PARTHENIUM MANAGEMENT THROUGH AQUEOUS EXTRACTS OF ALSTONIA SCHOLARIS

ARSHAD JAVAID*, SOBIYA SHAFIQUE, RUKHSANA BAJWA AND SHAZIA SHAFIQUE

Institute of Plant Pathology,
University of the Punjab, Quaid-e-Azam Campus Lahore, Pakistan.
*Corresponding author's e-mail: arshadjpk@yahoo.com

Abstract

Phytotoxic effect of aqueous leaf and bark extracts of Alstonia scholaris (L.) R. Br. was investigated against parthenium weed (Parthenium hysterophorus L.). In a laboratory bioassay, carried out in 9-cm diameter Petri plates, 2–10% aqueous extracts of fresh leaves significantly reduced germination of parthenium seeds from 30-80%. Seedling growth in terms of root and shoot length, and fresh biomass, was also significantly reduced by all except 2% extract concentration. Bark extracts of same concentrations proved less toxic resulting in an insignificant reduction in germination. Generally, the effect of bark extract on seedling growth was also insignificant. In foliar spray bioassay, three sprays of 50% and 100% w/v (on fresh weight basis) leaf extracts were carried out on 15 days old parthenium plants with 5 days intervals. A significant reduction in root and shoot biomass was recorded due to 100% foliar spray, after 2 week growth of the first spray. The present study concludes that aqueous leaf extract of A. scholaris contain potent herbicidal constituents for the management of parthenium weed.

Introduction

Parthenium (Parthenium hysterophorus L.) is an aggressive weed of the family Asteracea. It is native to the subtropics of North and South America but now has invaded Asia, Africa and Australia during the last 50 years. Since then, the weed has not only naturalized itself but has spread at an alarming rate and has become a dominant weed of wastelands/crops in many parts of world and has become a problematic weed (Navie et al., 1996; Evans, 1997). It has become a dominant weed in most of the wastelands and grazing lands in Pakistan (Javaid & Riaz, 2007; Riaz & Javaid, 2010). It has also been reported in some less competitive field crops in Pakistan (Javaid & Anjum, 2005). The weed is characterized with high reproductive potential and fast growth rate, thus becomes dominant in a newly colonized area in a very short time (Kohli & Rani, 1994). Parthenium posses a serious health risk, particularly to the urban populations. The chemical analysis has indicated that all the plant parts including trichomes and pollens contain toxins called sesquiterpene lactones. The major components of toxin being ‘parthenin’ and other phenolic acids such as caffeic acid, vanillic acid, anisic acid, chlorogenic acid and parahydroxy benzoic acid are lethal to human beings and animals (Oudhia, 1998). The weed is known to cause allergic reactions in people. Symptoms are itching on exposed skin and development of a dermatitis which may spread over the whole body. It also causes asthma (Evans, 1997; Suresh et al., 1994). In addition of health hazards a lot of available data also highlights its impact on agriculture as well as natural ecosystems (Javaid & Anjum, 2005; Javaid et al., 2009; Belz et al., 2007).

Parthenium is reported to be controlled by foliar spray of some chemical herbicides such as bromocil, diuron, terbacin, diquat, chlorimuron ethyl, metasulfuron methyl and buctril super (Mishra & Bhan, 1994; Javaid et al., 2006a, Javaid, 2007). However, control
does not last long enough as expected due to the large amount of seeds deposited in the seed bank and flash germination of the seeds. 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). Allelopathy as an ecological approach and allelochemicals as biological herbicides have been a challenge to current synthetic chemical approaches (El-Rokiek et al., 2006). Numerous allelochemicals are involved in the allelopathic activities of the allelopathic plants; such as phenolics, terpenoids, alkaloids, coumarins, tannins, flavonoids, steroids and quinines (Xuan et al., 2005). Several compounds extracted from higher plants, such as cineole, benzoazinones, quinolinic acid and leptospermones, have been applied in agricultural weed control with promising results such as Benzoazinones and Quinolinic acid by BASF, Germany; Cineole as Cinmethylene by Shell, USA: Letospermones as Triketones by Zeneca (Xuan et al., 2006). Some studies carried out in the recent years reveal that allelopathy can play a major role in controlling the spread and growth of parthenium. Aqueous extracts of allelopathic grasses, allelopathic crops such as rice and dicotyledonous plants such as Datura metel significantly suppressed the germination and growth of parthenium weed (Javaid et al., 2005, 2008, 2010; Javaid, 2010; Javaid & Anjum, 2006). Similarly, Shafique et al., (2005) showed that aqueous extracts of allelopathic trees viz., Azadirachta indica (L.) A. Juss., Ficus bengalensis L., Melia azadarach L., Mangifera indica L., and Syzygium cumini (L.) Skeels significantly reduced the germination and early seedling growth of parthenium. The present study was undertaken to investigate the effect of aqueous leaf and bark extracts of Alstonia scholaris on germination and seedling growth of parthenium.

Materials and Methods

Germination and early seedling growth bioassays: Fresh leaf and bark materials of A. scholaris were thoroughly washed with sterilized water and blended at 10 g 100 mL⁻¹ of distilled water and left for 2 hours at 20°C. These were filtered through a muslin cloth followed by Whatman No. 1 filter paper. This stock solution was further diluted to get 2, 4, 6 and 8% w/v solutions. The extracts were used in the experiments on the same day. In a laboratory bioassay, the effect of different concentrations of bark and leaf extracts on germination and early seedling growth of parthenium was studied. For this, 10 seeds of parthenium were placed in a 9-cm diameter Petri plate lined with a filter paper, and moistened with 3 mL of different concentrations of leaf and bark extracts. Treatment in a similar manner but with distilled water, served as control. Each treatment was replicated thrice. Petri plates were arranged in a completely randomized design in a growth chamber maintained at 25°C and 8 h light period daily. Germination was recorded daily up to 6 days. After 6 days, the seedling length and fresh biomass were determined.

Foliar spray bioassay: Plastic pots of 7-cm diameter and 6-cm deep were filled with sandy loam soil @130-g soil per pot. Fifteen days old parthenium plants were carefully transplanted to these pots. Aqueous extracts of 100 and 50% (w/v) of fresh leaves of A. scholaris was prepared as earlier. These extracts were sprayed on pot grown parthenium plants after 0, 5 and 10 days of transplantation. Plants of control treatment were sprayed with distilled water. Plants were harvested after 2 weeks and data regarding root and shoot dry biomass were determined.

Statistical analysis: The data were subjected to analysis of variance (ANOVA) followed by Duncan’s Multiple Range Test (Steel & Torrie, 1980) at p≤0.05 to compare treatment means.
Results and Discussion

**Effect of leaf extract on germination and early seedling growth:** Aqueous leaf extract of *A. scholaris* delayed seed germination as well as reduced the final germination percentage of parthenium. The extract was highly toxic and even the lowest concentration of the extract (2%) significantly reduced the final germination by 30% as compared with control. The increase in extract concentration resulted in a corresponding decrease in germination. The 10% extract reduced the germination by 80% as compared with control (Fig. 1A). These results support the earlier findings that the seedling growth of parthenium can be checked by aqueous extracts of allelopathic plant species. Similar inhibition in germination has also been reported due to aqueous leaf extracts of other allelopathic tree species viz., *Azadirachta indica* (L.) A. Juss., *Ficus bengalensis* L., *Melia azadarach* L., *Mangifera indica* L., and *Syzygium cuminii* (L.) Skeels (Shafique et al., 2005). Our results are also in agreement with the findings of Anjum et al., (2005), Javaid et al., (2005) and Javaid & Anjum (2006) who reported that aqueous extracts of allelopathic grasses viz., *Imperata cylindrica* (L., Beauv., *Desmostachya bipinnata* Stapf., *Dicanthium annulatum* Stapf., *Cenchrus pennisetiformis* Hochest and *Sorghum halepense* Pers., significantly suppressed the germination of parthenium.
Fig. 2. Effect of aqueous leaf and bark extracts of *Alstonia* on early seedling growth of parthenium in aqueous extract bioassay. Vertical bars show standard errors. Bars with different letters show significant difference (p≤0.05) as determined by Duncan's Multiple Range Test.

Leaf extracts of 6% and above exhibited a significant adverse effect on seedling shoot length. Effect of leaf extract on root length and seedling fresh biomass was even more severe where 4% and higher concentrations significantly declined the studied parameters. Increase in extract concentration resulted in a parallel decrease in root and shoot growth (Fig. 2). These results support the earlier findings that the seedlings growth of parthenium can be checked by aqueous extracts of allelopathic plant species (Javaid *et al.*, 2005; Javaid & Anjum, 2005, 2006; Shafique *et al.*, 2005). Leaves of *A. scholaris* contain many indole alkaloids which may be responsible for the herbicidal activity of the aqueous extracts. The leaves of *A. scholaris* collected in Pakistan, India, Philippines, Thailand, Malaysia, and Indonesia showed diverse alkaloidal patterns. In general, the continental trees from Pakistan, India and Thailand contain picrinine-type alkaloids, while those from Indonesia and the Philippines contain alkaloids based on the angustilobine skeleton (Atta-ur-Rahman *et al.*, 1985; Yamauchi *et al.*, 1990; Kam *et al.*, 1997; Salim *et al.*, 2004; Macabeo *et al.*, 2005). Generally, alkaloids are known as potential allelochemicals reducing the germination and growth of susceptible plant species (Whittaker & Fenny, 1971; Harborne, 1977).
Effect of bark extract on germination and early seedling growth: The bark extract proved less inhibitory than leaf extract and exhibited insignificant effect on germination of parthenium seeds (Fig. 2B). Bark extract also failed to exhibit any pronounced adverse effect on seedling root and shoot growth. Effect of all the extract treatments on shoot length and seedling biomass was insignificant. Only the highest concentration of 10% showed a significant adverse impact on seedling root length (Fig. 2). Bark of *A. scholaris* is known to contain several alkaloids, and fatty and resinous substances (Salim *et al.*, 2004). However, in the present study they failed to exhibit their phytotoxic effect against *Parthenium* probably because of their non-specificity towards this noxious weed. The species specificity of phytotoxins has also been demonstrated for other allelopathic plant 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).

Foliar spray bioassay: Foliar spray with both 100 and 50% leaf extracts adversely affected plant growth in parthenium. The adverse effect of foliar spray with 100% extract was significant where 46 and 67% reduction in shoot and root biomass was recorded, respectively (Fig. 3). In a recent study, Javaid *et al.*, (2006b) have reported that foliar spray with aqueous extracts of sunflower (*Helianthus annuus* L.) and sorghum (*Sorghum bicolor* L.) significantly suppressed the growth of parthenium. The present study concludes that aqueous leaf extracts of *A. scholaris* contain inhibitors probably alkaloids, for germination and growth of parthenium. Further studies are required to isolate and identify these inhibitors to be used as a lead for the synthesis of natural herbicides against one of the most noxious weeds of the world.

![Fig. 3](image-url)
References


(Received for publication 27 November 2008)