

## Allelopathic responses of *Parthenium hysterophorus* L. on germination and seedling vigour in *Sorghum vulgare* L. and *Cajanus cajan* L. and control measures for the weed

G.P. Satsangi, J.N. Shrivastava, Sandhya Kumari and Nidhi Gangwar  
Dayalbagh Educational Institute, Dayalbagh Agra, India

**Summary** The present investigation is an attempt to explore the allelopathic responses of *Parthenium hysterophorus* upon germination and seedling vigour of *Sorghum vulgare*, and *Cajanus cajan*, in order to ascertain the allelopathic potential of foliar extracts of *Azadirachta indica*, *Eucalyptus tereticornis* and *Datura alba* on seed germination of parthenium weed and suggest ways and means to control it. It was found that aqueous extract of *Parthenium hysterophorus* exhibits significant inhibitory effect on the growth of seedlings of *Cajanus cajan*. The maximum inhibition on germination was noticed in stem extract and minimum in root extract. In *Sorghum vulgare* seeds, maximum inhibition in germination was observed in root extract of the weed. Root-shoot elongation were also observed in root extract of the weed. In parthenium weed, maximum phenolic content was present in basal parts and minimum in leaves. The germination of *Parthenium hysterophorus* was inhibited maximum in *Azadirachta indica*, *Eucalyptus tereticornis* and least in *Datura alba*. People's participation should be encouraged for coming forward in eliminating parthenium weed by enlightening them of ill effects of this dangerous weed upon their lives. An Integrated Weed Management approach should be followed as an ideal control process for this noxious weed.

**Keywords** Allelopathic responses, parthenium, crop seeds, germination/seedling vigour.

### INTRODUCTION

*Parthenium hysterophorus* has drawn considerable attention of scientists as a grave health hazard causing several allergic diseases to human beings, such as dermatitis, eczema, rhinitis (hay fever), asthma, and bronchitis. It is native to Mexico and South America and has been widespread throughout India and in many other countries. Infestations occur along roadsides, railway tracks and irrigation channels. It is the second most abundant species on crop lands and is perceived as one of the most troublesome. It's allelopathic effect coupled with the absence of natural enemies is responsible for its rapid expansion, occupying more than six million hectares in both cropped and non-cropped areas in India. Parthenium weed residue releases phenolics affecting growth and nitrogen fixing potential in

pigeon pea (*Cajanus cajan*) fields (Mall and Dagar 1979). Aqueous extract exhibits a significant inhibition on germination of seeds and growth of seedlings of *Sorghum vulgare*, *C. cajan* and many more crops. The seed germination of *P. hysterophorus* was inhibited by leachates from chickpea (*Cicer arietinum*), mung bean (*Phaseolus mungo*) and *C. cajan* (Dhawan 1997). Oudhia (1999) reported the positive inhibitory allelopathic effect of some obnoxious weeds on germination and seedling vigour of various plants. Therefore, the present investigation is an attempt to explore the allelopathic responses of *P. hysterophorus* on *S. vulgare* and *C. cajan*, in order to ascertain the allelopathic potential of foliar extracts of some medicinal plants on germination of parthenium weed seeds and suggest ways and means to control the weed.

### MATERIALS AND METHODS

*Parthenium hysterophorus* plants were collected from crop fields. The roots, stems and leaves of the weed were cut and chopped into small pieces and allowed to decay in water separately for 4, 7, 10 days in a ratio of 1:10 w/v of weed material and water respectively. These decayed plant parts were filtered by Whatman's filter paper Number 40. These extracts and glassware were sterilised by autoclaving at a pressure of 15 lbs. inch<sup>-2</sup> for 15–20 minutes before experimentation.

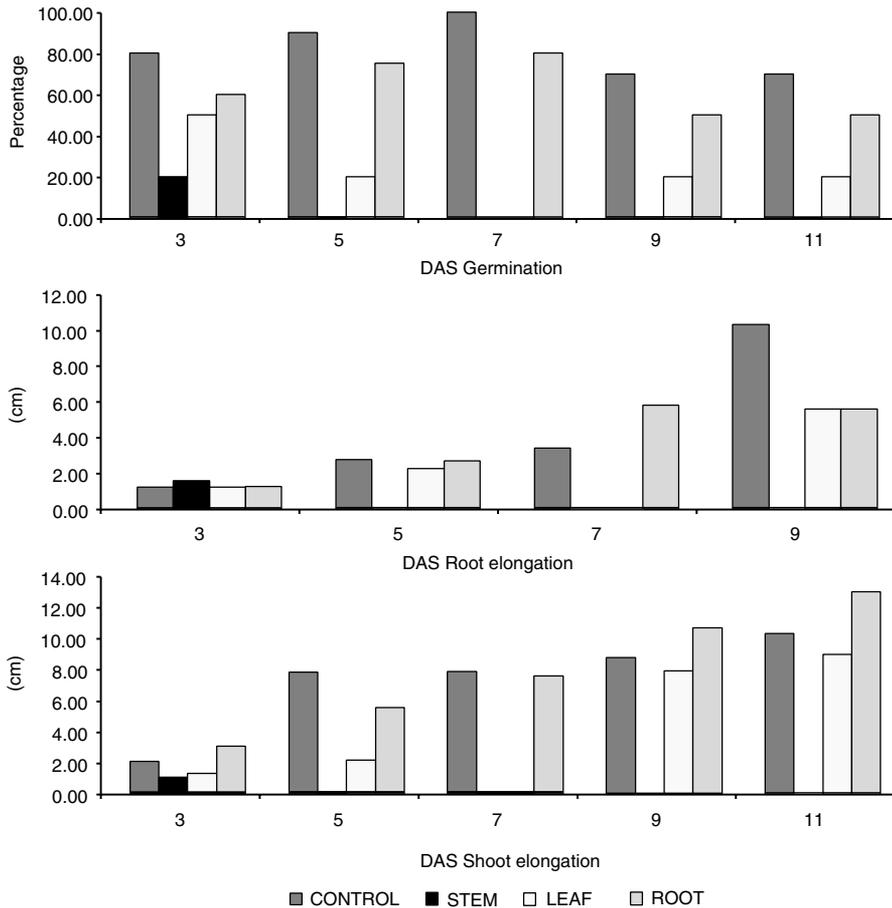
**Bioassay** The seeds of *C. cajan* and *S. vulgare* were soaked separately for 24 hours in 100 mL of aqueous extracts of different parts of *P. hysterophorus*. Seeds soaked in distilled water served as the control. The experiment was conducted in randomised block design in three replications (Oudhia *et al.* 1998). These seeds were arranged in Petri dishes lined with moist cotton and Whatman's filter paper Number 40. The status of germination, and root and shoot elongation after 3, 5, 7, 9, and 11 days after treatment were recorded. Bioassays were also conducted for aqueous leaf extracts of three medicinal plants viz. neem (*Azadirachta indica*), *Eucalyptus tereticornis* and *Datura alba* on germination of parthenium weed. Fresh leaves of these plants were collected just before sunrise (Dhawan and Dhawan 1995). Plant materials and water in ratio of 10:15 w/v was centrifuged at 5000 rpm, digested for 24 hours,

filtered volume of the filtrate was stored at 0°C. Its various concentrations (25, 50, 100%) were prepared using double distilled water as per requirement. Seeds of *P. hysterophorus* were germinated at 25 ± 2°C in Petri plates in BOD incubator. The treatment was replicated thrice with its control by using only doubled distilled water. Observations were recorded on 7th and 14th day after treatment and analysed accordingly.

**Phenol estimation** The germinated seeds of *C. cajan* in control and treated with parthenium weed were put into earthen pots for seedling growth. Thirty days old seedlings were selected for phenol estimation. In the same way, different parts of the *P. hysterophorus* weed were also used for phenol estimation available in it by Swain and Hullis (1959) method.

RESULTS AND DISCUSSION

**Allelopathic responses of *Parthenium hysterophorus* on germination and seedling vigour** It has been found that aqueous extracts of different parts of *P. hysterophorus* viz. root, stem and leaf exhibited a significant inhibition germination and seedling growth of *C. cajan* seed over the control. Maximum inhibition was caused by stem extract on the 3rd day (20% germination) which were totally inhibited after 5th day onward, followed by leaf and root extracts where seeds germination obtained 60% and 50% respectively. Although root extract supported germination (60%), almost similar trend is visualised in both parameters viz., root and shoot elongation. Maximum growth caused in root extract treated seeds, while it was minimum in stem extract treated seeds. Growth inhibition was observed after five days. Thereafter root elongation was completely on subsequent days no root elongation was noticed (Figure 1).



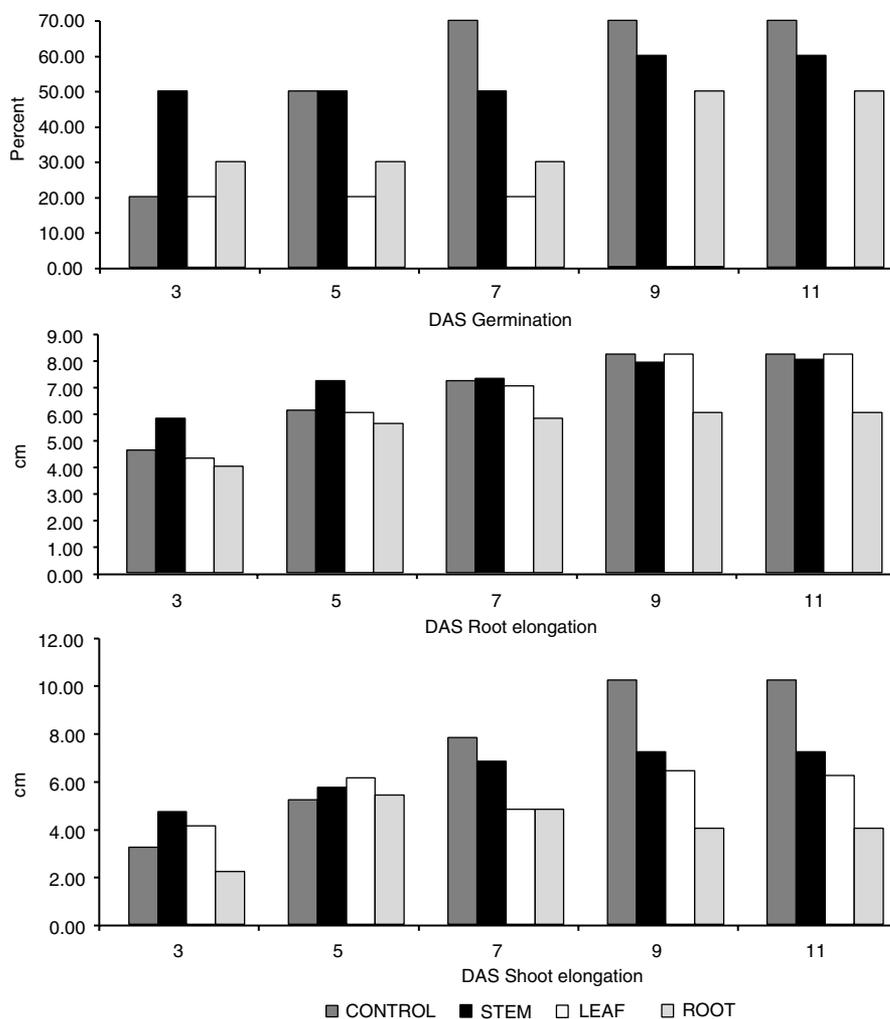
**Figure 1.** Effect of aqueous extracts of different parts of *Parthenium hysterophorus* on germination, root and shoot elongation in *Cajanus cajan*. DAS = Days After Soaking.

In case of *S. vulgare* seeds, it is observed that *P. hysterophorus* bears certain toxins responsible for inhibiting the germination of seeds. Maximum inhibition of the seeds caused in root extracts. In general, germination rate is directly related to number of days passed. Seedling vigour, root, shoot elongation are also directly associated with number of days. Maximum vigour is found in stem and leaf extract of *P. hysterophorus* while it is minimum in root extract (Figure 2).

**Phenolic analysis** The analysis shows that phenols estimated in all parts of the *P. hysterophorus* unevenly. Maximum phenol was recorded in roots and minimum in the leaves. In *C. cajan* plants (untreated with

aqueous extracts of different parts of *P. hysterophorus*) however, the phenol was evenly distributed all three parts respectively. *C. cajan* seedlings grown from the seeds treated with aqueous extracts of different parts of *P. hysterophorus* showed enhanced phenolic contents substantially in all its parts viz., root, stem and leaf. Maximum phenol quantity appeared in stem ( $1.283 \times 10^{-4} \text{ mg mL}^{-1}$ ), while the least in the root part ( $4.09 \times 10^{-5} \text{ mg mL}^{-1}$ ) (Figure 3).

**Effect of foliar extracts on germination of parthenium weed seeds** Foliar extracts of all the three plants viz., *A. indica*, *E. tereticornis* and *D. alba* inhibited the germination of parthenium weed seeds. In 50% concentration and 100% concentration of



**Figure 2.** Effect of aqueous extracts of different parts of *Parthenium hysterophorus* on germination, root and shoot elongation in *Sorghum vulgare*. DAS = Days After Soaking.

extracts of these plants caused 100% inhibition of the seed germination of the weed. With 25% concentration the inhibition ranged from 70 to 80% on the 7th day and 45 to 80% on the 14th day, whereas water treated control only 10% parthenium weed seeds could inhibit. The remaining 90% were germinated. Thus, growth of *P. hysterophorus* can be checked by spraying the foliar extracts of *A. indica*, and *E. tereticornis* at high concentration at the initial stages of the seed germination of the weed (Figure 4).

**Ways and means to control *Parthenium hysterophorus*** This weed can be controlled by taking mechanical, biological, chemical, legal and other measures as well as by integrating the available approaches.

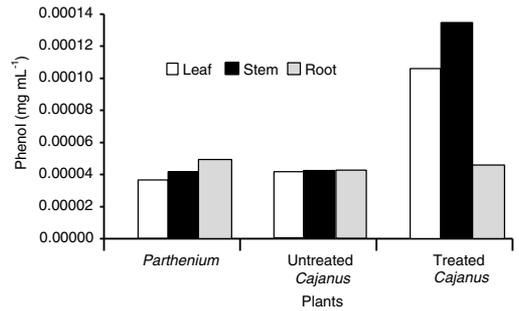
**Mechanical** The area infested with the weed should be ploughed thoroughly before flowering. Mowing should be repeated in wastelands. During rains, weed plants may be cut by sickles, heaped at one place and burnt with paddy hay drenched with kerosene oil to destroy the weed seeds. These activities should be done on mass scale by launching public campaigns against the weed.

**Biological** The insect *Zygogramma bicolorata* is a safe bio-agent and can be used for biological control of the weed. This pest has been successfully tried at Sullanpalya, Bangalore for controlling *P. hysterophorus* (Jayanth 1987).

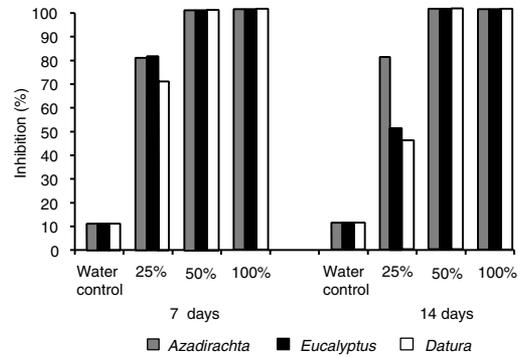
**Chemical** In non-cropped areas, spraying of 2,4-D amine salt (2–4 kg ha<sup>-1</sup>), picloram (10 kg ha<sup>-1</sup>), glyphosate (2–2.25 kg ha<sup>-1</sup>), atrazine (1.25 kg ha<sup>-1</sup>) or urea (20% solution) on the plants was found to be quite effective at all stages of growth. In cropped areas, pre-emergence treatment by atrazine (1.5–2 kg ha<sup>-1</sup>) controls the weed up to 5–8 months. Application of 2,4-D (1.5 kg ha<sup>-1</sup>) as post-emergence remedy controls the weed in sorghum fields.

**Legal** In India management of *P. hysterophorus* has been tried through legal act by issuing a notification in Karnataka State on 23 October 1975 in section 3, read with sub section (7) of the section 21 of Karnataka Agricultural Pest and Disease Act 1968, without much success. It may be attributed to lack of proper follow up action by administration Bhan *et al.* (1997) therefore, it is suggested that other states should also enact legislation against *Parthenium* with more administrative responsibility and control.

**Others** Planting of marigold adversely affects the germination and growth of *P. hysterophorus*. Similarly sowing of *Cassia sericea* with *Stylosanthes thymalis* in fields drastically reduces the population of parthenium weed. *Abutilon indicum* and *Tefrosia purpurea* may also be used for controlling the weed by cutting and incorporating it into the soil (Shankaran *et al.* 1996).



**Figure 3.** Phenolic content of different parts of *Parthenium hysterophorus* and *Cajanus cajan* (treated and untreated).



**Figure 4.** Inhibition of seed germination of *Parthenium hysterophorus* in aqueous foliar extracts of different plants.

An integrated approach of all the available measures for effective parthenium weed control as recommended by Bhan *et al.* (1997) seems to be the ideal way and measure for controlling this noxious weed growth.

The study indicated that filtrate of *P. hysterophorus* reduced the seed germination and seedling vigour of the crop seeds. It may be due to the presence of certain allelochemicals. Chandra *et al.* (1998) reported that *P. hysterophorus* contains several chemicals like germacrene D, geranial etc. Major constituents and compounds like Oct-1-en-3-ol, tran. Ol, trans cimins b-myrene, geranyl acetate, caryphellene oxides in traces Mall and Dagar (1979), Singh (1997) have also found inhibitory responses of foliar extracts of *P. hysterophorus* on germination and seedling growth up on a number of crops.

Synergistic effect of parthenium weed filtrate was also observed. Radosevich and Hott (1984) reported that effect of phenolics has been found more severe on seedling growth rather than germination. In the present study, phenol estimation showed its maximum

presence in basal parts which are usually left in the fields affecting the subsequent crops. Significant decrease in seed germination of crop seeds at higher level of filtrate may be due to presence of these chemicals.

Earlier reports state that roots, stems and leaves are a source of allelochemicals. Leaves are more consistent source of such inhibitors and considered to contain fewer and less potent toxins in small quantity (Aldrich and Kramer 1997). These results have been confirmed in present study. Dhawan and Dhawan (1993) and Shankaran *et al.* (1996) studied the impact of leaf extracts of trees over germination of *P. hysterophorus*. Dhawan (1997) studied the effect of fast growing trees specially *A. indica* and *E. tereticornis* on *P. hysterophorus* and concluded that allelochemicals extracted from these plants have potential use in controlling the *P. hysterophorus*. The present study also confirms this. *A. indica* leaf extracts have been found to influence the behavioural ecology and disrupt growth. The leaves of *D. alba* contain maximum quantity of alkaloids mainly hyoscyne, which does not permit the germination of the seeds of *P. hysterophorus*.

#### CONCLUSION AND SUGGESTIONS

On the basis of above discussions, the following conclusions may be suggested:-

- A bold program should be launched to enlighten the public about the ill effects of the weed for their health and seek their active participation for its elimination.
- An Integrated Weed Management approach should be adopted in place of depending on any single measure.
- Emphasis should be laid to adopt bioherbicides by replacing chemical ones to guard the crops against ill effects of chemical herbicides.

#### ACKNOWLEDGMENT

The authors express a deep sense of gratitude to Prof. S.S. Bhojwani, Director of the Institute, for giving us his valuable time and encouragement. Thanks are also due to Prof. V.P. Bhatnager, Head Botany Department, for providing laboratory facilities and cooperation.

#### REFERENCES

Aldrich, R.W. and Kramer, R.J. (1998). Principles in weed management. (Panima Publishing Corporation, New Delhi).  
Bhan, V.M., Sushil Kumar and Raghuvanshi, M.S. (1997). Future strategies for parthenium management. International conference on parthenium management, University of Agricultural Sciences, Dharwad, India, 6-8 October, Vol. 1, pp. 90-95.

Chandra, S., Shah, A.K., Prabhu Dutt, B. and Kaul, B.L. (1998). Essential oil composition of two weeds viz., *Parthenium hysterophorus* and *Ageratum sp.* Under Jammu Condition, Extended Abstracts of First International Agronomy Congress, Indian Society of Agronomy and ICAR, New Delhi, pp. 537.  
Dhawan, S.R. and Dhawan, Poonam (1993). Bio-control of *Parthenium hysterophorus* studies on seed germination, Proceeding of International Symposium on Integrated Weed Management for Sustainable Agriculture, Indian Society of Weed Science, Hisar, India, Vol. 2, pp. 24-26.  
Dhawan, S.R. and Dhawan, Poonam (1995). Effect of aqueous foliar extracts of some trees on germination and early seedling growth of *Parthenium hysterophorus* L. The World Weeds, Vol. 2 (3 and 4), pp. 217-222.  
Dhawan, S.R. (1997). Allelopathic inhibition of parthenium seed germination by plant extracts. *Flora and Fauna* 3 (2), 121-122.  
Jayanth, K.P. (1987). Introduction and establishment of *Zygramma bicolorata* on *Parthenium hysterophorus* L. in Bangalore India, *Current Science* 56, 310-311.  
Mall, L.P. and Dagar, J.C. (1979). Effect of *Parthenium hysterophorus* extract on germination and early seedling growth of three crops, *Journal of Indian Botanical Society* 58 (1), 40-43.  
Oudhia, P., Kole, S.E.S. and Tripathi, R.S. (1998). Stimulatory allelopathy of *Calotropis gigantea* R.Br. on germination and seedling vigour of linseed. Extended Summaries of First International Agronomy Congress, Indian Society of Agronomy and ICAR, New Delhi, pp. 27.  
Oudhia, P. (1999). Allelopathic effects of *Lantana camara*. *Acta. Bot. Indica* 27 (1), 1003-5.  
Radosevich, S.R. and Hott, J.S. (1984). 'Weed ecology - implication for weed management', pp. 264 (Wiley and Sons, New York).  
Sankaran, S., Kadasamy, O.S., Lognathan, C. and Balssubrahmaniam, N. (1996). Effect of various plants leaf leachates on the germination and seedling growth of *Parthenium hysterophorus*. In 'Allelopathy: field observations and methodology', eds S.S. Narwal and P. Taro. (Scientific Publishers, Jodhpur, India).  
Singh, S.P. (1997). Perspective in biological control of *Parthenium hysterophorus*. Proceedings of First International Conference on Parthenium Management, Dharwad, India, 6-8 October 1997.  
Swain, T. and Hullis, W.E. (1959). The phenolic constituents of *Prunus domestica*. *J. Sci. of Food and Agriculture* 10, 63-68.