

**ALLELOPATHIC EFFECT OF *Parthenium hysterophorus* ON GROWTH AND YIELD OF EGGPLANT (*Solanum melongena* L.)****AWANISH KUMAR SINGH<sup>1</sup>**

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**ABSTRACT**

The experimental study was conducted to evaluate the allelopathic effects of *Parthenium hysterophorus* on the vegetable crop eggplant (*Solanum melongena* L.). Fresh leaves of *Parthenium hysterophorus* were collected, sun-dried, and soaked for 24 hours; the filtrate was diluted with tap water to make different concentrations. There were five treatments viz., C0 (tap water); C1 (25% concentration); C2 (50% concentration); C3 (75% concentration); and C4 (100% concentration). The experiments were laid out in the Randomized Block Design (RBD) with three replications. Leaf leachates of *P. hysterophorus* at 25%, 50%, 75%, and 100% concentrations were applied to determine their effect on seed germination and growth parameters of the test crop in pot culture. Germination was significantly higher in the control group, but growth parameters showed a different trend. The gross return, net return, and higher cost-benefit ratio were reported maximum when the crops were treated with the 50% concentration. The results showed that allelochemical stress caused by aqueous *P. hysterophorus* was most pronounced in the 100% concentration (C4), causing severe inhibition. From this, we can predict that *Parthenium hysterophorus* possesses allelochemicals that exhibit both suppressive (at high concentrations) and stimulatory (at moderate concentrations) abilities on eggplant.

**KEYWORDS:** Allelopathy, Germination, Seedling Length, *Parthenium hysterophorus*, Eggplant, *Solanum melongena*

In the present world, various types of ecological and environmental disasters are taking place due to the high use of synthetic chemical compounds in agriculture. These toxic chemicals are damaging the ecological balance to a severe extent and introducing many fatal diseases. Synthetic fertilizers often contain toxins that can be destructive to the soil and leach into groundwater. Therefore, the demand for sustainable agriculture and eco-friendly alternatives to chemical compounds has increased.

Allelopathy is a natural ecological process of chemical inhibition or stimulation of one species by another, where substances acting as germination or growth modulators are released into the environment, influencing the development of nearby plants. The term Allelopathy was introduced by Professor Hans Molisch in 1937, derived from two Greek words allelon ("of each other") and pathos ("to suffer") (Molisch, 1937). Allelopathic chemicals can be present in any part of the plant, including leaves, flowers, roots, fruits, or stems.

The phenomenon of allelopathy refers to chemical interactions between all sorts of plants. During this process, the chemical exudates or leachates released from leaves, stems, or roots of a plant will inhibit the expansion of a neighboring one (Dongre and Singh, 2011). Stimulatory and inhibitory allelopathic effects depend upon the concentration of allelochemicals (Hill *et al.*, 2006). Higher concentrations of allelochemicals have been observed to have an inhibitory effect while lower concentrations exert a stimulatory allelopathic impact on

seed germination and growth of plants (Sahoo *et al.*, 2010).

*Parthenium hysterophorus* L. is native to tropical and subtropical America. It is a highly aggressive invasive weed that has severely threatened agricultural and grassland ecosystems in India, disrupting local biodiversity and crop production (Kohli *et al.*, 2006). The successful spread of *Parthenium* in so many parts of the world has been attributed to its allelopathic properties, primarily driven by the sesquiterpene lactone 'parthenin', which enables it to compete effectively with otherwise strong crop or pasture species (Stephen and Sowerby, 1996; Belz *et al.*, 2007).

Eggplant (*Solanum melongena* L.) belongs to the large and diverse Solanaceae family. It is a commercially important vegetable crop widely cultivated in India. This study aims to understand how the aqueous leaf extracts of *P. hysterophorus* impact the growth, germination, and yield of eggplant, helping to determine the ecological weed-crop interaction in field settings.

**MATERIALS AND METHODS****Study Area and Plant Collection**

The present study was conducted at the laboratory of the Department of Botany, S. G. N, Govt. P. G. College, Muhammadabda, Gohna, Mau, U.P. in the month of August 2016. Mature fresh plants of *Parthenium hysterophorus* L. were collected from the college campus and brought to the laboratory. Healthy eggplant seeds were procured from the local agricultural market, washed, and air-dried.

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### Preparation of Aqueous Leaf Extract

The collected leaves were sun-dried for 4-5 days. The dried leaves were crushed and soaked in tap water for 24 hours at a 1:10 proportion (weight by volume). After 24 hours, the leaf extract was filtered using a muslin cloth, and extracts of different concentrations were prepared. Thus, there were five treatments: C0: Control (Tap water)

- C1: 25% Concentration extract
- C2: 50% Concentration extract
- C3: 75% Concentration extract
- C4: 100% Concentration extract

### Phytotoxicity Test and Pot Culture

Before the seed germination test, empty and undeveloped seeds were discarded by floating them for 5 min in tap water. The seeds were surface sterilized with 0.1% mercuric chloride (HgCl<sub>2</sub>) solution for 3 min and washed 6-7 times with distilled water.

Polyethylene bags of 10 kg capacity were half-filled with 5 kg of air-dried loamy soil. Five seeds of eggplant were sown per bag, and 250 ml of the respective leaf exudates were added, while distilled water was used for the control. The bags were watered every alternate day with 100 ml of distilled water. The experiments were carried out under 70% relative humidity at 25°C with a 12 h photoperiod in a completely randomized block design with three replicates.

The germination of seeds was recorded on the 15th day after sowing (DAS). After germination, we remove all the plants except one or two healthy plants in polyethylene bag. Plant height, days to flowering, and yield parameters (fruits per plant, total yield) were recorded at 30, 60, and 90 DAS. Experimental results were statistically analyzed using critical difference (CD at 5%) as a measure of significance.

## RESULTS AND DISCUSSION

### Germination Percentage (%)

The highest percentage of germination was found at treatment C0 (Control). As the concentration of the plant extract increased, the percentage of seed germination was inhibited compared to the control in eggplant. The lowest germination percentage was recorded in C4 (100% concentration). Similar suppression of crop germination due to *Parthenium* aqueous extracts and soil residues has been well documented by Batish *et al.* (2002). Studies with other species have also reported that the response to allelochemicals is strongly concentration-dependent (Dongre *et al.*, 2004; Dongre *et al.*, 2010; Dongre and Singh, 2011). Allelochemicals that inhibit the growth of some species at certain concentrations might stimulate the growth of the same or different species at different concentrations (Narwal, 1994) (Table 1, Fig 1).

**Table 1: Effect of different concentrations of *Parthenium hysterophorus* leaf extract on Eggplant Height (cm) and Germination**

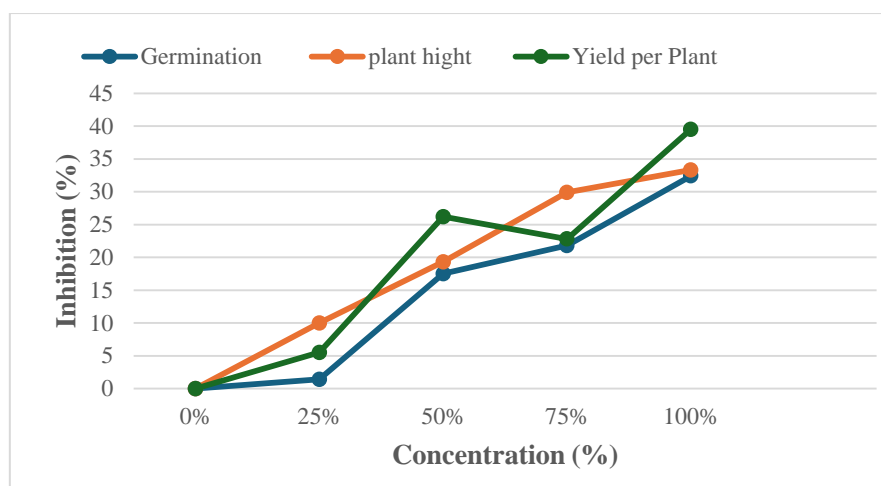
| Treatment    | Germination (%) | Plant Height at 30 DAS (cm) | Plant Height at 60 DAS (cm) | Plant Height at 90 DAS (cm) |
|--------------|-----------------|-----------------------------|-----------------------------|-----------------------------|
| C0 (Control) | 100.0           | 31.00                       | 55.00                       | 61.50                       |
| C1 (25%)     | 98.6 (-1.4)     | 28.60 (-7.7)                | 42.20 (-23.2)               | 55.32 (-10.0)               |
| C2 (50%)     | 82.5 (-17.5)    | 22.40 (-27.7)               | 38.10 (-30.7)               | 49.64 (-19.3)               |
| C3 (75%)     | 78.2 (-21.8)    | 20.80 (-32.9)               | 37.30 (-32.1)               | 43.10 (-29.9)               |
| C4 (100%)    | 67.6 (-32.4)    | 19.02 (-38.6)               | 34.00 (-38.2)               | 41.00 (-33.3)               |
| CD at 5%     | 5.9             | 1.9                         | 3.3                         | 4.0                         |

Data in parentheses indicate percent decrease from control.

**Table 2: Effect of different concentrations of leaf extract of *Parthenium hysterophorus* on Yield Parameters of Eggplant**

| Treatment    | Days to Flowering | Number of Fruits per Plant | Eggplant Yield per Plant (kg) |
|--------------|-------------------|----------------------------|-------------------------------|
| C0 (Control) | 55.2              | 18.00                      | 3.24                          |
| C1 (25%)     | 55.4              | 17.40 (-5.5)               | 3.06 (-5.5)                   |
| C2 (50%)     | 55.9              | 15.20 (-15.5)              | 2.39 (-26.2)                  |
| C3 (75%)     | 57.3              | 15.00 (-16.6)              | 2.50 (-22.8)                  |
| C4 (100%)    | 58.5              | 14.10 (-21.6)              | 1.96 (-39.5)                  |
| CD at 5%     | 1.22              | 2.45                       | 0.12                          |

Data in parentheses indicate percent decrease from control



**Figure 1: Inhibitory effect of *Parthenium* leaf leachates on germination, plant height and yield per plant of eggplant**

### Plant Height

Plant height was recorded at 30, 60, and 90 DAS as influenced by different percentages of *Parthenium* leaf extracts. At 90 DAS, it was observed that plant height was significantly affected by different concentrations. Interestingly, the maximum plant height was found in treatment C2 (50% extract), followed by C1. The minimum plant height was found in C4 (100% extract). Different allelochemicals have different sites of action in a plant. Thus, the sensitivity to allelochemicals and the extent of inhibition varied with species and organs (Maharjan *et al.*, 2007). Some earlier works have also reported that *Parthenium hysterophorus* L. heavily reduces root and shoot length of agronomic crops at higher extract concentrations (Bhatt *et al.*, 1994; Mersie and Singh, 1987).

### Days Taken to Flowering

The earliest flowering was observed in the Control (C0) group at 55.2 days, whereas an increase in treatment concentration resulted in delayed flowering, taking a maximum of 58.5 days in the C4 treatment. Allelochemicals affect all functions of plant life including photosynthesis, respiration, and overall physiological development (Rice, 1984) (Table 2)

### Yield Parameters (Fruits per Plant and Total Yield)

Highest number of fruits per plant and maximum eggplant yield per plant (kg) were observed in treatment C2 (50% leaf extract), followed by C1 (25%). The lowest yield was observed in C4 (100% leaf extract) (Table 2, Fig 1). These results conform with the findings of Oluwafemi (2014) and the broader understanding that parthenium residues can significantly depress agronomic yield (Mersie and Singh, 1987). The physical and chemical processes important for the growth and

development of plants are frequently modified by chemicals released from neighboring plants, which can affect the plant negatively or positively in some cases (Iqbal *et al.*, 2013). The intensity of allelopathic effects depends heavily on the concentration of substances present in the extract (Dongre & Singh, 2007). Due to the presence of allelochemicals, the aqueous extract of *Parthenium hysterophorus* L. showed a severe inhibitory effect on productivity at its highest concentration (Rajan, 1973).

### CONCLUSION

The maximum height of the plant, growth, and yield parameters were recorded at C2 (50% leaf extract) for Eggplant under parthenium leaf extract, whereas the maximum germination was noted in the control. The allelochemicals present in *Parthenium hysterophorus* have a concentration-dependent effect—acting as a stimulant at moderate concentrations but causing severe allelopathic inhibition at higher concentrations (100%). The continuous decline in plant growth, delayed flowering, and reduced yield parameters with increasing extract concentration strongly suggest an inhibitory or phytotoxic effect of the treatment on eggplants. The higher concentrations (C3 and C4) likely disrupted the physiological and metabolic activities of the plants, leading to poor fruit setting and reduced overall biomass production. It can be concluded that a heavy infestation or incorporation of *Parthenium hysterophorus* in the field will negatively affect the growth and yield of succeeding eggplant crops. To decrease the impact of the parthenin effect on the crop, the removal of *Parthenium* plants before flowering or before the sowing of crops is highly recommended.

## REFERENCES

- Batish D.R., Singh H.P., Kohli R.K. and Kaur S., 2002. Allelopathic effects of *Parthenium hysterophorus* residues in soil. *Agronomy Journal*, **94(5)**: 1036-1040.
- Belz R.G., Reinhardt C.F., Foxcroft L.C. and Hurle K., 2007. Residue allelopathy in *Parthenium hysterophorus* L. Does parthenin play a leading role? *Crop Protection*, **26(3)**: 237- 245.
- Bhatt B.P., Chauhan D.S. and Todaria N.P., 1994. Effect of weed leachates on germination and radicle extension of some food crops. *Indian Journal of Plant Physiology*, **37**:177-179.
- Dongre P.N., Singh A.K. and Chaubey K.S., 2004. Allelopathic effects of weed leaf leachates on seed germination of blackgram (*Phaseolus mungo* L.). *Allelopathy Journal*, **14(1)**: 65-70.
- Dongre P.N. and Singh A.K., 2007. Inhibitory effects of weeds on growth of wheat seedlings. *Allelopathy Journal*, **20(2)**: 387-394.
- Dongre P.N., Chaubey K.S. and Singh A.K. 2010. Effects of leaf extracts of weeds on growth and yield of green gram. *Allelopathy Journal*, **25(1)**: 213-220.
- Dongre P.N. and Singh A.K. 2011. Inhibitory Allelopathic Effects of Weed Leaf Leachates on Germination and Seedling Growth of Wheat (*Triticum aestivum* L.). *Crop Research.*, **42 (1, 2, 3)**: 27-34.
- Hill E.C, Ngouajio M. and Nair M.G., 2006. Differential response of weeds and vegetable crops to aqueous extracts of hairy vetch and cowpea. *Hort Sci.*, **41**: 695-700.
- Iqbal M.A., Hussain M., Rehman M.W.U., Ali M., Rizwan M. and Fareed M.I., 2013. Allelopathy of Moringa. A review, *Sci. Agri.* **3(1)**: 9-12.
- Kanchan S.D. and Jayachandra, 1980. Allelopathic effects of *Parthenium hysterophorus* L. Part IV. Identification of inhibitors. *Plant and Soil*, **55**: 67-75.
- Kohli R.K., Batish D.R., Singh H.P. and Dogra K.S., 2006. Status, invasiveness and environmental threats of three tropical American invasive weeds (*Parthenium hysterophorus*, *Ageratum conyzoides*, *Lantana camara*) in India. *Biological Invasions*, **8(7)**: 1501-1510. IV. Identification of inhibitors. *Plant Soil*, **55**: 67-75.
- Maharjan S., Shrestha B.B., Jha P.K., 2007. 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)**.
- Mersie W. and Singh M., 1987. Allelopathic effect of parthenium (*Parthenium hysterophorus* L.) extract and residue on some agronomic crops and weeds. *Journal of Chemical Ecology*, **13(7)**: 1739-1747.
- Molisch H., 1937. *Der Enfüsslin earp flanzeandre Allelopathie* Gustav Fischer, Jena.
- Narwal S.S., 1994. *Allelopathy in Crop Production*. Scientific Publishers, Jodhpur, India.
- Oluwafemi A.B., 2014. Allelopathic effects of *Moringa olifera* on the germination and seedling survival of *Euphorbia heterophylla* L. *Global Journal of Biology, Agriculture & Health Sciences*, **3(1)**: 195-198.
- Rajan L., 1973. Growth inhibitors from *Parthenium hysterophorus* L. *Current Science*, **42(20)**:729-730.
- Rice E.L., 1984. *Allelopathy*, 2<sup>nd</sup> Edition. Academic Press, London, UK.
- Sahoo U.K., Jeecelee L., Vanlalhriatpuia K., Upadhyaya K. and Lalremruati J.H., 2010. Allelopathic effects of leaf leachate of *Mangifera indica* L. on initial growth parameters of few home garden food crops. *World Appl. Sci. J.*, **10**: 1438-1447.
- Stephen W.A. and Sowerby M.S., 1996. Allelopathic potential of the weed *Parthenium hysterophorus* L. in Australia. *Plant Protection Quarterly* **11**: 20-23.