

Effect of Foliar Spray of Aqueous Extract of *Parthenium hysterophorus* on Growth of Sunflower

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ABSTRACT

Aqueous extracts of 10, 30 and 50% (w/v) obtained from aerial parts of *Parthenium hysterophorus* inhibited germination and seedling growth of sunflower (*Helianthus annuus* L.) in a bioassay conducted in petri plates. Foliar spray of these extracts on pot grown sunflower plants resulted in reduced root and shoot length and biomass. Capitulum diameter and dry biomass as well as number of seeds per capitulum were also adversely affected by foliar spray of the extracts. The inhibitory potential of the extracts was increased by increase in concentration.

Key Words: Foliar; Growth; Sunflower; Aqueous

INTRODUCTION

Parthenium hysterophorus, one of the “worst weeds, is an annual plant native to tropical America and Mexico and has spread prolifically in central Queens land, now occurs widely along the roadsides, wastelands and also in crop fields in east Africa, India, Australia and Pakistan. This weed was not found to have any place in the world’s worst weeds till 1977 (Holm *et al.*, 1977). But within last 10 years it has become one of the seven most dangerous weeds of the world (Singla, 1992). As a species facing little environmental resistance, *P. hysterophorus* has become a menace in wastelands and non-cropped areas. The absence of natural agents that restrict the spread of this plant as in its original homeland, high fecundity, efficient seed dispersal mechanisms, allelopathic impact on neighbouring plants, high rate of seed production, unsuitable for grazing and wide adaptability to varying soil and climatic conditions have enabled this plant to invade rapidly a variety of growing environments.

Chemical analysis has indicated that all plant parts contain toxins from the chemical group of sesquiterpene lactones (Oudhia & Tripathi, 1998). Narwal (1994) has isolated many allelochemicals such as parthenin, p-coumaric acid, caffeic acid, coronopillin and sesquiterpene lactones, from the aqueous extracts of *Parthenium* responsible for allelopathic effects on other plants. This weed is known to cause adverse effects not only on plant growth (Nath, 1988; Adkins *et al.*, 1997) but also causes some diseases in human beings and livestock e.g. bronchitis, dermatitis and hay fever (Auld & Medd, 1987).

The present research work was, therefore, designed to study i) the effect of aqueous extract of aerial parts of *P. hysterophorus* on germination and seedling growth of sunflower and ii) the effect of foliar spray of *P. hysterophorus* on growth and yield of pot grown sunflower plants.

MATERIALS AND METHODS

Aqueous extract bioassay. Freshly growing *P. hysterophorus* plants were collected from various localities in and around the University Campus. These plants were washed carefully under tap water, and then dried with blotting paper. Aerial plant parts were separated, cut into fine pieces and weighed. The weighed sample of plant material was crushed in sterilized mortar and pestle and soaked in the sterilized water at the rate of 50 g of shoots per 100 mL of distilled water for 48 h at room temperature. The extract was filtered through thin muslin cloth and finally through Whatman filter paper No. 1. This stock solution was preserved at 4°C in pre-sterilized beakers in a refrigerator. The extract was generally used within a week. From 50% stock solution, further dilutions of 30 and 10% were made by adding sterilized water. The pH of 50, 30 and 10% solutions were 5.98, 6.65 and 7.15, respectively.

Certified seeds of Sunflower var. DK-3915-3, were obtained from Punjab Seed Cooperation Lahore. Healthy seeds of Sunflower were surface sterilized with 3% sodium hypochlorite solution for 5 min. The seeds were then thoroughly rinsed with sterilized distilled water. Double layer of sterilized Whatman filter paper No.1 was placed in pre-sterilized petriplates. The filter papers were moistened with 3 mL of various concentrations of extract and with distilled sterilized water in the case of control treatment. Ten surface sterilized seeds were placed in each petriplate. There were three replicates for each treatment (Hussain & Abidi, 1991). Germination of seeds was recorded for ten days after sowing. After 10 days of sowing, shoot and root lengths and biomass was recorded.

Foliar spray bioassay. Clay pots of 30-cm diameter were filled with air-dried and sieved field soil taken from Botanical Garden, University of the Punjab, Lahore. Five gram of home garden fertilizer obtained from market was

thoroughly mixed in the soil at the time of filling of pots. Each pot contained five kg of soil. The pots were placed in wire netting enclosure for growth experiment under prevailing natural climatic conditions. Initially, five surface sterilized and presoaked seeds were sown in each pot, which were thinned to three uniform seedlings per pot after germination. After 10 days of sowing, plants were sprayed with 10, 30 and 50% w/v aqueous extracts of *P. hysterophorus*. Control plants were sprayed with sterilized water. Each treatment was replicated thrice. Application of spray at ten days intervals were carried on up to 90 days.

A total of two harvests were designed. First harvest was taken after 45 days of sowing and second after next sixty days corresponding to two growth stages viz., vegetative and maturity, respectively. At each harvest, plants from three replicate pots of each treatment were carefully uprooted. Shoots were separated from roots and their lengths and fresh weights were recorded. Samples were then oven dried at 60°C till constant weight. At the final harvest, capitulum diameters as well as fresh weights were also recorded and seeds in each capitulum were counted.

All the data were statistically analyzed by applying Duncan's New Multiple Range (DMR) Test on computer software COSTAT at 5% level of significance.

RESULTS

Aqueous extract bioassay. Data regarding the percentage seed germination of sunflower, exposed to various concentrations of aqueous shoot extract of *P. hysterophorus*,

Fig. 1. Effect of aqueous extracts of *Parthenium hysterophorus* on germination of sunflower. Vertical bars show standard errors of means of three replicates; Values with different letters show significant difference ($P = 0.05$) as determined by DMR test

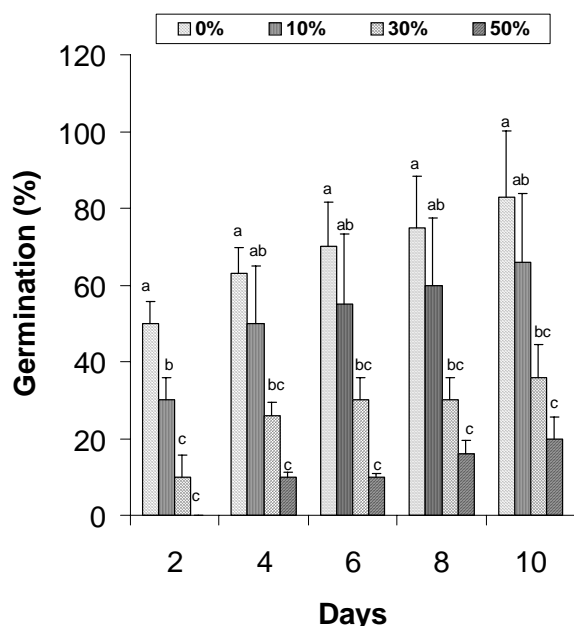
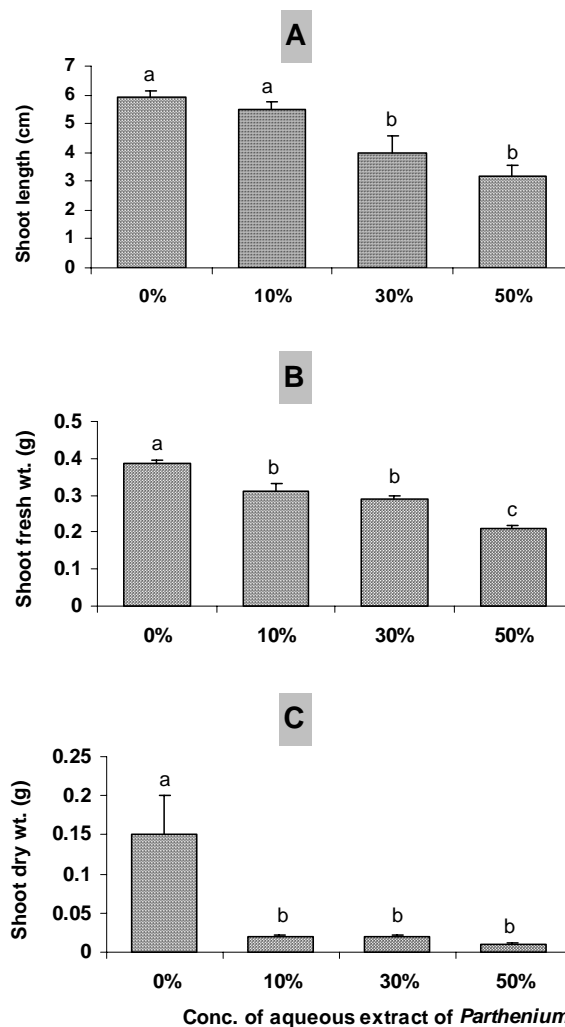


Fig. 2 (A–C). Effect of aqueous extracts of *Parthenium hysterophorus* on shoot growth of sunflower. Vertical bars show standard errors of means of three replicates; Values with different letters show significant difference ($P = 0.05$) as determined by DMR Test

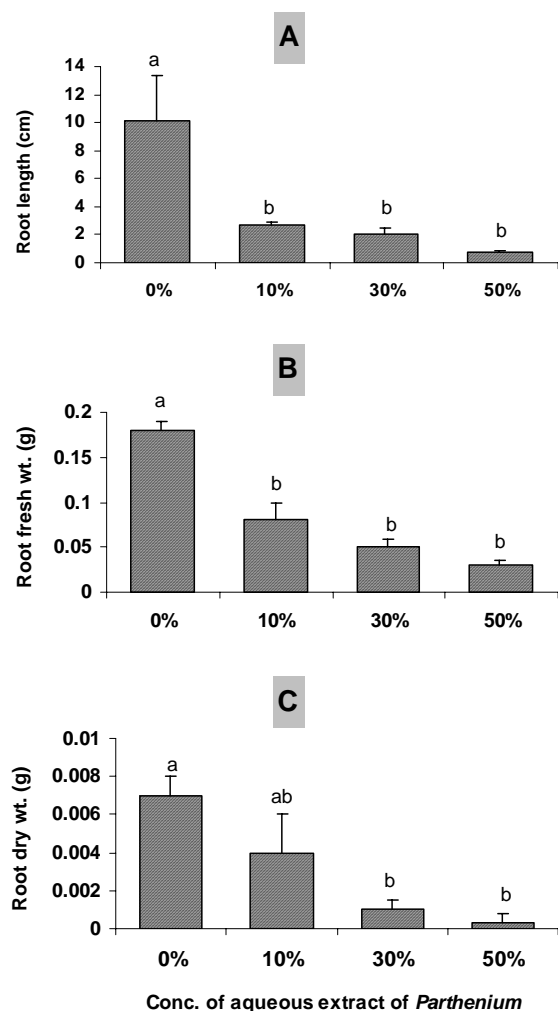


are presented in Fig. 1. The results indicate that germination was suppressed in all the concentrations of aqueous extract of *P. hysterophorus* and the rate of inhibition was directly proportional to the level of concentration.

Shoot length was not significantly affected by lower concentration of allelochemicals. The higher concentrations of 30 and 50%, however, caused significant reduction in shoot length (Fig. 2-A). The shoot growth in terms of fresh biomass production was significantly depressed in all concentrations as compared to control, the affect being more pronounced at 50% concentration (Fig. 2-B). The data on dry weight gain of shoot revealed that the dry biomass production of seedlings was most severely affected (Fig. 2-C).

Root growth was inhibited significantly under

Fig. 3 (A–C). Effect of aqueous extracts of *Parthenium hysterophorus* on root growth of sunflower. Vertical bars show standard errors of means of three replicates; Values with different letters show significant difference ($P = 0.05$) as determined by DMR Test

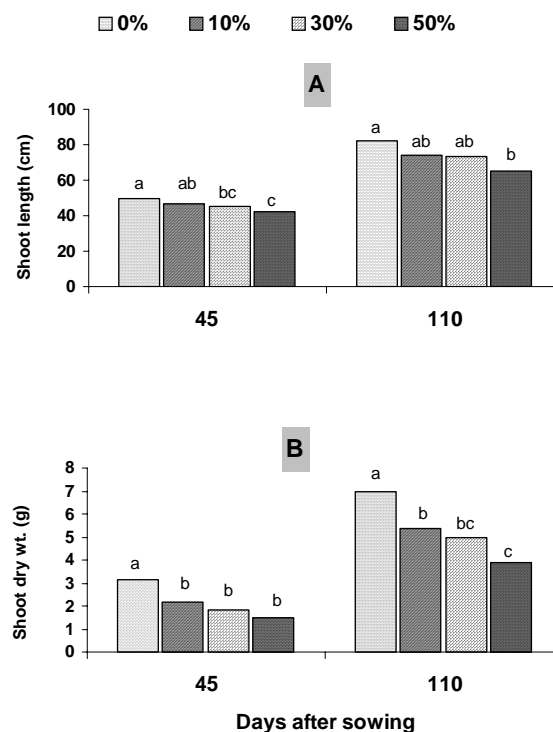


allelopathic effect of all the concentrations. Growth in length as well as fresh and dry weight losses were directly proportional to increasing concentrations of the aqueous extracts. Dry biomass production was significantly inhibited in 30 and 50% concentrations of aqueous extract (Fig. 3A–C).

Foliar spray bioassay. The data on average shoot length at two harvest intervals indicate that the shoot length of test species was significantly suppressed by 50% foliar spray treatment (Fig. 4-A). Dry weight decline was statistically significant and parallel to dosage. Lowest shoot biomass was observed in plants sprayed with 50% extract (Fig. 4-B).

Root length was found to be adversely affected by all concentrations of the aqueous extract. However, the effect was not statistically significant in the earlier stage of

Fig. 4 (A–B). Effect of foliar spray of aqueous extracts of *Parthenium hysterophorus* on shoot growth of sunflower. Values with different letters show significant difference ($P = 0.05$) as determined by DMR Test



growth. In the later stages dosage effect became more pronounced and a particularly sharp decline in root growth, in terms of length, was observed in higher dosage treatments of 30 and 50% (Fig. 5A). Root dry weight production was significantly suppressed by the aqueous extracts. The inhibitory potential of the extracts was increased by increasing the concentration (Fig. 5B).

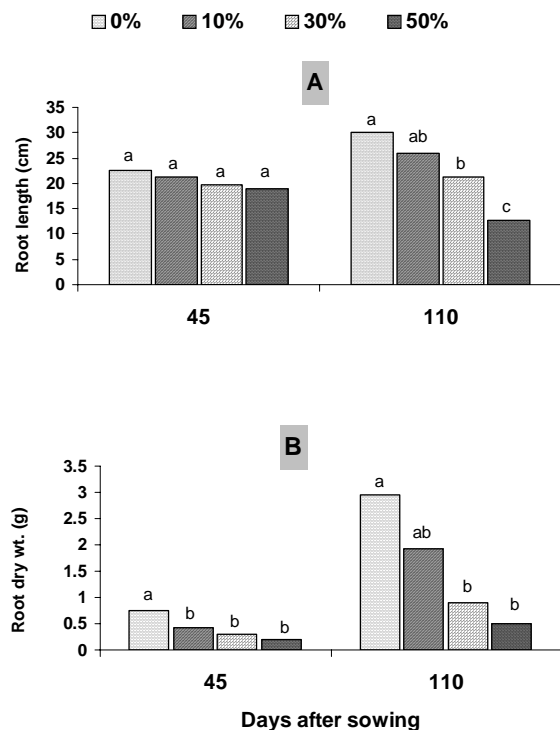
The spray of different concentrations of aqueous extract significantly suppressed the capitulum diameter. A similar inhibitory effect was also recorded on capitulum biomass and number of seeds per capitulum (Fig. 6 & 7).

DISCUSSION

The present investigations reveal that the *P. hysterophorus* has strong allelopathic potential against sunflower. Aqueous shoot extracts of the species employed in various concentrations caused significant inhibition in germination and growth of the test crop species. Similarly, in foliar spray assays the test species was found to be highly susceptible. Under the allelopathic stress, the growth was severely depressed. Dosage effect was highly pronounced and directly proportional to the increasing concentrations of aqueous shoot extract.

Aqueous extract from shoot of *Parthenium* invariably

Fig. 5(A–B). Effect of foliar spray of aqueous extracts of *Parthenium hysterophorus* on root growth of sunflower. Values with different letters show significant difference ($P = 0.05$) as determined by DMR Test



reduced the germination and seedling growth of sunflower and the effect was more pronounced in high concentrations. These results are in line with earlier findings (Kill & Yun, 1992; Bajwa *et al.*, 1998) and the reduced germination and seedling growth inhibition have been attributed to the presence of water-soluble inhibitors (Hussain & Abidi, 1991).

In pot experiment, shoot growth in terms of shoot length and biomass production was markedly suppressed by aqueous extract of *Parthenium* in the test species. Similar observations have also been demonstrated by Hsu *et al.* (1989) and Lawrence *et al.* (1991) in other plant species. Foliar applications of allelopathic extract employed in higher concentrations probably affected the photosynthetic activity of leaves due to which the growth in terms of length and dry weight was markedly influenced. Furthermore, the allelochemicals are also known to reduce uptake of nutrients (Kolesnichenko & Aleikina, 1976), suppress the activity of growth hormones such as IAA and Gibberellins (Kefeli & Turetskaya, 1976) and disturb the process of photosynthesis (Barkosky *et al.*, 1999), which may result in declined shoot growth. It has also been suggested that other basic plant process such as respiration, chlorophyll production, hormonal balance, protein synthesis, permeability and plant water relations may alter by allelopathic compounds

Fig. 6(A–B). Effect of foliar spray of aqueous extracts of *Parthenium hysterophorus* on diameter and dry weight of capitula of sunflower. Values with different letters show significant difference ($P = 0.05$) as determined by DMR Test

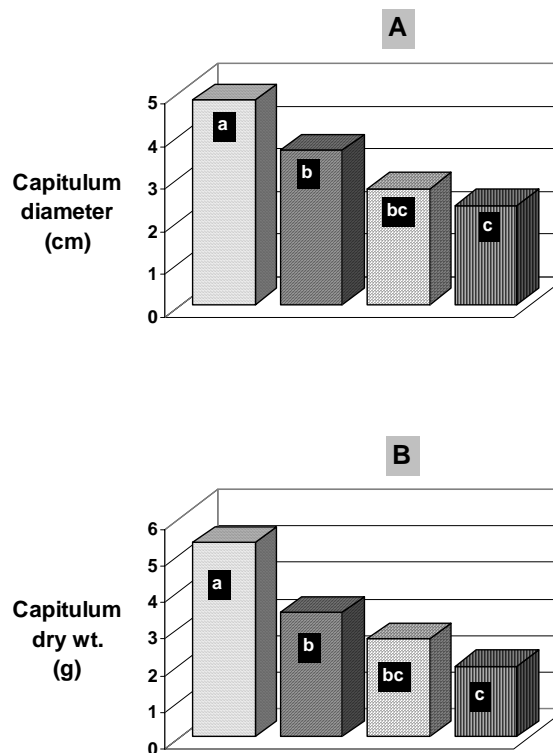
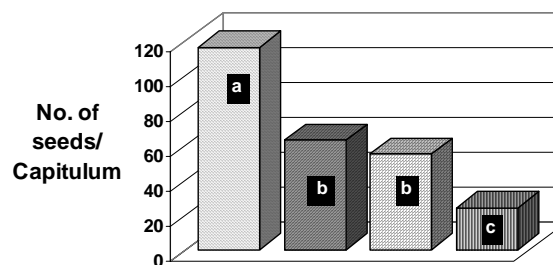


Fig.7. Effect of foliar spray of aqueous extracts of *Parthenium hysterophorus* on number of seeds per capitulum of sunflower. Values with different letters show significant difference ($P = 0.05$) as determined by DMR Test.



(Yamane *et al.*, 1992).

The reduced shoot growth under the allelopathic stress may also be attributed to reduced root growth. Root length as well as root fresh and dry weight of test species was significantly suppressed by aqueous shoot extract of *P. hysterophorus*. These observations are also supported by the findings of Afzal *et al.* (2000), who reported that root

growth of *Vigna radiata* and *Phaseolus vulgaris*, both in terms of length and biomass production, was significantly reduced by aqueous shoot extract of *Imperata cylindrica*, at all the growth stages. Hussain and Abidi (1991) have also reported similar reduction in root growth of *Dicanthium annulatum*, *Chrysopogon montanus* and *Medicago polymorpha* by the *Imperata cylindrica*. The reduced root growth of test species may also be attributed to the reduced mitotic activity of root cells under allelopathic stress (Jensen & Welbourne, 1962; Bukolova, 1971). The reduced root and shoot growth under the allelopathic resulted in declined capitulum's diameter and biomass the test

The sunflower test species exhibited a variable response with respect to extract concentrations. The varied susceptibility of different species to such extracts has previously been attributed to inherent differences in physiological and morphological characteristics of test species (Shaukat *et al.*, 1983). The species specificity of phytotoxins has also been demonstrated for extracts of *Lolium multiflorum* Lamb (Naqvi & Muller, 1975), *Artemisia herba-alba* Asso., (Friedman *et al.*, 1977), *Inula grantioides* Boiss. (Shaukat *et al.*, 1983) and *Albizia samans* Merr. (Noor & Khan, 1994). Toxicity is associated with the presence of strong electrophilic and nucleophilic system, which act on specific positions of proteins and enzymes, alter their configurations and affect their activity (Macias *et al.*, 1992).

Thus, the evidence obtained from present studies on germination and growth response of sunflower to aqueous extracts strongly suggests a highly marked allelopathic potential of *P. hysterophorus* against this species. Since in Pakistan, *Parthenium* is very extensively spreading in all open localities, wastelands and roadsides and is emerging as a real threat, if early appropriate measures to stop its invasion are not taken in time then it may become a major weed problem in our cultivated lands.

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