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Assessment of Allelopathic Potential of Parthenium hysterophorus L. leaf extract on germination and growth of Chenopodium album L.

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ABSTRACT

To reduce usage of chemical herbicides in farms and gardens and developing sustainable agriculture, this article studies the allelopathic effects of *Parthenium hysterophorus* leaf aqueous extract on seed germination and sapling growth of *Chenopodium album.* A study conducted to assess the inhibitory growth effects of *Parthenium hysterophorus* and to understand the weed to weed interference in a broader prospective. The seeds of the test plant, an invasive weed, *Chenopodium album* L were soaked into three different concentrations of the leaf aqueous extract of *P. hysterophorus* to assess the effect of extract on the growth of the test plant. The leaf extract from the freshly collected leaves of *Partenium* was prepared with some desired modifications to combat the osmotic effect. The study revealed that aqueous leaf extract of *Parthenium hysterophorus* have significantly affected the germination and initial growth of a test plant. Further, we observed a progressive reduction in the plant growth in terms of root length, shoot length and dry biomass with increasing concentration of leaf aqueous extract. The study concludes that *Parthenium hysterophorus* is an allelopathic plant with the ability to inhibit the germination and growth of weeds and offers an eco-freidnly approach to weed management and combat the crop losses incurred by weeds.

Key words: *Parthenium hysterophorus, Chenopodium album* allelopathy, weed management, leaf extract,

I. INTRODUCTION

Weeds have been shown to exert a significant economic and ecological impact on the ecosystem. These have the deleterious capability to interfere and thereby reduce the crop yield to a greater extent. To combat the losses incurred by weeds different chemical herbicides has been employed. These herbicides exert a drastic impact on our environment and their escape into water bodies has proven lethal to natural flora and fauna. Various alternative measures for weed management with eco-friendly tendencies to minimize the apparent deadly influences from herbicides and pesticides have been proposed and allelopathy has been postulated as the viable strategy to the weed menagement. The allelopathic suppression of one plant by another plant is often confused to be the response of competition. In broader prospective, it is a biotic interference more like a chemical warfare in which a donor plant executes its allelochemicals to negatively affect the growth and establishment of another plant(s) in its surrounding. The term allelopathy was first introduced by Molisch in 1937 [1]. Since then many researchers are constantly surfing and screening out plants with allelopathic potential. Biochemicals with inhibitory properties already exist in many plants and different plants employ different organs including leaves,

stem, roots, flowers, fruits, bark and buds for their accumulation [2, 3, 4, 5]. Khanh et al., presented allelopathy as a successful tool for sustainable agricultural production [6]. The reduction in crop yield due to the weeds remains a threat to the global food production and need of the hour is the management of weed through the eco-friendly techiques. Weed inhibition by allelopathy promises new possibilities of weed management in agricultural practices [7]. Allelopathy is a natural ecological process in which various donor species inhibit or promote the functioning of recipient species in their proximity [8] by releasing allelochemicals [9] through volatilization, leaching, decomposition of residues, leaf and root exudation [10, 11]. Allelochemicals are secondary metabolites that are produced by plants to affect the overall growth of other neighboring plants [9].

Chenopodium album (family, Chenopodiaceae) is an annual weed found extensively in the gardens and crop fields of Aligarh, Uttar Pradesh, India, causes heavy loss to crop productivity. *Parthenium hysterophorus* (family, Asteraceae), another weed, is one of the major and serious pests that infest the local crops of Aligarh affecting the crop quality and yield. A few preliminary allelopathic studies conducted in the past showed the inhibitory effect of *P. hysterophorus* on growth and development of recipient plants. Extracts from leaf and flower of *Partheium* inhibited seed germination and seedling growth of *Eragrostis tef* [12] and *Lactuca sativa* [13]. *Parthenium* residues have reflected a strong inhibitory effect on the growth and establishment of *Brassica* species [14]. The research on allelopathic interference of this weed through root exudates and root residues is scanty. It is thus hypothesized that *Parthenium* leaves with comparatively more biomass possess relatively more allelochemicals than its roots. An *in vitro* study was therefore planned to determine weed against weed interference, the role of leaf aqueous extract of *P. hysterophorus* in imparting an allelopathic effect on the germination and growth of C. album, target plant, since *C. album* is a serious weed.

II. MATERIALS AND METHODS

2.1 Collection of the plant material

The leaves of *Parthenium hysterophorus* were freshly collected from many sites in Aligarh, Uttar Pradesh (27°, 29°, to 28°, 10° north latitude and 77°, 29° to 78°, 38° east longitude), at a distance of about 126 Km from India's capital New Delhi.

2.2 Preparation of leaf extract

The leaf extract from the freshly collected leaves of *Partenium* was prepared using the protocol of Netsere and Mendesil [15] with desired modifications. The osmolality of extract was measured with vapor pressure osmometer (VAPRO 5520). It varied between 104–106 m mol/Kg that did not induced any osmotic effect, i.e. exosmosis in our test plant. The leaf extract was filtered through Buchner funnel with Whatman filter paper no.1 and was stored at room temperature under the dark condition for 24 hours for further use. After the said time different concentrations (0.5%, 2% and 8%) of the leaf extract were prepared by adding double distilled water.

2.3 Seeds

Seeds of the test plant *Chenopodium album* were purchased from Weed Research Institute, Jabalpur, MP, India. Ten seeds of each plant in triplicate were sterilized with 0.1 % $HgCl_2$ solution (0.5g HgClCs powder was dissolved in 500 ml distilled water) for 5 sec [16]. The surface sterilized seeds were washed with sterilized distilled water in laminar air flow (Microfilt, India) 4-5 times before using for the germination assay.

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2.4 Assessment of the allelopathic effect of the leaf extracts of Parthenium hysterophorus.

To assess the allelopathic effect of the leaf of *P. **hysterophorus*** on *C. album,* following parameters were studied:

1. Effect of the leaf extract of *P. hysterophorus* on percent seed germination of *C. album*.
2. Effect of the leaf extract of *P. hysterophorus* on growth parameters (root length, shoot length, and dry biomass) of *C. album.*

2.4 Effect of the leaf extract of *P. hysterophorus* on seed germination of the selected plant seeds (*in vitro*)

Germination assay

The seeds of the test plant were soaked into three different concentrations (0.5%, 2% and 6%) of the leaf extract of *P. hysterophorus* for 24 hours. In control, distilled water was added. The seeds were aseptically planted in the sterilized Petri-plates (Borosil) with germination paper. All the three concentrations of the *P. hysterophorus* leaf extract were applied to the seeds of each plate (triplicate) except the control. All the plates were incubated at room temperature for 8 days. To keep germination paper wet each plate was watered (10ml) regularly under aseptic conditions. After the 8th day, the percent germination of the seeds, average (triplicate) and standard deviations were calculated using one-way analysis of variance (ANOVA). The root length, shoot length, and dry biomass of the test plant seedlings were calculated after 15 days.

Statistical analysis

The experiment was performed in triplicates. One way analysis of variance (ANOVA) from SPSS version 16.0 was used to test the significant difference of all the data recorded in the studies. The data are presented in the form of mean with standard error and considering p values < 0.05 as significant. All results were statistically analyzed through DMRT (Duncan, 1955).

IV. RESULTS

4.1 Assessment of the allelopathic effect of the leaf extracts of P. hysterophorus on seed germination of C. album.

After eight days of incubation at room temperature the percentage of germination was calculated by counting the total number of germinated plantlets. The seeds of the test plant *C. album* showed normal germination at control (87.66±1.45). The germination of the test plant was significantly reduced at all the concentrations of aqueous leaf extracts of *P. hysterophorus.* We observed that the germination percentage of our test plant was very low at the higher concentration of leaf aqueous extract. The results revealed that the reduction in germination was concentration dependent. The maximum inhibition in germination percentage (59.33±2.33) was recorded at 2% concentration, however, there was a complete inhibition of germination in seeds treated with 8% leaf aqueous extract. The highest percentage of germination was recorded at 0.5% concentration of aqueous leaf extract (77.66±1.45) (Fig 1).

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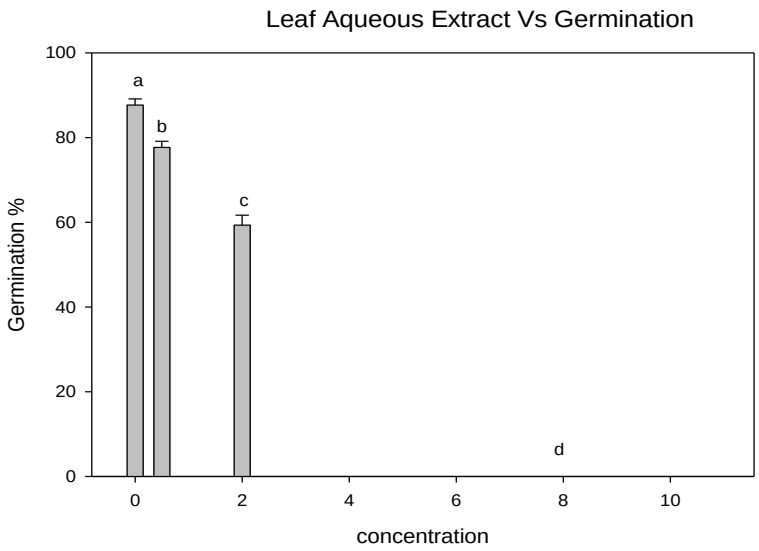

Fig. 1 Allelopathic effect of leaf aqueous extract of *Parthenium hysterophorous* on the germination percentage of *Chenopodium album*.

4.2 Assessment of the allelopathic effect of the leaf extract of *P. hysterophorus* on root length, shoot length and dry biomass of *C. album*.

The growth of *P. hysterophorus* measured in terms of root, shoot length and dry biomass reduced significantly in *C. album* compared to control (Fig 2). The inhibitory effect was more on root than shoot length. The control plant showed a root length of about 12.66±0.88. All the treatments of aqueous leaf extract reduced the root length significantly. There was nearly 50% reduction in root length in the plants treated with 2% aqueous leaf extract. Reduction in root length, shoot length and dry biomass was concentration dependent. The control plants showed a mean shoot length of about 10.66±0.88. All the treatments reduced significantly the shoot length and the maximum reduction was recorded in plants treated with 2% leaf extract (5.5±0.28). There was significant reduction in the dry biomass of the test plant in all treatment in concentration dependent manner. In control the dry biomass was recorded as 10.00±0.01 and the maximum reduction occurred in plants treated with 2% leaf extract was calculated as 4.5±0.28. We observed a progressive decline in all the growth parameters with the increase in concentration of leaf aqueous extract.

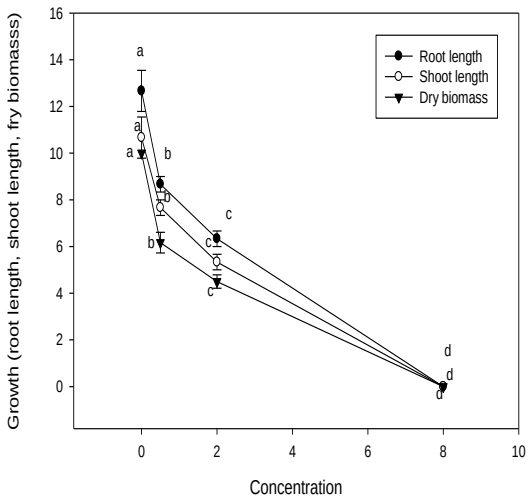

Fig. 2 Allelopathic effect of leaf aqueous extract of *Parthenium hysterophorous* on the root length (cm), shoot length (cm) and dry biomass (mg) of *Chenopodium album*.

V. DISCUSSIONS

The present study demonstrates that the leaf aqueous extracts of *P. hysterophorus* exerts a phytotoxic influence on *C. album.* In all the leaf extract treatments; root length, shoot length and dry biomass reduced indicating thereby the presence of some growth inhibitors. Possibly, these inhibitors come from the weed through either or all of the modes of release of allelochemicals like leachation, decomposition of dead and decaying tissue or root exudates [8]. Upon treatment, these accumulate in toxic levels and affect the plant growth. The present study where bioassay plants were grown directly on petriplates bears a great ecological significance since it demonstrates allelopathy under laboratory conditions [17]. Several studies have shown that leaves form an active site where allelochemicals accumulate and can be used to inhibit the growth of weeds and help in weed management. The results indicate that leaf extract from *P. hysterophorus* show phytotoxicity and their effect was differential and tissue specific with phytotoxicity in the order dry biomass> root length> shoot length. This shows that leaf extracts of *P. hysterophorus* contain growth inhibitory metabolites that significantly decrease the overall growth of the test plant. Aqueous extracts prepared from leaf extract of *P. hysterophorus* were toxic to the test plant mainly due to the adverse affect on growth and developmental process of plants. This indicates the presence of inhibitors in leaf that may leach out with water under field condition and impart its negative effect on the growth of other neighbouring plants. It has been demonstrated by several workers that even the leaf debris amended in soil severely affected growth of wide range of test plants. Such a finding is not novel, as a number of weed residues impart inhibitory and play role in the suppression of the emergence and growth of other plants including economically important crops [18]. The results indicate that the allelochemicals of *P. hysterophorus* not only retard growth of the test plants but also reduced the germination percentage of test plant to a greater extent thereby showing its possible role in weed management. Even though the molecular

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mechanism of this decrease is not known yet, the observed reduction could be due to enhanced degradation of already present proteins or due to their reduced synthesis. Irrespective of the mechanism involved, a decline in the amount of proteins impart adverse affect on the growth and development of the test plants. The bioassay studies with leaf extract reflect that it contains some inhibitory components that reduce the growth of test plants. Possibly, these inhibitors release from the leaf extract accumulate into the petriplates and play role in decreasing the growth parameters of the test plant. Several workers have analysed the leaf composition and have found an appreciable amount of phenolics – the most common metabolites in fresh leaves, shoots, roots and leaf debris. Phenolics have been postulated as the most common water-soluble allelochemicals known to play a significant role in plant-plant interactions including allelopathy [19, 20]. These being soluble in water find it easy to leach out from green foliage through rainfall and get accumulated in soil in toxic levels, where they bring about subsequent changes in growth and vegetation patterns on the other plants [21]. Based on the results, the study concludes that *P. hysterophorus* interferes with *C. album* through weed to weed interaction and offers a promising way out to weed management in an eco-friendly manner.

VI. REFERENCES

[1] H Molisch, Einfluss einer pflanze auf die andere, *Allelopathie*,1937.

[2] Inderjit, and K. M. M. Dakshini, Allelopathic effect of Pluchea lanceolata (Asteraceae) on characteristics of four soils and tomato and mustard growth, *American Journal of Botany*, 1994, 799-804.

[3] Z.Y. Ashrafi, S. Sadeghi, and H.R. Mashhadi, Allelopathic effects of Barley *(Hordeum vulgare*) on germination and growth of wild varley (*Hordeum spontaneum*), *Pakistan Journal of Weed Science Research, 13*, 2007, 99-112.

[4] A Gulzar and M.B. Siddiqui, Evaluation for allelopathic impact of Terminalia arjuna (Roxb.) wight and arn bark against Cassia sophera. *African Journal of Agricultural Research, 8*(*39*), 4937-4940.

[5] A Gulzar and M.B. Siddiqui, Allelopathic effect of aqueous extracts of different part of Eclipta alba (L.) Hassk. on some crop and weed plants. *Journal of agricultural extension and rural development*, *6*(*1*), 2014, 55-60.

[6] T.D. Khanh, M. I. Chung, T.D. Xuan, and S. Tawata, The exploitation of crop allelopathy in sustainable agricultural production, *Journal of Agronomy and Crop Science*, *191*(*3*), 2005, 172-184.

[7] H.P. Singh, D.R. Batish, and R.K. Kohli, Allelopathic interactions and allelochemicals: new possibilities for sustainable weed management, *Critical reviews in plant sciences*, *22*(*3-4*), 2003, 239-311.

[8] E.L. Rice, Allelopathy, 2nd Edition (Academic Press: Orlando, Florida, 1984, 422).

[9] M Farooq, K. Jabran, Z.A. Cheema, A. Wahid, and K.H.M. Siddique, The role of allelopathy in agricultural pest management, *Pest management science 67(5)*, 2011, 493-506.

[10] M.O. David, and T. N. Erik, The physiology of plants under stress: soil and biotic factors (*John Willey and Sons Inc., New Jersey*, 2000, 352-377).

[11] L.A. Weston, P.R. Ryan, M. Watt, Mechanisms for cellular transport and release of allelochemicals from plant roots into the rhizosphere, *Journal of Experimental Botany*, *63*(*9*), 2012, 3445–3454.

[12] T Tefera, Allelopathic effects of *Parthenium hysterophorus* extracts on seed germination and seedling growth of *Eragrostis tef*, *Journal of Agronomy and Crop Science*, *188*(5), 2002, 306-310.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

[13] M Wakjira, G. Berecha, and B. Bulti, Allelopathic effects of *Parthenium hysterophorus* extracts on seed germination and seedling growth of lettuce, *Tropical Science 45*(*4*), 2005, 159-162.

[14] H.P. Singh, D.R. Batish, J.K. Pandher, and R.K. Kohli, Phytotoxic effects of *Parthenium hysterophorus* residues on three *Brassica* species, *Weed Biology and Management* 5(3), 2005, 105-109.

[15] A Netsere and E. Mendesil, E, Allelopathic effects of *Parthenium hysterophorus* L. aqueous extracts on soybean (*Glycine max* L.) and haricot bean (*Phaseolus vulgaris* L.) seed germination, shoot and root growth and dry matter production. *Journal of Applied botany and food quality*, *84*(2), 2012, 219.

[16] S Maharjan, B.B. Shrestha, and P.K. Jha, Allelopathic effects of aqueous extract of leaves of *Parthenium hysterophorus* L. on seed germination and seedling growth of some cultivated and wild herbaceous species. *Scientific World*, *5*(*5*), 2007, 33-39.

[17] J. T. Romeo, Raising the beam: Moving beyond phytotoxicity. *Journal of Chemical Ecology 26*, 2000, 2011 – 2014.

[18] J. R. Qasem, and C. L. Foy, Weed allelopathy, its ecological impacts and future prospects: a review. *Journal of Crop Production 4*, 2001, 43 – 119.

[19] U Blum, S. R. Shafer, and M. E. Lehman, Evidence for inhibitory allelopathic interactions involving phenolic acids in field soils: Concepts vs. an experimental model. *Critical Reviews in Plant Sciences 18*, 1999, 673 – 693.

[20] J Mizutani, Selected allelochemicals. *Critical Reviews in Plant Sciences 18*, 1999, 653 – 671.

[21] E Castells, J. Penuelas, and D. W. Valentine, Effects of plant leachates from four boreal understorey species on soil N mineralization, and white Spruce (Picea glauca) germination and seedling growth. *Annals of Botany 95*, 2005, 1247 – 1252.