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CONTROL OF *PARTHENIUM HYSTEROPHORUS* L., BY AQUEOUS EXTRACTS OF ALLELOPATHIC GRASSES

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Abstract

Both the root and shoot extracts of the three allelopathic grasses viz., *Dicanthium annulatum* Stapf., *Cenchrus pennisetiformis* Hochest and *Sorghum halepense* Pers., reduced germination and suppressed early seedling growth of exotic weed *Parthenium hysterophorus* L. Aqueous extracts of *D. annulatum* and *C. pennisetiformis* were more inhibitory than extracts of *S. halepense.* The highest suppressive ability was exhibited by extracts of *C. pennisetiformis* where 20% shoot and 25% root extract completely inhibited the germination of *P. hysterophorus.* In general shoot extracts were more inhibitory than the root extracts.

Introduction

Parthenium hysterophorus is native to the subtropics of North and South America. It is a fast maturing annual weed which is spreading rapidly in Pakistan. The weed is very common along the roadsides, around the agricultural fields and on wastelands. The allelopathic nature of this weed has been well documented and water soluble phenolics and sesquiterpene lactones have been reported from the roots, stems, leaves, inflorescences, pollens and seeds (Evans, 1997).

The phenomenon of allelopathy where one plant exerts a detrimental effect on another through the production of germination and growth inhibiting substances has been widely reported (Shaukat *et al*., 1983; Rizvi *et al.,* 2000). It can play an important role in regulating plant diversity (Chou & Lee, 1991). Chemicals released from plants into the environment are of major significance in adaptation of species and organization of communities (Chou, 1989). Basic plant processes such as hormonal balance, protein synthesis, respiration, photosynthesis, plant water relations and chlorophyll production may be affected by allelochemicals (Yamane *et al.,* 1992). Putnam & Duke (1979) introduced the concept of utilizing the allelopathic crop residues for weed control in crops. Cheema *et al*., (1997) found that aqueous extract of sorghum and sunflower has the potential to suppress the weed infestation in wheat crop. Similarly, Mahmood & Cheema (2004) found that sorghum mulch significantly reduced the density and dry biomass of one of the world's worst weed *Cyperus rotundus.* Akhtar *et al*., (2001) reported that aqueous extracts of *Cirsium arvense* and *Ageratum conyzoides* could suppress the germination and early seedling growth of some weeds of wheat. Moradshahi *et al*., (2003) found that aqueous extracts of *Eucalyptus camaldulensis* Schlecht., has the potential to suppress growth of *Echinochloa crus-galli* (L.) Beauv., *Avena fatua* L., and *Rumex acetosella.* Similarly Dahiya & Narwal (2003) found that root exudates of *Helianthus annuus* L., are allelopathic towards *Agropyron repens* (L.) Beauv., *Ambrosia artemsiifolia* L., *Avena fatua* L., *Celosia crustata*, *Chenopodium album* L., *Cynodon dectylon* (L.) Pers. Singh *et al*., (2005) studied the herbicidal effect of volatile oils from leaves of *Eucalyptus citriodora* against the noxious weed *P. hysterophorus* and found that a concentration of 5.0 nL ml^{-1} *Eucalyptus* oil completely inhibited the germination. Uremis *et al*., (2005) have reported significant suppression of *Physalis angulata* L., a

problem weed in maize, cotton and soybean fields in Turkey, by aqueous extracts of 6 *Brassica* spp.

The phenomenon of allelopathy has been widely reported in grasses. Many grasses like *Lolium multiflorum* (Naqvi & Muller, 1976), *Dicanthium annulatum* (Dirvi & Hussain, 1979), *Panicum antidotale* (Begum & Hussain, 1980), *Cenchrus pennisetiformis* (Hussain & Anjum, 1981), *Eragrostis poaioides* (Hussain *et al*., 1984), *Imperata cylindrica* (Hussain & Abidi, 1991), *Desmostachya bipinnata* (Bajwa *et al*., 1998) and many others have been reported to exhibit allelopathy to preclude the associated species by reducing their regeneration, growth and yield. The objective of the present study was to assess the potential of aqueous extracts of three allelopathic grasses viz. *Dicanthium annulatum, Cenchrus pennisetiformis* and *Sorghum halepense* to control the germination and early seedling growth of *P. hysterophorus.*

Materials and Methods

Fresh plant materials of three allelopathic grasses viz., *Dicanthium annulatum, Cenchrus pennisetiformis* and *Sorghum halepense* were collected from University of the Punjab, Quaid-e-Azam Campus Lahore, Pakistan. After thorough washing with sterilized water, plants were separated into shoot (leaves and stems) and roots (including rhizomes). Extracts were obtained by soaking 25 g crushed root and shoot materials in 100 ml distilled water for 36 hours at 25 ºC and filtered. Further dilutions of 20, 15, 10 and 5% w/v were prepared by adding appropriate quantity of water to the 25% w/v stock solution. The extracts were stored at 4 ºC.

Seeds of *P. hysterophorus* were sown on a filter paper seedbed in sterilized Petri dishes. The filter papers were moistened with aqueous root and shoot extracts of the test allelopathic grasses. Controls were treated similarly with distilled water. There were three replicates of each treatment with 10 seeds per Petri plate. The plates were incubated at 25 ºC for 7 days. Plates were regularly checked for moisture. Germination, root and shoot length, and seedling fresh biomass was recorded at the end of the experiment. Data were analyzed statistically by applying Duncan's Multiple Range Test (Steel & Torrie, 1980).

Results

Effect of aqueous extracts of allelopathic grasses on germination of *P. hysterophorus*: Germination of *P. hysterophorus* seeds was adversely affected by aqueous extracts of all the three test allelopathic grasses. However, germination response varied with the test grass species. Aqueous extracts of *C. pennisetiformis* were highly effective in reducing the germination of *P. hysterophorus*. All except 5% extracts had significantly negative impact on germination of *P. hysterophorus.* The 20% shoot and 25% root extracts completely inhibited the germination. (Figs. 1A & 2A). Aqueous extracts of *D. annulatum* also exhibited a significant suppressive ability even at 5% concentration. Shoot extract was comparatively more inhibitory than root extract. Highest concentration of 25% of both shoot and root reduced the germination to 20 and 25% respectively, as compared to 100% germination in control (Figs. 1A & 2A). Aqueous extracts of *S. halepense* were found comparatively less effective in reducing germination of *P. hysterophorus* than the extracts of rest of the two test grasses. Lower concentrations of 5 and 10% of both root and shoot extracts of this test grass species exhibited insignificant effect against germination of *P. hysterophorus*. Higher concentrations of 15-25% were, however, significantly reduced the germination of *P. hysterophorus* seeds (Figs. 1A & 2A).

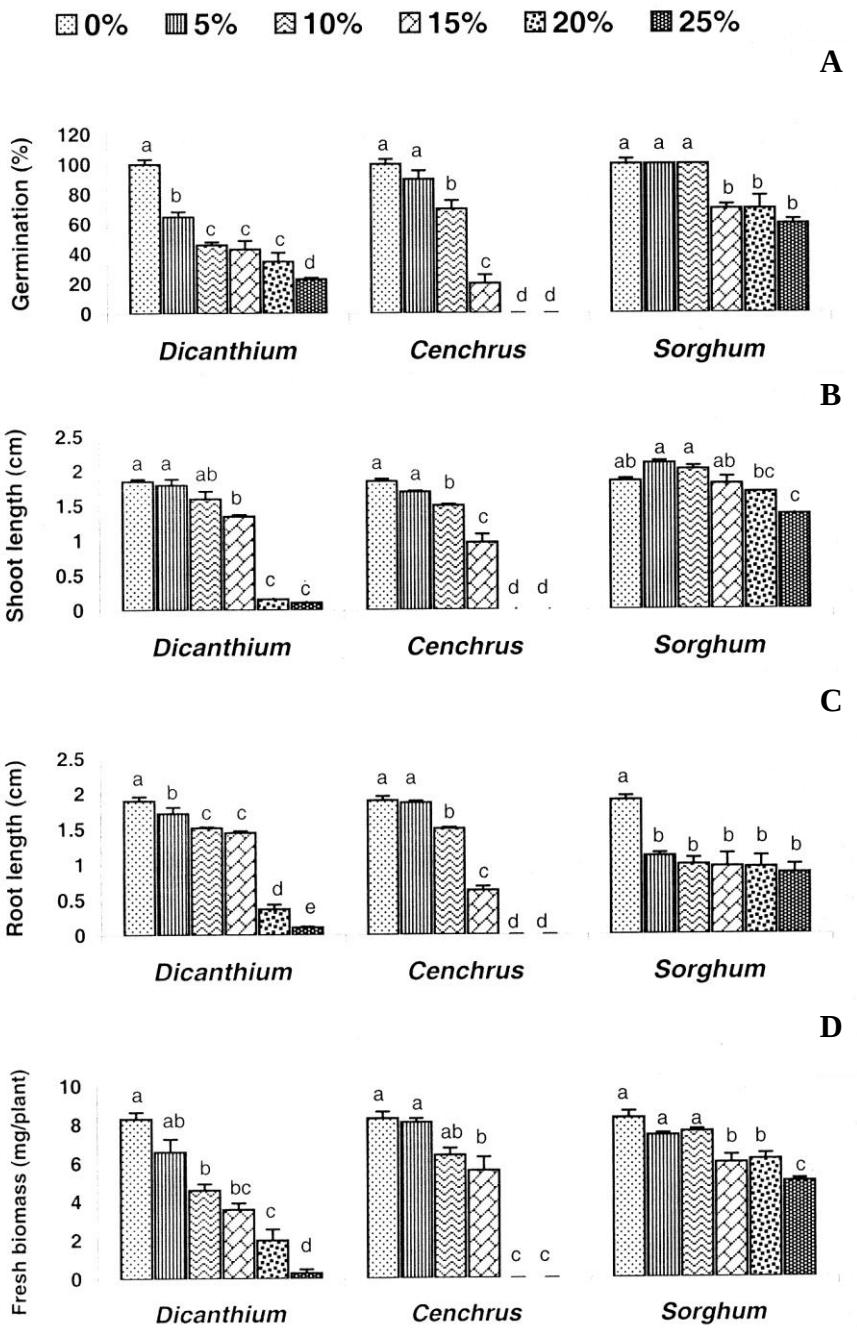

Fig. 1. Effect of aqueous shoot extracts of three allelopathic grasses on germination and early seedling growth of Parthenium hysterophorus. Vertical bars show standard errors. For each grass bars with different letters show significant difference as determined by DMR Test.

Effect of aqueous extracts of allelopathic grasses on seedling growth of *P. hysterophorus*: Similar to that of germination, *P. hysterophorus* seedling growth response to aqueous extracts of different grasses was variable. Generally extracts of *D. annulatum* and *C. pennisetiformis* were more inhibitory against root and shoot length and seedling biomass production than extracts of *S. halepense*. A 20% shoot extract of *C. pennisetiformis* completely arrested the radicle and plumule growth of *P. hysterophorus.* Similarly 25% shoot extract of *D. annulatum* was highly suppressive resulting in 89, 88 and 96% reduction in shoot length, root length and seedling biomass, respectively. In contrast, 25% shoot extract of *S. halepense* reduced shoot length, root length and seedling biomass of *P. hysterophorus* by 25, 54 and 38%, respectively (Figs. 1B-D & 2B-D). Root extracts of *D. annulatum* and *C. pennisetiformis* were comparatively less inhibitory than corresponding shoot extracts. Generally inhibitory potential of the extracts increased by increasing the extract concentration. Lower concentrations of 5 and 10% of shoot extracts and 5% of root extract of *S. halepense* insignificantly stimulated seedling shoot length (Figs. 1B-D & 2B-D).

Discussion

Water extracts of all the three test allelopathic grasses exhibited phytotoxic activity against germination and early seedling growth of the noxious weed *P. hysterophorus.* Similar phytotoxic effects of these and other allelopathic grasses like *Lolium multiflorum, Panicum antidotale, Eragrostis poaioides* etc., have also been reported against other susceptible plant species (Naqvi & Muller, 1975; Dirvi & Hussain, 1979; Begum & Hussain, 1980; Hussain *et al*., 1984). Recently Anjum *et al*., (2005) and Javaid *et al*., (2005) found that aqueous extracts of allelopathic grasses *Imperata cylindrica* and *Desmostachya bipinnata* not only suppress the germination and growth of *P. hysterophorus* under experimental conditions but also reduce the spread of this noxious weed in field. Grasses generally exhibit phytotoxicity due to presence of phenolic allelochemicals (Naqvi & Muller, 1975; Hussain & Abidi, 1991). The reduction in seedlings root and shoot length may be attributed to the reduced rate of cell division and cell elongation due to the presence of allelochemicals in the aqueous extracts (Buckolova, 1971).

Shoot extracts of *C. pennisetiformis* and *D. annulatum* were comparatively more inhibitory to germination and seedling growth of *P. hysterophorus* than corresponding root extracts indicating that shoot contains greater amount/number of inhibitors than does the root. The greater inhibitory effect of aqueous extracts of aerial parts on germination and growth of the test species than the effect of sub-aerial parts has also been reported in other plant species (Kil & Yun, 1992; Noor & Khan, 1994). Lower concentrations of 5 and 10% of shoot extract and 5% of root extract of *S. halepense* stimulated seedling shoot length of *P. hysterophorus.* Similar effect of aqueous extracts of *Inula grantioides* Boiss., and *Capsicum annuum* L., on seedling growth of test species has also been reported (Shaukat *et al.,* 1983; Reigosa *et al.,* 1999).

The germination and seedling growth response of *P. hysterophorus* to aqueous extracts of various test allelopathic grass species was different. This unequal susceptibility to different extracts could be due to inherent differences in various biochemicals involved in the process. The species specificity of phytotoxins has also been demonstrated for other allelopathic plants species (Shaukat *et al.,* 1983; Noor & 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).

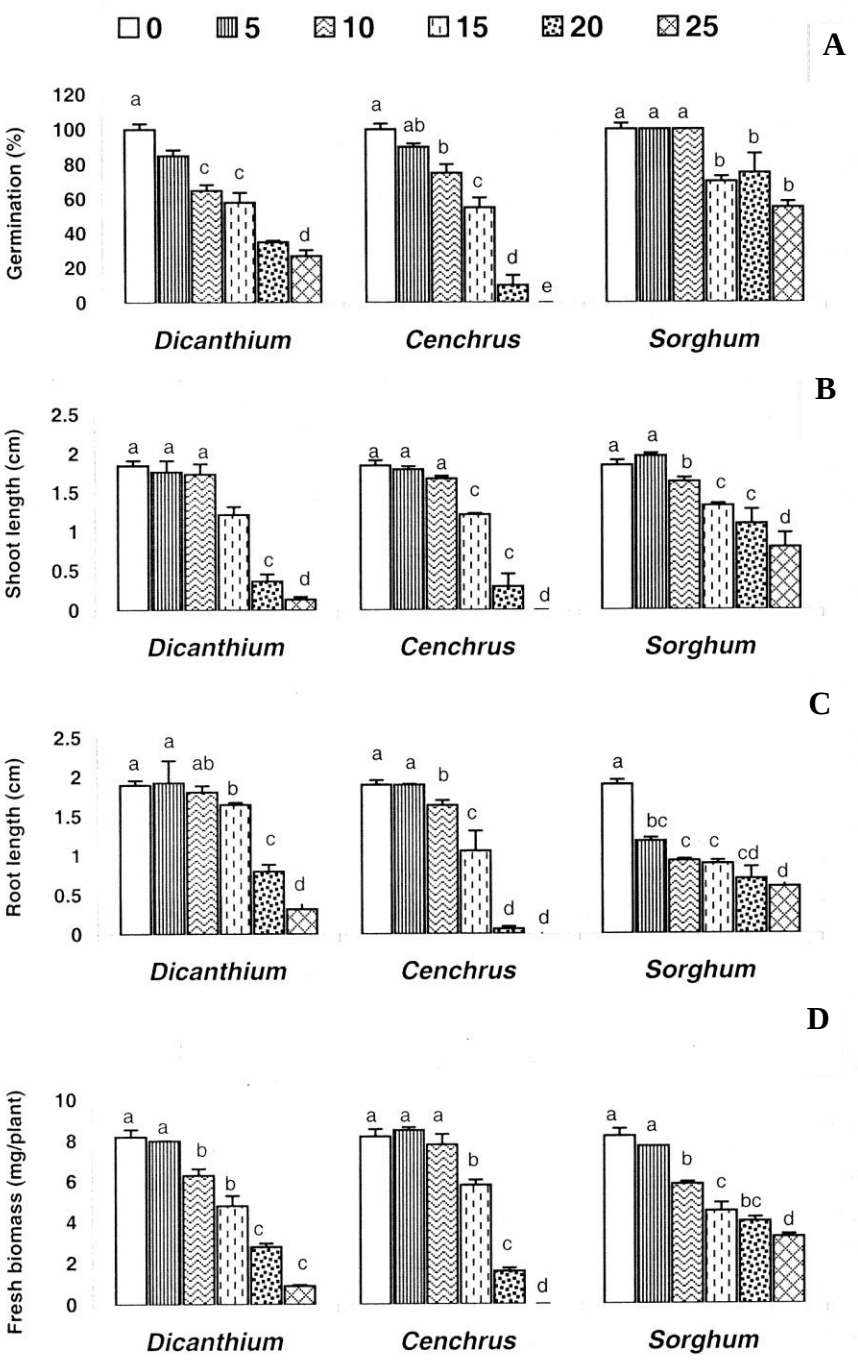

Fig. 2. Effect of aqueous root extracts of three allelopathic grasses on germination and early seedling growth of Parthenium hysterophorus. Vertical bars show standard errors. For each grass bars with different letters show significant difference as determined by DMR Test.

The present study reveals that the aqueous extracts of *C. pennisetiformis* and *D. annulatum* are highly effective against germination and growth of *P. hysterophorus.* There is need to carry out studies to test the efficacy of these crude extracts under field conditions. Furthermore, the allelochemicals responsible for germination and growth reduction of *P. hysterophorus* should be isolated and identified. 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 world's worst weeds. Earlier there are examples of screening natural products for preparation of new herbicides with least adverse effects. Artemisinin, a sesquiterpene lactone from *Artemisia annua* L., is a patent plant growth inhibitor (Ditomaso & Duke, 1991). Leptospernone is an allelochemical from which the triketone class of herbicides was developed (Mitchell *et al*., 2001). 1, 8 coneole, a monoterpene, has been identified as one of the most potent allelochemicals released by *Artemisia* app., and a synthesize analog, cinmethylin is being sold as a herbicide in Europe (Duke *et al*., 2002).

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