-2. Effect of different concentrations of aqueous leaf extract of allelopathic trees on germination of *Phalaris minor*.

Test species	Conc. (%)	Germination (%)								
		Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day10
Control	**0**	0a	21b-d	57bc	85a	91a	91a	100a	100a	100a
Alstonia scholaris	**2**	0a	0d	6de	6c	15c	15d-f	15d-f	15d-f	21d-f
	4	0a	0d	0e	0c	15c	15d-f	15d-f	28c-f	28c-f
	8	0a	0d	0e	15bc	15c	21c-f	21c-f	21c-f	28c-f
Azadirachta indica	**2**	0a	0d	6de	21bc	28bc	43c-e	43c-e	43c-e	43b-e
	4	0a	0d	0e	0b	0c	6ef	21c-f	21c-f	28c-f
	8	0a	0d	0e	0b	0c	15df	15d-f	15d-f	21d-f
Eucalyptus citriodora	**2**	0a	6b-d	15de	36b	43b	43c-e	43c-e	51cd	57b-d
	4	0a	0d	0e	6c	6c	6ef	6ef	6ef	6ef
	8	0a	0d	0e	0c	0c	0f	0f	0f	0f
Mangifera indica	**2**	0a	28bc	36cd	36b	43b	57bc	64bc	64bc	64a-c
	4	0a	15cd	28c-e	28b	28bc	36c-f	43c-e	70b	70ab
	8	0a	0d	21de	21bc	21bc	28c-f	28c-f	28c-f	28c-f
Syzygium cumini	**2**	0a	60a	80a	100a	100a	100a	100a	100a	100a
	4	0a	36b	70ab	91a	91a	91a	100a	100a	100a
	8	0a	0d	21de	36b	36b	50cd	57bc	57bc	57b-d

In each column values with different letters show significant difference (P = 0.05) as determined by Duncan's Multiple Range Test.

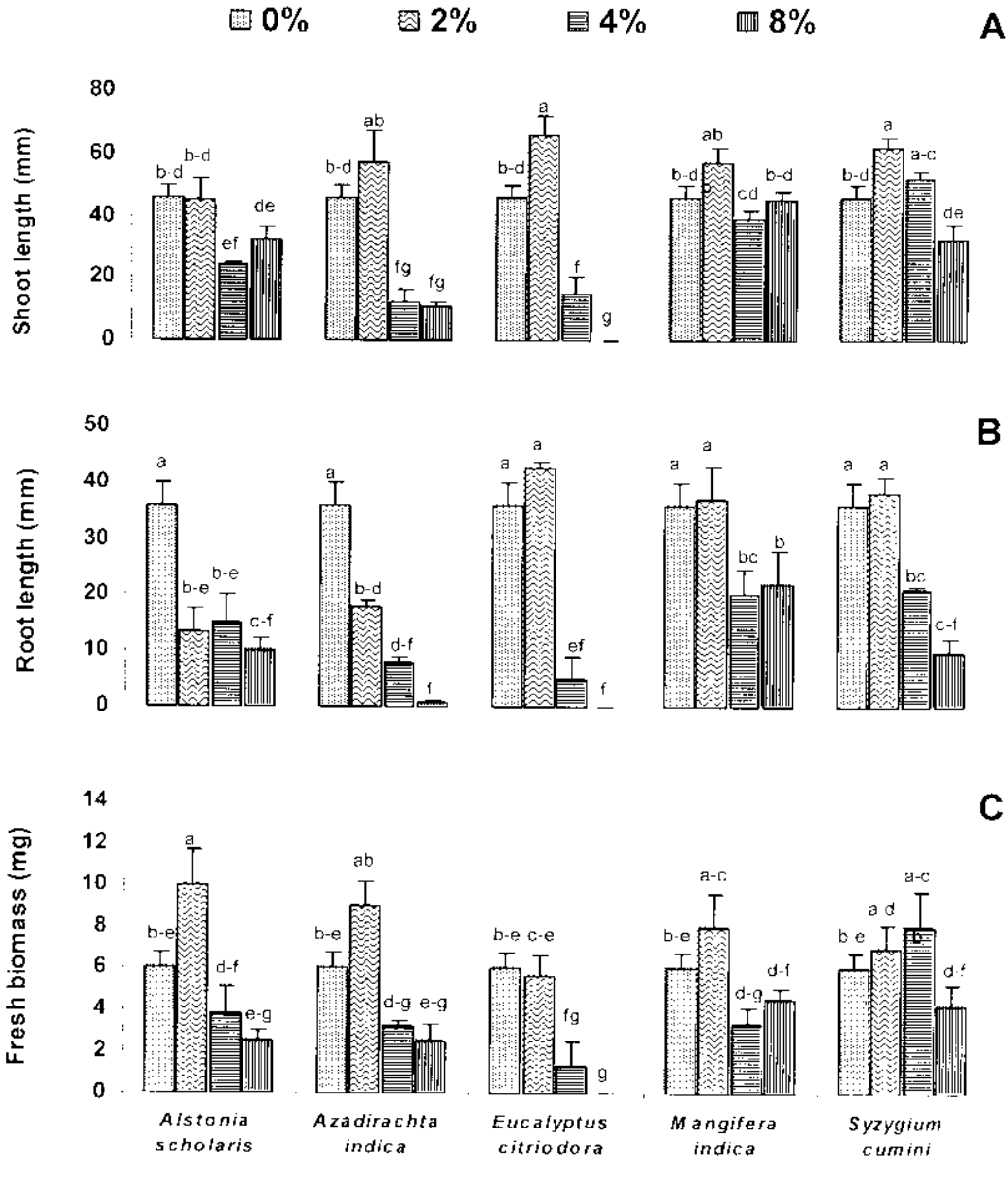

Fig. 1: Effect of aqueous leaf extracts of five allelopathic trees on shoot length (A), root length (B) and fresh biomass (C) of *Phalaris minor*.
Vertical bars show standard error of mean of three replicates.
Bars with different letters show significant difference (P 0.05) as determined by Duncan's Multiple Range Test.