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Allelopathic Impact of *Lantana camara* L. Extract on Seed and Seedling Traits of *Capsicum annum*.

Abstract

This study was made to assess the allelopathic effects of an aqueous extract of *Lantana camara* L., a potential invasive plant on growth and seedling related traits of red chilli (*Capsicum annum* L.). The seeds were treated in 10%, 20%, 40%, 80% and 100% concentrations. The leaf aqueous extract of *Lantana camara* L. showed significant inhibitory activity on germination potency of the seed in terms of Germination Index. Besides, Phytotoxicity, for the *Capsicum annum* L. was found out, Germination Index was found to be decreased with increase in the concentration of aqueous leaf extracts and phytotoxicity increased. The maximum and minimum inhibitory values were obtained in 100% and 10% extract concentrations respectively. All the results and observations obtained in this experimental study were discussed in the view of phyto-chemical constituents of *Lantana camara* L. and their probable allelopathic property against the seed germination.

Keywords: Allelopathic; *Lantana camara* L.; Seed germination; red chilli (*Capsicum annum* L.); Germination index

Introduction: Allelopathy is a fascinating yet complex form of plant interaction, carried out through the release of chemical substances into the surrounding environment. The donor plants can influence the germination, growth, and development of recipient plant species. *Lantana camara* L., a member of the family **Verbenaceae**, is recognized as a common weed in many regions of the world, particularly in tropical areas, and has been extensively studied for its allelopathic potential against both weeds and crop plants. Several researchers have investigated these effects: Ahmad et al. examined the impact of *Lantana camara* aqueous extracts on seed germination and seedling growth of selected agricultural crops; Enyew et al. reported its effects on maize (*Zea mays*) and wheat (*Triticum turgidum* L.); El-Kenany et al. studied its influence on the germination of *Phalaris minor* L.; Ranwala et al. evaluated it in *Ludwigia* sp. L.; Bansal et al. in rice; Gantayet et al. in green gram; Gentle et al. on Australian forest species; Hossain et al. on agricultural crops of Bangladesh; Binggeli et al. reported its role in displacing communities from their lands; Oudhiya et al. tested it on soybean; Saxena et al. on water hyacinth; Mishra et al. in *Trigonella*; Rugare et al. in black jack; Tadele et al. in agricultural crops; Kong et al. in *Eichhornia*; Kumbhar et al. on crop plants; Achhireddy et al. on *Morrenia odorata* L.; and Dobhal et al. on woody shrubs.

In addition to *Lantana camara* L., several other plant species have been investigated to understand the possible physiological mechanisms underlying allelopathic effects on black gram. For instance, Suman et al. and Siddiqui et al. examined allelopathic impacts in black pepper through leaching, while Singh et al. studied the effects of eucalyptus leaf leachates. Shankar et al. evaluated the influence of phenolics and terpenoid extracted from *Gmelina*

1 *arborea* on the germination of black gram, and the role of salicylic acid on nodulation, nitrogenous compounds, and related enzymes of *Vigna mungo* L. has also been explored.

1 Experimental studies have further reported mechanisms of tolerance in crop seedlings exposed to stressful environments. For example, Prasad et al. and Palma et al. highlighted the role of peroxisomal proteases in various physiological processes under stress conditions, while Foyer et al. investigated key defense mechanisms in transgenic plants. Similarly, Roy-Macauley et al. evaluated proteolytic activities in *Phaseolus* and *Vigna* leaves from both sensitive and resistant plants.

1 In this context, the present study was undertaken to evaluate the allelopathic effect of aqueous extracts of *Lantana camara* L. on red chilli (*Capsicum annum* L.), since such an investigation has not been previously reported.

Research Objective: Allelopathic impact of *Lantana camara*- leaf extract on germination of red chilli (*Capsicum annum*).

Hypothesis

The researcher hypothesized that there is no impact on *Lantana*-leaf extract on germination of *Capsicum annum*.

Materials and Methods Materials

1 **Collection of *Lantana camara* L. plant materials:** Fresh, healthy leaves of *Lantana camara* were collected from the bank side of the River Subarnarekha at Jamshedpur (Fig. 1). The leaves were thoroughly washed under running tap water to remove surface dust and other contaminants, and then air-dried at room temperature. Afterwards, the dried leaves were cut into small pieces using a cutter.



Lantana camara

2 **Collection of *Capsicum annum* L. seeds:** Well-matured seeds of *Capsicum annum* L. were obtained from the Jamshedpur Agro Service and Industries Corporation (JASIC). These seeds were sun-dried for 3 hours and subsequently surface-sterilized by soaking in a sodium hypochlorite solution for 5 minutes.



Capsicum annum

Preparation of *Lantana camara* L. aqueous extract (LCAE): Fresh leaves were soaked in distilled water for one hour at room temperature. The extract was prepared by grinding the leaves using a mortar and pestle at a ratio of 30 g of leaf material to 100 ml of distilled water. The crude extract was then heated at 60 °C for 30 minutes, followed by centrifugation at 5000 rpm for 10 minutes. The resulting supernatant was filtered through Whatman No. 1 filter paper, and the filtrate was diluted with distilled water to obtain different concentrations (10%, 20%, 40%, 80%, and 100%) as required for the treatments.

Experimental setup: Petri plates (9 cm diameter) were thoroughly washed with detergent and hot water to eliminate potential pathogens and contaminants. In each plate, 35 seeds of *Capsicum annum* L. were placed, and 6 ml of the test solution was applied. The control sets received 6 ml of distilled water. To maintain moisture, the respective concentrations were replenished as required, and all plates were prepared in duplicate. The experiment was conducted at room temperature (30 ± 4 °C). Germination was monitored daily for three consecutive days.



Figure: Seeds of *Capsicum annum* L. will be soaked in distilled water only.



Figure: Treated seeds will be sown in different pots containing homogeneous soil to raise M1 plants.



Figure: M2 plants will be grown from these seeds obtained from the M1 plants through selfing.



Result Analysis:

The findings of the present study revealed that seeds treated with aqueous extracts of the donor plant exhibited a marked inhibitory effect on the recipient plant with respect to germination percentage (Table 1). The highest concentration (100%) of leaf extract produced the greatest inhibitory effects on germination and root length when compared with the control. A progressive increase in inhibition was observed with increasing extract concentration.

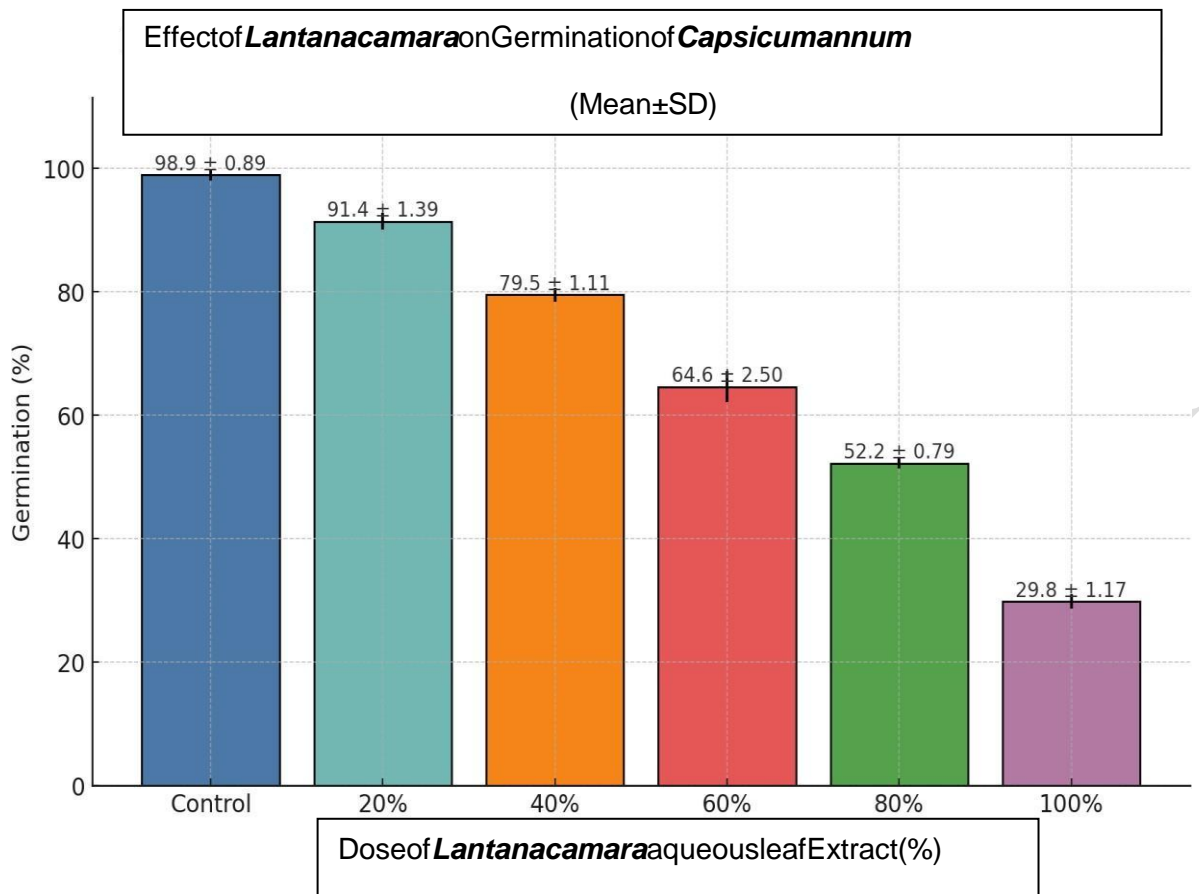
Radical growth increased daily in both the control and treated seeds, with maximum elongation recorded on the third day. However, radical length was consistently lower in seeds

exposed to 100% extract compared to the control. Seeds treated with 20% and 40% concentrations showed daily increases in radical length, with the maximum length observed on the third day in the 20% treatment, while a slight reduction was recorded at 40%. Seeds exposed to higher concentrations (80% and 100%) displayed marked reductions in radical growth, with the maximum reduction occurring at 100%.

The germination index was significantly reduced at 80% and 100% concentrations. Other morphological alterations observed included inhibited or delayed germination, seed darkening and swelling, reduced radical elongation, necrosis or swelling of root tips, curling of the root axis, root discoloration, absence of root hairs, and increased formation of seminal roots.

Table-1 Seed Germination(%)

Leaf Extract								
Dose (%)	No. of Seed	R-1	R-2	R-3	R-4	Mean	S.D.	Germination (%)
Control	35	99.8	99.6	98	98.4	98.9	0.89	98.9±0.89
20%	35	93.2	91.3	89.8	91.3	91.4	1.39	91.4±1.39
40%	35	81.1	78.5	79.5	79.1	79.5	1.11	79.5±1.11
60%	35	68.2	64.2	63.5	62.5	64.6	2.50	64.6±2.50
80%	35	52.4	51.2	52.3	53.1	52.2	0.79	52.2±0.79
100%	35	30.1	31.2	29.5	28.4	29.8	1.17	29.8±1.17



Discussion

Allelopathy is a fascinating yet complex form of interaction between plants, where chemical compounds are released into the environment to affect the growth and development of neighboring plants. Various plant groups, including algae, lichens, and both annual and perennial weeds, are known to exhibit significant allelopathic interactions.

The present study investigates the strong inhibitory allelopathic effects of aqueous extracts from *Lantana camara* L. (donor species) on the germination of *Vigna mungo* L. The results showed that seed germination was highly sensitive to different concentrations of the donor plant's aqueous extract. According to Cruz-Ortega et al., the inhibition of root elongation could be attributed to the presence of phenolic compounds, which are thought to interfere with the phosphorylation pathways, disrupting the activation of Mg^{2+} ions and ATPase activity.

Verdeguer et al. examined the phytotoxic effects of essential oils from *Lantana camara*, *Eucalyptus camaldulensis*, and *Eriosephalus africanus* on weeds in Mediterranean summer crops. They found that reductions in root and shoot growth were due to the presence of aromatic alkaloids and phenolic compounds, which adversely affect germination and plant development. Numerous secondary metabolites, such as phenolics, terpenoids, alkaloids, polyacetylenes, fatty acids, and steroids, are known to inhibit the growth of other plants by disrupting their metabolic activities.

Specifically, *Lantana camara* contains at least 14 different allelochemicals, with Lantadene A (a pentacyclic triterpenoid) and Lantadene B being the most notable. These compounds can disturb energy flow and interfere with the activity of enzymes, proteins, and amino acids during the germination of recipient plants.

Our enzyme analysis revealed a marked increase in protease activity. Studies by Solomon et al., Ryan et al., Hatsuga et al., Kim, Dubey et al., Silveira et al., and Sweetlove et al. reported that proteases play a key role in plant defense under stress by aiding the synthesis of biomolecules and acting against toxic chemicals.

In conclusion, the findings suggest that the aqueous leaf extract of *Lantana camara* has significant allelopathic potential. However, further research under field conditions is essential to explore its practical application as a bio-herbicide, particularly for managing weed species that are resistant to conventional chemical pesticides.

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