Allelopathic Impact of*Lantanacamara*L.Extract onSeedandSeedling Traitsof *Capsicum annum*.

Abstract

Thisstudywasmadetoassessthe allelopathiceffectsofaqueousextractof*Lantanacamara* 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. Theleaf 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;*Lantanacamara*L.;Seedgermination;redchilli(*Capsicum annum* L).;Germinationindex

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. onAustralian 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; Achhireddyet al. on *Morrenia odorata* L.; and Dobhal et al. on woodyshrubs.

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. Shankaretal.evaluatedtheinfluenceofphenolicsandterpenoidsextractedfrom*Gmelina*

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.

Experimental studies have further reported mechanisms of tolerance in crop seedlings exposed to stressfulenvironments. Forexample, 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.

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

ResearchObjective: Allelopathicimpactof*Lantanacamara*- leafextractongerminationof red chilli (*Capsicum annum).*

Hypothesis

Theresearcherhypothesizedthatthereisnoimpacton Lantana-leafextractongermination of *Capsicum annum.*

MaterialsandMethods Materials

Collection of *Lantana camara* L. plant materials: Fresh, healthyleavesof*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

Collection of*Capsicumannum* L**. seeds:** Well-maturedseedsof*Capsicumannum* L. were obtainedfromtheJamshedpurAgroServiceandIndustriesCorporation(JASIC).Theseeds were sun-dried for 3 hours and subsequently surface-sterilized by soaking in a sodium hypochlorite solution for 5 minutes .

Capsicum annum

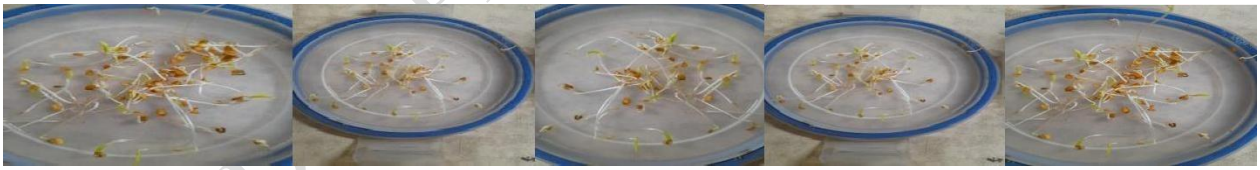
Preparation of *Lantana camara* L. aqueous extract (LCAE): Fresh leaves were soaked in distilled water for one hour at room temperature. The extract was prepared by grinding the leaves using a mortar and pestle at aratio of30 gof leaf materialto 100mlofdistilled water. The crude extract was then heated at 60 °C for 30 minutes, followed by centrifugation at5000 rpm for 10 minutes. The resulting supernatant was filtered through Whatman No. 1filter 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:Seedsof*Capsicumannum*L.willbesoakedindistilledwateronly.

Figure:Treatedseedswillbesownindifferentpotscontaininghomogeneoussoilto to raise M1 plants.

Figure:M2 plantswillbegrownfromtheseedsobtainedfromtheM1plantsthroughselfing.



ResultAnalysis:

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 leafextract produced the greatest inhibitory effects on germination and root length when compared with thecontrol. A progressive increase in inhibition was observed with increasing extract concentration.

Radical growth increased daily in both the control and treated seeds, with maximum elongationrecordedonthethird day. However, radical lengthwasconsistentlylower inseeds

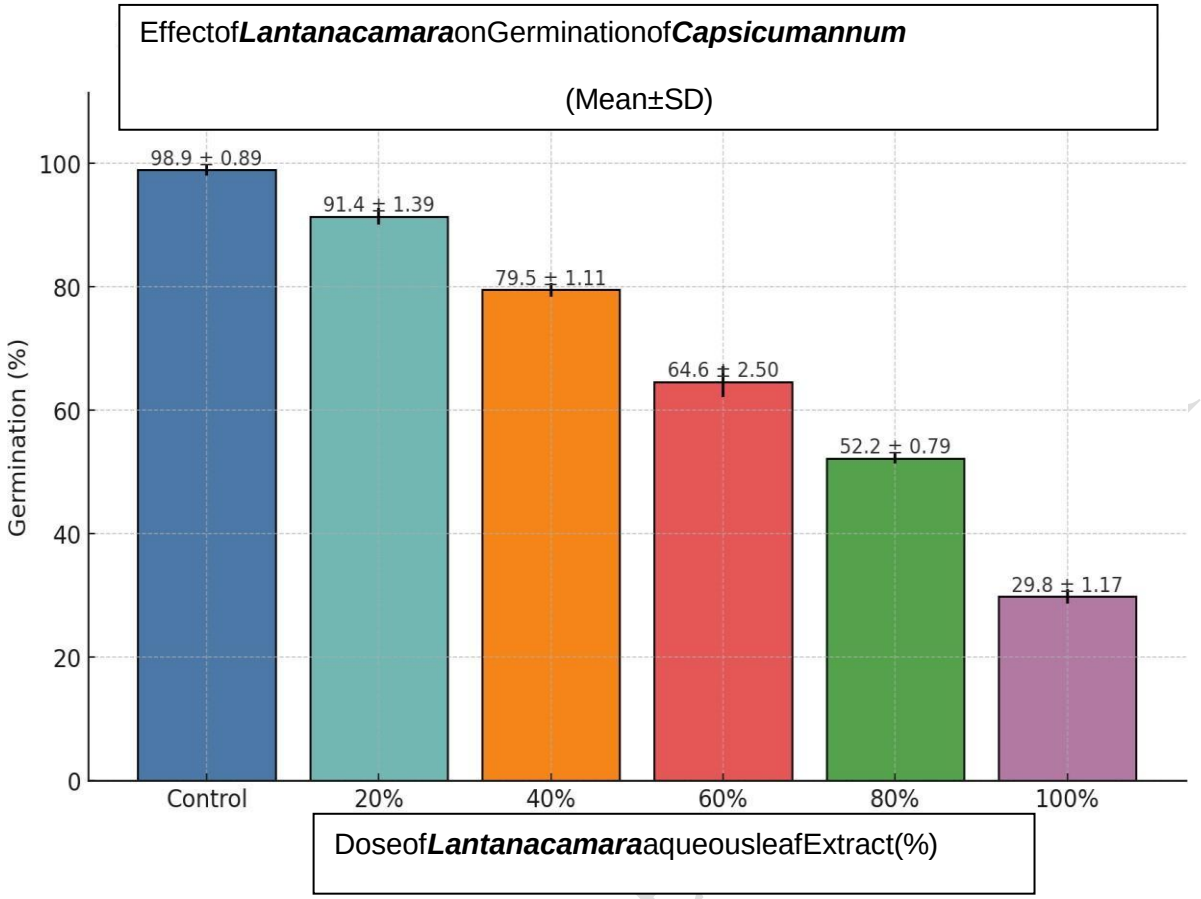
exposed to 100% extract compared to the control. Seeds treated with 20% and 40% concentrations showed daily increases in radical length, with the maximum length observed on the third day in the 20% treatment, while a slight reduction was recorded at 40%. Seeds exposed to higher concentrations (80% and 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, seeddarkening 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-1SeedGermination(%)

LeafExtract

Dose (%)	**No.ofSeed**	**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 interferewith 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 *Eriocephalus 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 LantadeneA(apentacyclic triterpenoid) andLantadene Bbeingthemost notable. Thesecompoundscan 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., Ryanet al., Hatsugaiet al., Kim, Dubeyet al.,Silveiraet al.,and Sweetloveet 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 researchunder fieldconditions isessential to explore its practical application as a bio-herbicide, particularly for managing weed species that are resistant to conventional chemical pesticides.

References:

- Ahmed R, Arfin-Khan MAS, Sharif AM, et al. Allelopathic effects of *Lantanacamara* on germination and growth behaviour of some agricultural crops in Bangladesh. J For Res. 2007;18(4):301-4.
- Achhireddy NR, Megh S. Allelopathic effects of Lantana (*Lantana camara*) on milkweed vine (*Morrenia odorata*). Weed Science. 1984;32(6):757-61.
- Archna S, Shahi HN, Pushpa S, et al. Allelopathic influence of *Vigna mungo* (black gram) seeds on germination and radical growth of some crop plants. Plant Growth Regulation. 2002;38(1):69-74.
- Arpana M. Phytotoxic effect of Lantana camara leaf extract on germination and growth behavior of *Trigonella foenum graceum* L. International Journal of Scientific Research. 2013;2(5):18-9.
- BansalGL. Allelopathic effectof*Lantanacamara*onriceand associated weedsunder the mid-hill conditions of Himachal Pradesh, India. Proceedings of the Workshop on Allelopathy in Rice. Manila (Philippines): International RiceResearch Institute.1998.
- ChiouCH,MullerCH.Allelopathicmechanismof*Archtostaphylousglandulosa* varietyZazaeisis,AmericanMediterranean. Nature.1972;88:324-47.
- Cruz OR, Gabriela AC, Ana LA. Allelochemical stress produced by the aqueous leachate of Callicarpa acuminata: effects on roots of bean, maize, and tomato. Physiologia Plantarum. 2002;116(1):20-7.
- Dubey RS. (1999) Protein synthesis by plants under stressful conditions. In:Pessarakli M, editor. Handbook of Plant and Crop Stress 2. New York City: Marcel Dekker, USA;. p 365-97.
- Dobhal PK, Kohli RK, Batish DR. Evaluation of the impact of *Lantana camara* L. Invasion, on four major woody shrubs along Nayar river of Pauri Garhwal, in Uttarakhand Himalaya. Int J Biodivers Conserv. 2010;2(7):155-61.

- Einhellig FA. Allelopathy: Current status and future goals. In: Inderjit A, Dakshini KMM, editors. Allelopathy: Organisms, processes, and applications. Washington: American Chemical Society, USA; 1995. p 1–24.
- El-LakwahFA,HamedMS,Abdel-LatifAM.Effectivenessof*Lantanacamera*and *Neriumoleander*extractsaloneandinmixtureswithtwoinsecticidesagainst

Rhizopertha dominica (F.). Annals of Agricultural Science Moshtohor. 1996;34(4):1879-1905.

- Foyer CH, Descourvieres P, Kunert KJ. Protection against oxygen radicals: an important defense mechanism studied in transgenic plants. Plant, Cell &Environment. 1994;17(5):507-23.
- Gantayet PK, Adhikary SP, Lenkaet KC, et al. Allelopathic impact of *Lantanacamara* on vegetative growth and yield components of green gram (Phaseolus radiatus). Int J Curr Microbiol App Sci. 2014;3 (7):327-35.
- Gentle CB, Duggin JA. Allelopathy as a competitive strategy in persistent thickets of *Lantana camara* L. in three Australian forest communities. Plant Ecology. 1997;132(1):85-95.
- HatsugaiN, Miwa K, Kenji Y, et al. A plant vacuolar protease, VPE, mediates virus-induced hypersensitive cell death. Science. 2004;305(5685):855-8.
- InderjitA.Plant phenolicsinallelopathy.TheBotanicalReview.1996;62(2):186-202.
- Kamal HM, Alam N. Allelopathic effects of *Lantana camara* leaf extract on germinationand growthbehavior ofsome agriculturaland forest cropsinBangladesh. Pakistan Journal of Weed Science Research. 2010;16(2):217-26.
- Kenany E, Eman T, Salama M. Suppression effects of *Lantana camara* L. aqueous extracts on germination efficiency of Phalaris minor Retz. and Sorghum bicolor L.(Moench). Journal of Taibah University for Science. 2013;7(2):64-71Rice EL. Allelopathy. Cambridge: Academic Press, England; 2013. 366 p.
- Kim JY, Seong CP, Indeok H, et al. (2009) Protease inhibitors from plants with antimicrobial activity. Int J Mol Sci.;10(6):2860-72.
- Kong CH, Wang P, Zhang CX, et al. Herbicidal potential of allelochemicals from *Lantana camara* against *Eichhornia crassipes* and the alga *Microcystis aeruginosa*. Weed research. 2006;46(4):290-5.
- Kumbhar BA, Patel GR. Phytotoxic effects of Lantana on hypocotyl and radicle growth of some crops of Patan. Int J Int sci Inn Tech Sec C. 2013;2(6):8-11.
- Ladd JN, Butler JHA. Short-term assays of soil proteolytic enzyme activities using proteins and dipeptide derivatives as substrates. Soil Biol Biochem. 1972;4(1):19-30.
- Macauley RH, Fodil YZ, Kidric M, et al. Effect of drought stress on proteolytic activities in Phaseolus and Vigna leaves from sensitive and resistant plants. Physiologia Plantarum. 1992;85(1):90-6.
- Molla AE, Nagappan R. Allelopathic effect of *Lantana camara* L. Leaf powder on germination and growth behaviour of maize *Zea mays* Linn. and wheat *Triticum turgidum* Linn. Cultivars. Asian J Agric Sci. 2015;7(1):4-10.
- Nadirsha PS Nawab, Yogamoorthi A. Allelopathic Effects of Aqueous Extract of *Lantana camara* L. on Seed Germination of Black Gram *Vigna mungo* L.. EnvironSci Ind J. 2016;12(11):122.
- Oudhia, P. Allelopathic effects of *Lantana camara* L. On germination of soyabean. Legume Research. 1999;22:273-4.
- Prasad TK. Mechanisms of chilling-induced oxidative stress injury and tolerance in developing maize seedlings: Changes in antioxidant system, oxidationofproteinsand lipids, and protease activities. The Plant Journal. 1996;10(6):1017-26.
- Palma JM, Sandalio LM, Corpas FJ, et al. Plant proteases, protein degradation, and oxidative stress: Role of peroxisomes. Plant Physiology and Biochemistry. 2002;40(6):521-30.

- Pierre B, Desissa D. *Lantana camara*-the invasive shrubthatthreatens to drive people out of their land. Newsletter of the Ethiopian Wildlife and Natural History Society. 2002.
- RajbanshiSS, InubushiK. Chemicaland biochemicalchanges during laboratory-scale composting of allelopathic plant leaves (*Eupatorium adenophorum* and *Lantana camara*). Biol Fertil Soils. 1997;26(1):66-71.
- Rugare JT. Allelopathic effects of Lantana (*Lantana camara*) on blackjack (Bidens pilosa) and pearl millet (*Pennisetum glaucum*). Asian Journal of Agriculture andRural Development. 2013;3(8):543-53.
- Ryan CA. Protease inhibitors in plants: Genes for improving defenses against insects and pathogens. Annu Rev Phytopathol. 1990;28(1):425-49.
- Sahid IB, John BS. Allelopathic effect of Lantana (*Lantana camara*) and Siam weed (*Chromolaena odorata*) on selected crops. Weed science. 1993;41(2):303-8.
- Saxena MK. Aqueous leachate of*Lantana camara* kills water hyacinth. J ChemEcol. 2000;26(10):2435-47.
- Shankar SRM, Girish R, Karthik N, et al. Allelopathic effects of phenolics and terpenoids extracted from *Gmelina arborea* on germination of Black gram (*Vigna mungo*) and Green gram (*Vigna radiata*). Allelopathy Journal. 2009;23(2):323-32.
- Sharma OP, Dawra RK, Makkar HPS. Isolation and partial purification of Lantana (*Lantana camara* L.) toxins. Toxicol Lett. 1987;37(2):165-72.
- Siddiqui ZS. Allelopathic effects of black pepper leachings on *Vigna mungo* (L.) Hepper. Acta Physiol Plant. 2007;29(4):303-8.
- Singh NB, Singh R. Effect of leaf leachate of eucalyptus on germination, growth and metabolismofgreengram, blackgramand peanut.AllelopathyJournal. 2003;11(1):43-51.
- SolomonM, BeatriceB, Massimo D, et al. Theinvolvement ofcysteine proteasesand protease inhibitor genes in the regulation of programmed cell death in plants. The Plant Cell. 1999;11(3):431-43.
- Silveira JA, Viégas RA, Da Rocha IM, et al.(2003) Proline accumulation and glutamine synthetase activity are increased by salt induced proteolysis in cashew leaves. J Plant Physiol.;160(2):115-23.
- Sudheera R, Attigala LR, Silva S. Herbicidal potential of *Lantana camara* L. On Ludwigia spp. in paddy soil. Tropical Agricultural Research and Extension. 2015;17(1):10-18.
- Sweetlove LJ, Heazlewood JL, Herald V, et al.(2002) The impact ofoxidative stress on Arabidopsis mitochondria. Plant J.;32(6):891-904
- Tadele D. Allelopathic effects of Lantana (*Lantana camara* L.) Leaf extracts on germination and early growth of three agricultural crops in Ethiopia. Momona Ethiopian Journal of Science. 2014;6(1):111-9.
- Verdeguer M, Blázquez M, Herminio B. Phytotoxic effects of *Lantana camara*, Eucalyptus camaldulensis and Eriocephalus africanus essential oils in weeds of Mediterranean summer crops. Biochem Sys Ecol. 2009;37(4):362-9.