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Full Length Research Paper

Herbicidal effects of aqueous extracts of three *Chenopodium* species on *Avena fatua*

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Herbicidal effects of aqueous leaf extracts of three *Chenopodium* species; *Chenopodium album* L., *Chenopodium murale* L. and *Chenopodium ambrosioides* were evaluated on wild oat (*Avena fatua* L.), one of the problematic weeds of wheat. Among the aqueous extracts of 0, 2, 4 and 6% (w/v) employed in bioassays, 6% of *C. album* and 2% of *C. murale* caused significant inhibition in germination of *A. fatua* resulting in 66 and 34% decline in germination, respectively. Lower concentration of 2% of all the three *Chenopodium* species enhanced seedling growth of *A. fatua*. The highest extract concentration of *C. album* (6%) markedly suppressed both length and biomass of shoot of test weed species. The highest herbicidal effect was exhibited by 6% *C. album* leaf extract, resulting in 88, 89, 70 and 92% reduction in maximum and total root length, number of roots and root biomass, respectively. This study concludes that the aqueous leaf extracts of *C. album* contain herbicidal constituents for the management of *A. fatua*.

Key words: Aqueous extracts, *Avena fatua, Chenopodium*, natural herbicides.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the leading winter cereal crop of Pakistan, occupying the largest area of all single crops grown in Pakistan. It is cultivated on an area of 8.358 m ha with grain production of 21.612 m tons (Anonymous, 2005). It is a staple food for the masses and enjoys the pivotal position in the Pakistani agricultural system. Among other factors responsible for low yield, weeds significantly reduce growth, yield and quality of wheat grains (Siddiqui et al., 2010). Weeds use the soil fertility, available moisture, nutrients and compete for space and sunlight with the crop plants which results in yield reduction (Al-Yemeny, 1999). Pervaiz and Quazi (1999) reported that weeds cause up to 17.25% losses in yield of wheat. The losses on annual basis in monetary terms in wheat amount to more than 28 billion at national level (Hassan and Marwat, 2001). Wild oat (*Avena fatua*) is an important weed of wheat in Pakistan. *A. fatua* has increased tremendously in the rainfed and irrigated areas of the country as well as in other places in the world. It is an annual grassy weed and is difficult to eradicate because its life cycle is closely linked with that of wheat. Therefore, it is highly competitive with wheat and causes severe reduction in yield which may range from 10 to 73% (Tiwari et al., 1988). Similarly, Balyon et al. (1991) quantified 17 to 62% losses in winter wheat yield due to wild oats competition, depending on cultivars. Recently, Khan and Hassan (2006) reported that a density of 30 *A. fatua* plants per m^{-2} reduced grain yield in wheat by 22.3%.

Chemical weed control has been proved to be efficient and economical in controlling *A. fatua* and other grassy weeds in wheat (Bibi et al., 2005; Marwat et al., 2005). However, *A. fatua* has become resistant against some well known herbicides such as imazamethabenz-methyl and diclofop-methyl (Nandula and Messersmith, 2000, 2007). Furthermore, increasing public concern on environmental issues requires alternative weed management systems which are less pesticide dependant or based on naturally occurring compounds (Singh et al., 2003). Numerous recent studies reflected good prospects of using extracts of plants as alternative to synthetic herbicides for the management of problematic weeds such as *Parthenium hysterophorus* L. (Javaid et al., 2006, 2008, 2010a, 2011; Javaid and Anjum, 2006; Bajwa et al., 2010), *Phalaris minor* (Javaid et al., 2006,

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Table 1. Analysis of variance for various growth parameters of *A. fatua* as affected by different concentrations of aqueous extracts of three *Chenopodium* species.

Trait	df	Mean square						
		Germination	Shoot length	Shoot fresh weight	Maximum root length	Total root length	Number of root	Root fresh weight
Treatments	11	633*	1.94 ns	263***	2.82**	17 ns	1.6*	80***
Test species (S)	2	1033*	0.44 ns	137*	3.37*	17 ns	1.11 ns	0.07 ns
Concentration (C)	3	218ns	4.77*	355***	4.60**	25*	2.31*	88**
S×C	6	707*	1.04 ns	259***	1.76 ns	12 ns	1.43 ns	102***
Error	24	247	1.04	32	0.98	8.25	0.69	14.6
Total	36							

*, **, ***, Significant at P≤0.05, 0.01 and 0.001, respectively. ns: Non-significant.

2010b), *Chenopodium album* L., *Rumex dentatus* L. and *Convolvulus arvensis* L. (Cheema and Khaliq, 2000; Anjum and Bajwa, 2007). Many compounds such as cineole, benzoxazinones, quinolinic acid and leptospermones, extracted from higher plants, are known to have promising results in the control of agricultural weeds (Xuan et al*.,* 2006).

This study was carried out to investigate the herbicidal effects of aqueous leaf extracts of three species of *Chenopodium* namely: *Chenopodium album, Chenopodium murale* and *Chenopodium ambrosioides* on germination and seedling growth of *A. fatua*.

MATERIALS AND METHODS

Preparation of aqueous extracts

Fresh leaves of three *Chenopodium* species namely, *C. album, C. murale* and *C. ambrosioides* were collected from University of the Punjab, Quaid-e-Azam Campus Lahore, Pakistan. Leaves were thoroughly washed with sterilized water. Leaves were cut into small pieces, blended at 6 g 100 ml^{-1} of distilled water and left for 2 h at 25°C. Materials were filtered through a muslin cloth followed by Whatman No. 1 filter papers. These 6% w/v stock extracts were further diluted to get 2 and 4% by adding distilled water.

Aqueous extract bioassays

In a laboratory bioassay, the effect of different concentrations of the extracts was studied on germination and early seedling growth of *A. fatua*. Weed seeds were collected from University of the Punjab, Quaid-e-Azam Campus, Lahore, Pakistan. Petri plates of 9 cm diameter were sterilized in an electric oven at 150°C for two hours. Ten seeds of *A. fatua* were placed in each Petri plate lined with a filter paper. Three milliliters of leaf extracts of different concentrations of all the three test *Chenopodium* species were added to each Petri plate. Treatment in a similar manner with distilled water, served as control. Each treatment was replicated thrice. Petri plates were arranged in a completely randomized design in a growth room at 25°C.

After 12 days of incubation, germination of A. fatua seeds was recorded. Maximum and total root length, number of roots, shoot length and fresh biomass of root and shoot were recorded and average data per plant was calculated.

Statistical analysis

Standard error of means was calculated for all the treatments. All the data were analyzed by two-way analysis of variance (ANOVA) followed by Duncan's multiple range test (Steel and Torrie, 1980) to separate the treatment means, using computer software SPSS.

RESULTS AND DISCUSSION

Effect of aqueous extracts on germination of *A. fatua*

Analysis of variance revealed that the effect of test C*henopodium* spp. was significant, while that of the extract concentration was insignificant for germination. The interactive effect of species and concentration was significant for this studied parameter (Table 1). The highest concentration of 6% of aqueous extracts of *C. album* significantly declined the germination of *A. fatua* by 66%*.* The effect of 2 and 4% extracts of *C. album* was however, not much pronounced against the germination of the test weed species. In contrast, 2% aqueous extract of *C. murale* exhibited a significant negative effect resulting to 34% reduction in germination. In contrast, the effect of higher concentrations of *C. murale* was insignificant on germination. None of the aqueous extract concentrations of *C. embrosioides* showed significant negative effect on the germination of test weed (Figure 1A). In contrast, Datta and Ghosh (1987) reported marked suppression in germination and root growth of *Abutilon indicum* and *Evolvulus numularius*. Herbicidal effect has been attributed to the presence of three terpenes in *C. ambrosioides* and oxalic acid in *C. murale.* The variable susceptibility to different extracts presently displayed by these test species might be due to inherent differences in interactive processes among biochemicals involved. The species specificity of phytotoxins has also been demonstrated for other allelopathic plant species (Javaid and Anjum, 2006; Javaid et al., 2007). Toxicity is assumed to be associated with the presence of strong electrophilic or nucleophilic systems. Action of such systems on specific positions of proteins or enzymes would alter their configuration and affect their activity

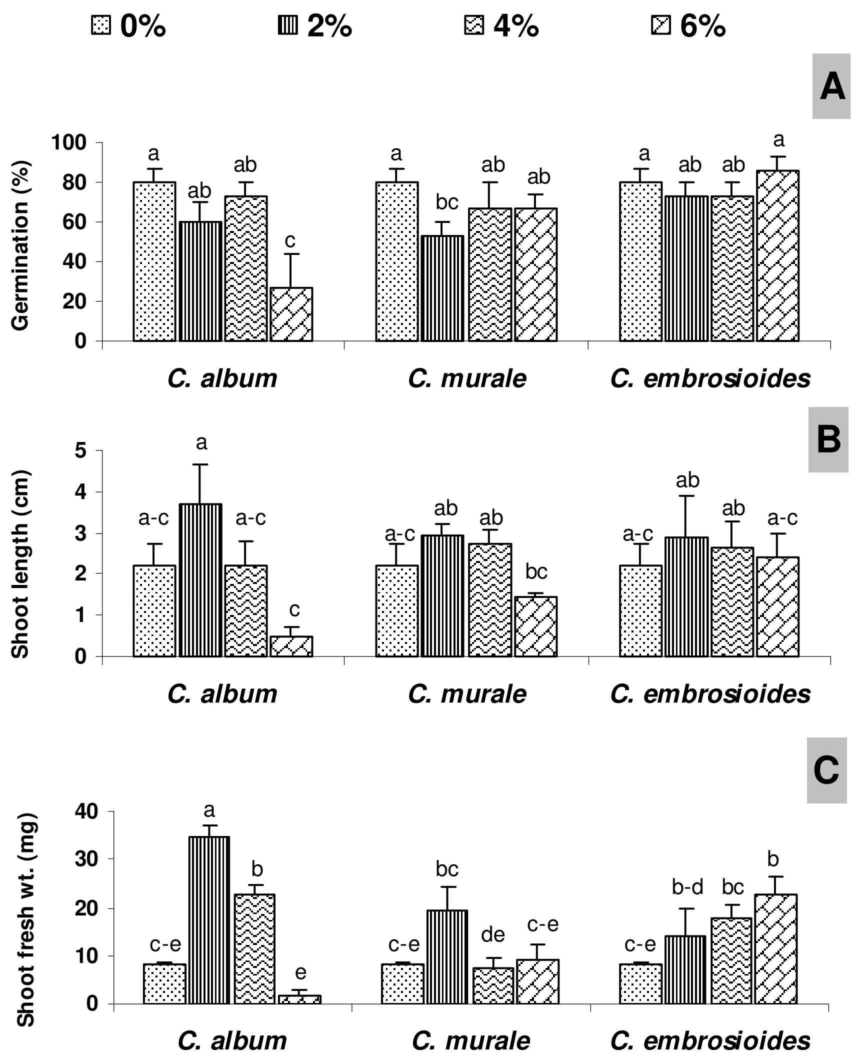

Figure 1. Effect of aqueous shoot extracts of three *Chenopodium* species on germination and seedling shoot growth of *A. fatua*. Vertical bars show standard errors; bars with different letters show significant difference as determined by DMR test at P≤0.05.

(Macias et al., 1992).

Effect of aqueous extracts on shoot growth of *A. fatua*

The effect of the three test species of *Chenopodium* was insignificant, while that of the extract concentration was significant for shoot length of *A. fatua* (Table 1). Lower concentration of 2% aqueous extract of all the three *Chenopodium* species enhanced shoot length of *A. fatua* seedlings. The effect was more pronounced in the case of *C. album* as compared to the other two species. Extract concentration of 6% of both *C. album* and *C. murale* adversely affected the shoot length, resulting in 77 and 36% reduction in the studied parameter, respectively. The effect of all the concentrations of *C. ambrosioides* was insignificant on shoot length (Figure 1B). The effect of *Chenopodium* species, extract concentration as well as the interactive effect of the two, was significant for shoot biomass (Table 1). The aqueous extract of 2% of all the three *Chenopodium* species enhanced shoot biomass. The highest stimulation was recoded for *C. album* followed by *C. murale* and *C. ambrosioides*. The highest concentration of 6% of *C. album* extract markedly reduced the shoot biomass. Conversely, in *C. ambrosioides*, there was a gradual increase in shoot biomass by increasing the extract concentration (Figure 1C). Earlier studies have also revealed that *C. album* reduced the germination and growth of associated crops and weed species (Kadioglue et al., 2005). In a recent study, Javaid and Riaz (2007) have indicated that 1 to 3% leaf-residue of *C. album* as soil amendment, significantly reduced shoot growth of maize.

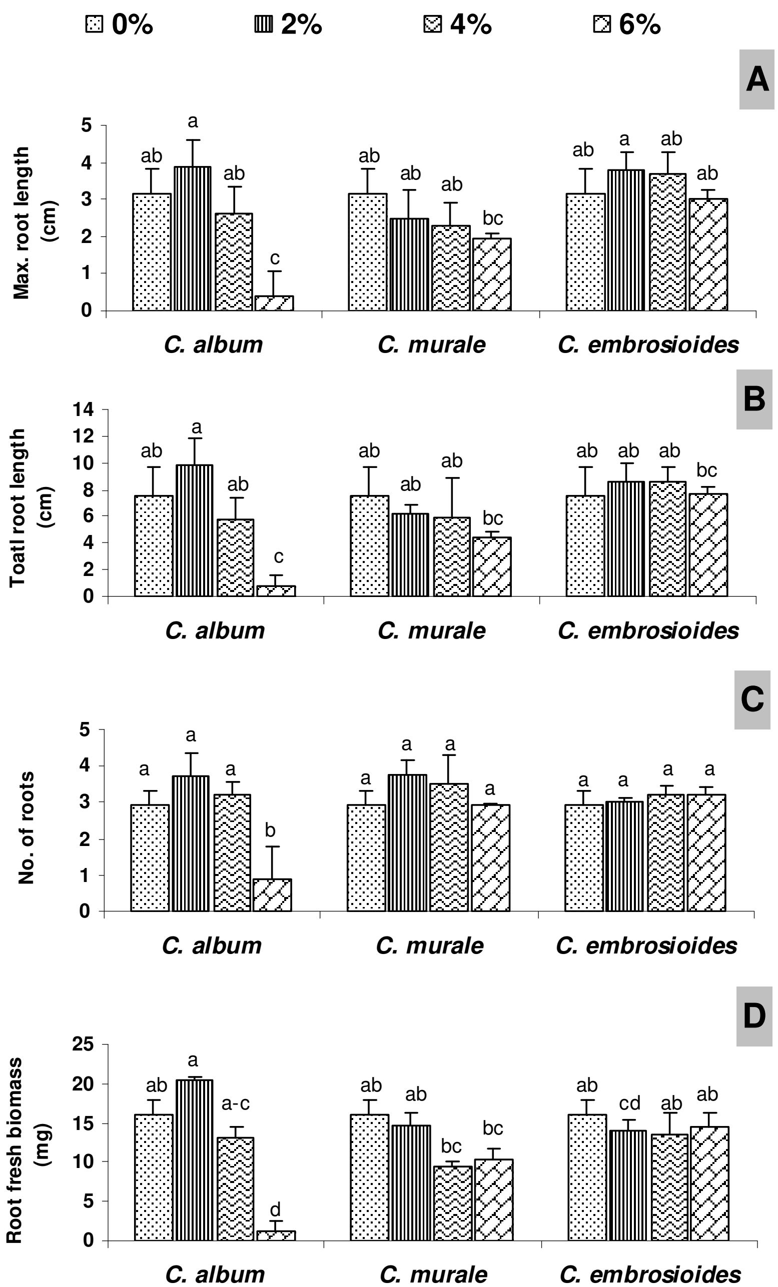

Figure 2. Effect of aqueous shoot extracts of three *Chenopodium* species on root growth of seedling of *A. fatua*. Vertical bars show standard errors; bars with different letters show significant difference as determined by DMR Test at P≤0.05.

They reported 15 to 25%, 45 to 64% and 31 to 43% reduction in length, and fresh and dry biomass of shoot, respectively, due to the incorporation of various concentrations of *C. album.*

Effect of aqueous extracts on root growth of *A. fatua*

Maximum as well as total root lengths were enhanced by 2% extracts of *C. album* and *C. ambrosioides.* The 6% extract of *C. album* significantly reduced maximum and total root length by 88 and 89%, respectively. The number of roots and root biomass were similarly affected. There were 70 and 92% decline in number of roots and root biomass due to 6% shoot extract of *C. album* (Figure 2A to D). However, as the concentration of shoot extract increased, a gradual decrease in all the studied root parameters except for number of roots of *A. fatua* was recorded. However, the adverse effect of extracts on various root growth parameters was insignificant (Figure 2A to D). *C. ambrosioides* extracts were found to be least effective in reducing root growth, and none of the employed extract concentrations exhibited any marked effect on the studied parameters (Figure 2A to D). Recently, Javaid and Anjum (2006) have found that lower concentrations of 5 and 10% of shoot extract and 5% of root extract of *Sorghum halepense* stimulated seedling shoot length of *Parthenium hysterophorus.* Similar effects of the aqueous extracts of *Inula grantioides* Boiss. and *Capsicum annuum* L. on seedling growth of test species have also been demonstrated against various test species by Shaukat et al. (1983) and Reigosa et al. (1999).

The results of this study revealed that aqueous leaf extracts of *C. album* contain substantial germination and growth inhibitors, and can therefore be effectively manipulated for management of one of the problematic grassy weed of wheat crop (*A. fatua*). However, further studies are required to evaluate the herbicidal efficacy of *C. album* leaf extract against *A. fatua* under field conditions before its recommendation to the farmers.

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