

ALLELOPATHIC EFFECTS OF INVASIVE ALIEN SPECIES *PARTHENIUM HYSTEROPHORUS* L. ON SEED GERMINATION OF PADDY AND WHEAT

Binita Shrestha and Chandra Bahadur Thapa

Department of Botany, Prithvi Narayan Campus, Tribhuvan University, Pokhara Nepal

E-mail: binishrestha1995@gmail.com

cbthapadr@yahoo.com

ABSTRACT

The invasive species are the major cause of crop loss, across the globe, mainly due to their allelopathic effects on the growth of crop plants. In this study, we explored the allelopathic effects of *Parthenium hysterophorus* on germination of two major cereal crops of Nepal, Rice (*Oryza sativa*) and Wheat (*Triticum aestivum*). The experiment was conducted at laboratory of Department of Botany, Prithivi Narayan Campus, Pokhara, Nepal during 2017. In laboratory, seeds of rice and wheat were treated with aqueous extracts of *P. hysterophorus* plant parts viz. root, stem, leaf, inflorescence and whole plant with concentration of 5, 10, 15 and 20%. The experiment was laid out in a complete randomized design (CRD) in a factorial arrangement with three replicates of each test. The result suggests that the effect was more on wheat than on rice. The maximum inhibition in seed germination of rice was recorded by the inflorescence extract however, in wheat seed germination was inhibited by leaf extract. In both rice and wheat, roots were highly affected than shoots because root first encounters the toxic allelochemicals and absorbs it. The highest concentration (20%) of leaf, inflorescence and whole plant extract was found to be most pernicious whereas root and stem were recorded to have little effects.

Key words : Alien species, allelopathy, invasive, germination.

INTRODUCTION

Invasive Alien Species (IAS) are introduced from foreign countries or the regions of the country either by intentionally or unintentionally due to human activity, that has encroached the native species as it has self- establishing capacity and has resulted in the clear changes in the native biodiversity (Masum *et. al.*, 2013). IAS get successfully established in any ecosystem because of their special capacity like high growth rate, high reproductive potential, adaptive nature and allelopathy (Kholi and Rani, 1994). Among these, allelopathy plays a vital role to invade a new ecosystem (Callaway and

Aschehoug, 2000; Hierro and Callaway, 2003). Thus, allelopathy is the chemical effect of any plant or microorganism to the surrounding plant or microorganism species that is able to inhibit and stimulate their growth. *Parthenium hysterophorus* is one of the invasive alien species/weed that has a strong allelopathic effect on the other species. Now, this noxious weed is considered as the major threat to the native ecosystems.

Parthenium hysterophorus belongs to the plant family Asteraceae. It is an annual, erect and profusely branched herb. It is usually 50-150 cm long, stem highly branched; leaf simple with

profusely dissected leaflets; flower head occur on a corymb, phyllaries 10 in 2 series, ovate, dull white, 3-4mm in diameter; disc floret; numerous, dull white; stamen-4, anther-exserted; ovary sterile; ray floret found just opposite to inner phyllaries only 5 ray florets per flower head, corolla obsolete, stamen-absent, stigma-parted, style short, ovary oval, dorsiventrally flattened. Fruit cypsela, each flower head bearing 5 cypselas, flat and triangular shape with thin, white, spoon shaped appendages (Maharjan, 2006). A mature plant can produce 15000-25000 seeds (Haseler, 1976; Joshi, 1991). Seeds can germinate immediately but if buried under soil, can remain viable even up to 4-6 years (Navie *et al.*, 1998). *Parthenium hysterophorus* germinates during spring, produce flower and seeds throughout its life period and dies in winter (Adkins *et al.*, 2014). This invasive plant can germinate, grow and flower at the varieties of climatic conditions, mostly favors warm climate. It can survive in a wide variety of soils like fertile (black, alkaline, cracking-clay soil), sandy loam, and clay loams (Adkins *et al.*, 2014). Especially, the polluted area, pasture land, roadside and railways tracks, agricultural land nearby highways are suitable for the profuse growth of *P. hysterophorus*.

Parthenium hysterophorus is originated by the natural hybridization between *P. confertum* and *P. bipinnatifidum* (Nath 1998). It was supposed that the weed was native to Central America, the West Indies and South America (Picman and Picman, 1984) and later on has spread to many countries of Asia, Africa and Australia (Navie *et al.*, 1996). It is an alien invasive weed species considered as the world's seventh most devastating and poisonous weed (Bezuneh, 2015). It is locally known as congress grass, carrot weed, bitter weeds, false ragweed, fever few, white top, in different parts of the world

(Bhowmik *et al.*, 2007). *Parthenium* weed has now invaded more than 20 countries including 5 continents and many islands. South East Asia, the Pacific and Western Africa are likely to have the adverse effect of invasion by *P. hysterophorus*

Parthenium hysterophorus is presumed to have entered Nepal with food grains, vehicles and imported goods from India because of the open boarder between India and Nepal. In Nepal, it is commonly called as Kanike ghash, Bethu ghans, padke phul (Tiwari *et al.* 2005). In Pokhara valley, it is also called as seto paati, as its leaves are similar to *Artimisia* (Tite pati) and this weed has white flowers. This insalubrious weed was first reported from Nepal by Hara *et al.*, 1982 and the herbarium specimen was collected for the first time in 1967 by Malla from Trisuli (Tiwari *et al.*, 2005). In the recent context of Nepal, this noxious weed has already encroached roadsides of most of the highways and pasture lands and are in the process. Similarly, in case of Pokhara Valley *P. hysterophorus* is seen usually in the dumping sides (Polluted area), on the roadways, play grounds (pasture land), etc., But it has not encroached the agricultural land yet which are far away from the roadways but the farm lands near transportation area are badly affected.

Rice (*Oryza sativa*) and Wheat (*Triticum aestivum*) are the two staple cereal crops grown in different parts of Nepal. The rapid spread of *P. hysterophorus* is likely to have an adverse effect on the growth of the major staple food crops, including rice and wheat. Thus, in this study, we aimed to investigate the allelopathic effects of *P. hysterophorus* on the germination and growth of two major cereal crops of Nepal.

MATERIALS AND METHODS

The experiment was conducted at the Botanical laboratory of Prithivi Narayan Campus, Pokhara. Mature (flowering) *Parthenium hysterophorus*

were uprooted from five different areas of Pokhara valley; Chauthe, Chhorepatan, Hari Chowk, Malepatan and Sirjana Chowk. The collected plant samples were thoroughly washed with tap water to remove the soil and other particles. The plants were then separated into different parts like leaf, inflorescence, stem, root and whole plant and dried in an oven at about 70°C. The different plant parts were packed properly in the air tight plastic bags for about five months. The seeds of Rice (local variety-Gurdi) and Wheat (varieties WK 1204, Rampur composite) were also collected from different places of Pokhara. After five months, the cut small parts of the plant were grounded separately with pestle and mortar. Powdered and aqueous extracts were prepared by using the methods of Heisey (1990). Five, 10, 15 and 20 grams of each (leaf, inflorescence, root, stem and whole plant) plant part was weighted and 100 ml distilled water was added. The solution was left for 24 hours for soaking at room temperature (21-25°C). After 24 hours of soaking, it was filtered through muslin cloth followed by Whatman's no. 1 filter paper and hence extracts of 5, 10, 15 and 20% concentration solution were prepared. The seeds of Rice and Wheat were treated with 0.1 % of Sodium hypochlorite for 2-3 minutes and then washed for several times with distilled water for surface sterilization. Then, 10 seeds of rice and wheat were placed in a petridish (9 cm diameter) lined with Whatman's no. 1 filter papers and crop seeds were moistened by 10ml each of 5%, 10%, 15% and 20% aqueous extracts and distilled water (Control). The laboratory experiment comprised of 50 treatment of five different concentrations (5%, 10%, 15% and 20% along with distilled water that served as a control), for each of leaf, stem, root, inflorescence and whole plant with two crop seeds (Rice & Wheat). The treatments

were arranged in a complete randomized design (CRD) with 3 replications. All the replicates were kept on the bench of a laboratory with 12 hours supply of fluorescent light during the night. Seeds were considered to be germinated with the emergence of the radicle. Data on germinated seeds (in number) were collected from the next day of sowing to the seventh day. The average data obtained from the experiment in the laboratory was subjected to statistical analysis. Standard deviation was calculated using STDEV-statistical software (STDEV Version 7, 2008).

RESULTS AND DISCUSSION

Effect of Parthenium hysterophorus extracts on seed germination of Rice

Seed germination was observed to be affected by the treatment of extracts. The germination percentage declined with the increase in the concentration of different parts and whole plant of *P. hysterophorus* on rice. Inflorescence extract was more inhibitory as compared to the other parts. The percentage of inhibition by inflorescence extract as compared to control were 96.7 ± 4.71 , 73.33 ± 20.54 , 63.33 ± 12.5 and 60 ± 8.2 in 5%, 10%, 15% and 20% respectively. Also, the results showed that the different part of *Parthenium* differ in their allelopathic potential and found that crop species were also variously sensitive. However, at low concentration (5%), all seeds were germinated in root, stem, leaf and whole plant extract except in inflorescence extract. Our current findings are consistent with the previous findings. Tedele (2002) found a low effect of inflorescence and leaf extract at the lowest (1.0%) concentration on seed germination of teff. The root and stem extract of *P. hysterophorus* were recorded to have lower effect on rice seeding germination as compared to other extracts. Similarly, in the record of

Tedele (2002), there was no adverse effect on teff seed germination with aqueous extracts from root and shoot of *P. hysterophorus*. As the concentration of extract increased, the rate of inhibition increased and 20% concentration was found more severe than others whereas in root, stem, leaf and whole plant the pattern of inhibition was more or less similar but 20% extract concentration of whole plant was found to be more inhibitory than root, stem and leaf (Fig. 1)

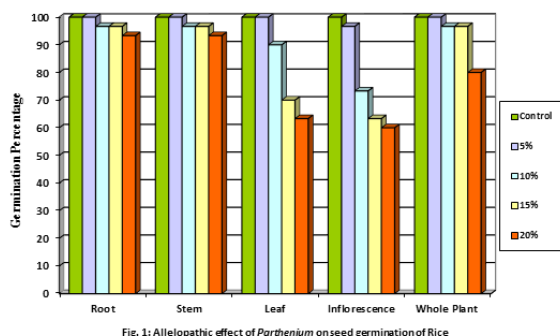


Fig. 1: Allelopathic effect of *Parthenium* on seed germination of Rice

Effect of *Parthenium hysterophorus* extracts on seed germination of wheat

Allelopathy of *P. hysterophorus* showed intense suppression effects to wheat like in rice. In the highest concentration (20%), of leaf extract was noted as the most harmful for wheat, as none of the seeds was germinated (Fig. 2); inhibition by leaf extract on wheat germination as compared to control were: 53.33 ± 12.5 , 20 ± 8.2 , 6.7 ± 5 , zero (0) in 5, 10, 15, and 20% respectively. Then the whole plant, inflorescence, stem and root were observed to be notorious to wheat respectively. Even in lower concentration 5%, seed germination was highly affected. While in case of rice, lower concentration hadn't such pronounced effect, this might be due to different allelopathy potential on different species. Species-species variation in reaction to aqueous extract of *P. hysterophorus* was reported in previous studies (Srivastava *et al.*, 1985;

Mersie and Singh, 1987; Kohli *et al.*, 1996 and Kidanie, 2011). As the concentration increases, the rate of germination declines (Fig. 2).

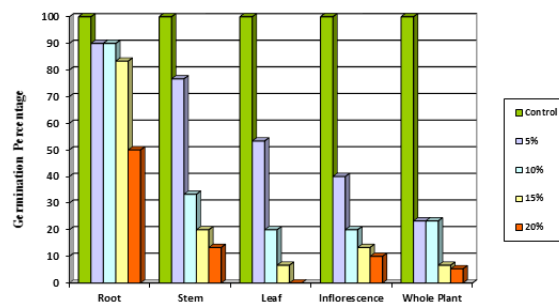


Fig. 2: Allelopathic effect of *Parthenium* on seed germination of Wheat

CONCLUSIONS

We found that the extract of *P. hysterophorus* has a significant adverse effect on the germination of two major staple crops of Nepal. Considering its high rate of invasion across the agricultural lands in Nepal and its inhibitory effect on the growth of Rice and Wheat, its eradication should be taken into a high priority. If this invasive herb is not controlled properly, it would cause a devastating threat to the Nepalese staple crops, leading to an adverse effect on our food security.

ACKNOWLEDGMENTS

We are thankful to the Department of Botany, Prithvi Narayan Campus, for providing laboratory facilities. We highly acknowledge the contribution of an anonymous reviewer to improve the standard of this manuscript.

REFERENCES

- Adkins S.W, S Sangita., S Asad., B.B. Shrestha (2014). The Biology and Management of *Parthenium* weed Now Affecting the Native and Agro-Ecosystems of Nepal. *Proc. of the International Conference on Invasive Alien Species Management*, 23-29
- Bhowmik P.C. and J.D. Doll (2007). Allelopathic effect of annual weed residues on growth and its potential management. *Ecoprint*

14:1-17

- Bezuneh T.T. (2015). Phytochemical and Antimicrobial Activity of *Parthenium hysterophorus* L.: A Review. *Science Journal of Analytical Chemistry*, **3(3)**:30-38. doi;10.11648/j.sjac.20150303.11
- Callaway R.M. and E.T. Aschehoug (2000). Invasive plants versus their new and old neighbours: a mechanism for exotic invasion. *Science*, **290**: 521-523
- Haseler, W. H. (1976). *Parthenium hysterophorus* L. in Australia. *Pest Articles & News Summaries* (PANS). **22**: 515-517
- Heisey R.M. (1990). Allelopathic and herbicidal effects of extracts from tree of heaven *Ailanthus altissima*. *American J. Bot.* **77**: 662-670
- Hierro J.L. and R.M. Callaway (2003). Allelopathy and exotic plant invasion. *Plant and Soil* **256**: 29-39
- Joshi, S., (1991). Interference effect of *Cassia uniflora* Mill. On *Parthenium hysterophorus* L. *Plant and Soil*. **132**: 215-223
- Kidanie A.B. (2011). *Allelopathic effects of Parthenium hysterophorus* L. on Germination, Seedling Growth and Biomass production of Chickpea and Sesame; M.Sc Thesis, Haramaya University
- Kohli R.K., D. Rani, H.P. Singh and S. Kumar (1996). Response of crop seeds towards the leaf leachates of *Parthenium hysterophorus* L. *Indian Journal of Weed Science*, **28**: 104-106
- Maharjan, S. (2006). *Phenology, leaf attributes and allelopathic potential of Parthenium hysterophorus* L., a highly allergic invasive weed in Kathmandu valley, M.Sc. Thesis, Central Department of Botany, Tribhuvan University.
- Masum S.M., H. Mirza and M.H. Ali (2013). Threats of *Parthenium hysterophorus* on agroecosystems and its management: a review. *International Journal of Agriculture and crop sciences*, **6(11)**, 684-697.
- Mersie, W. and M. Singh (1987). Allelopathic effect of *Parthenium* (*Parthenium hysterophorus* L.) extract and residue on some agronomic crops and weeds. *Journal of Chemical Ecology*, **13**: 1739-1747
- Nath, R. (1988). *Parthenium hysterophorus* L.-A Review. *Agricultural Review* **9(4)**: 171-179
- Picman J. and A.K. Picman (1984). Autotoxicity in *Parthenium hysterophorus* and its possible role in the control of germination. *Biological Systematics and Ecology*, **12**:287-92
- Srivastava, J.N., J.P. Shukla and R.C. Srivastava (1985). Effect of *Parthenium hysterophorus* L., extract on the seed germination and seedling growth of barley, pea, and wheat. *Acta Bot Indica*, **13**: 194-197
- Tedele (2002). Allelopathic effects of *Parthenium hysterophorus* on seed germination and seedling growth of *Eragrostis tef*. *Journal of Agronomy and Crop Science*, **188**: 306-310
- Tiwari S., B. Adhikari, M. Siwakoti, and K Subedi (2005). *An Inventory and Assessment of Invasive Alien Plant Species of Nepal*. IUCN- The World Conservation Union, Nepal.

Received 18 Feb 2018,

Revised accepted 13 July 2018