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Microcosm Study to Assess Allelochemical Potential of *Lantana camara* on *Lactuca sativa*

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***Abstract*:** The allelopathic potential of *Lantana camara* can be deleterious to native diversity and productivity of food crops. The present study aimed to assess the allelopathic potential of *L. camara* on the germination and growth of *Lactuca sativa* through bioassay method. Two pots i.e., control (P_1) and experimental (P_2) were taken for microcosm studies with healthy and *L. camara* invaded soil, respectively. There were differential germination percentage (P_2-80%, P_1-93.33%), germination potential (P_2 0.86, P_1 0.93), germination index (P_2 4.33, P_1 4.66), and germination rate index (P_2 346.66, P_1 435.55). The allelochemicals from *L. camara* adversely influenced the seed germination. However, the growth parameters such as seedling height (32.35cm), root/shoot length (4.75cm/27.6cm), and seedling biomass (1.559g) were higher in *L. sativa*. Thus, *L. camara* exhibited stimulatory as inhibitory effects on *L. sativa*. However, further studies are warranted for explicit elucidation of chemical ecology and allelopathic effects of *L. camara*.

Keywords: Chemical ecology, Plant invasion, Allelopathy, Allelochemicals, *Lantana camara, Lactuca sativa*, Sustainable management

Chemical ecology can manifest remarkable impact on pattern and distribution of biodiversity (Rai and Singh 2020). The distribution and abundance of flora is determined by their allelopathic interactions with invasive alien plants (Enyew and Raja 2014, Vanlalruati and Rai 2022). Allelopathy is influenced by competition for resources and stress from disease, extreme temperatures, and herbicides (Ogunsanya et al 2018). These stresses often increase the production of allelochemicals and accentuate their actions to avoid competition in their environment (Ogunsanya et al 2018, Talhi et al 2020). Due to the production of allelochemicals into the rhizosphere of surrounding crop plants, *Lantana camara* hindered germination, growth, development, and metabolism of food crops (Qasem 2006). *L. camara* interfere with native plants through allelopathy and it is widely distributed in different parts of India (Craig et al 2011, Bhattacharya et al 2020). Further, *L. camara* demonstrates the ability to survive in a wide range of climates and soil types, demonstrating its broad ecological amplitude and strong allelopathy (Day et al 2003; Rai and Singh 2020). The success of *Lantana* in different environmental conditions could be due to its allelopathic effect on other plants which may impair native plants' vitality (Day et al 2003). Maiti et al (2008) reported that the lantana leaf leachates inhibited the seed germination, germination rate, seed viability, and seedling emergence capacity of *Mimosa* spp. Various allelopathic compounds like salicylic acid, gentisic acid, coumarin, ferulic acid, p-hydroxybenzoic acid and 6-methyl coumarin were extracted from *L. camara* (Yi et al 2006). Some other allelochemicals identified in *L. camara* which are cytotoxic in nature (Ma et al 2004) (Table 1). The allelopathic effect of *L. camara* has been reported on many crops such as *Brassica juncea L*., (Ahmed et al 2007), *Oryza sativa L*. (Hossain and Alam 2010), and *Phaseolus radiatus* (Gantayet et al 2014). In addition, the extract of *L. camara* has also been observed to inhibit the seed germination and seedling growth of many species such as *Salvinia molesta* (Saxena et al 2013), *Brassica campestris*, *Ipomoea aquatica*, *Sorghum bicolor* L. and *Zea mays* (Veraplakorn 2017). Therefore this experiment is carried out in order to find out the effect of the allelochemicals present in *L. camara* on the germination process and seedling growth of the selected food crop (*L. sativa*) using bioassay method.

MATERIAL AND METHODS

The study was conducted in a greenhouse at Mizoram University, Tanhril, Mizoram, India, for 3 months duration (April-June), 2021. Two pots were taken in which soil sample along with leaf litter was taken from the site invaded by *L. camara* . Another soil sample was taken from a healthy forest soil and kept as control. A fast growing crop i.e., *L. sativa* seed was selected and sown in both the pots. *L. sativa* is a fast growing food crop and is commonly grown in the Mizoram, therefore used as bioassay plant. Studies have also indicated that *L. sativa* is responsive to allelochemicals which may clearly visualize the bioassay results (Tadele 2014, Nasrollahi et al 2018). The changes in the morphology of the plant were carefully examined at different time intervals. On the 59^{th} day, when the plants was fully grown, two replicas from each pots were taken out.The plant height (root and shoot length) was measured. The various parameters such as seedling heights (H), root Length and shoot length (RL & SL), biomass (b), germination percentage (GPe), germination potential (GPo). germination index (GI), germination rate index (GRI), vigor index (VI) were estimated (Singh et al 2014).

RESULTS AND DISCUSSION

In comparison to the control pot the germination parameters were higher in the experimental pot (Table 2). This indicates that the

Table 1. Allelochemical compounds present in all parts of *Lantana camara*

Compounds name	Biological activity
β-pinene	Inhibiting the seed germination, growth and antibacterial activity.
Camaric acid	Nematicidal activity
1,8-Cineole	Inhibiting the growth of plant.
Cinnamic acid	Inhibited the activity of plasma H+-ATPase, PPase and inhibit the process of seed germination.
Dipentene	Inhibiting the growth of plant.
Geniposide	Inhibited hepatoxicity and the DNA repair synthesis induced by aflatoxin B1 in rat primary hepatocytes.
Icterogenic acid	Toxic to sheep, cattle, goats.
Lantadene A, B,C D	Death of horses, cattle, sheep, goats and rabbits by failure of liver and other organs.
Lantanilic acid	Nematicidal activity.
Lantanoside	Antimicrobial and Nematicidal activity.
Linaroside	Antibacterial activity
Palmitic acid	Inhibiting the growth of vegetables
ρ-Coumaric acid	suppress root-infecting fungi , root-knot nematode , inhibit the process of seed germination and inhibit the growth of morning glory
Ursolic acid	Inhibitors of human leucocyte elastase,
Verbascoside	Inhibitor of protein kinase and possesses antitumor activity.

Source: Wahab 2004, Gopie-Shkhanna and Kannabiran 2007

seeds were less vital in the experimental soil, ascribed to allelopathic effects on the plants. Gindri et al (2020) also observed that *L. camara* resulted in disruption of cellular membrane and induced the formation of reactive oxygen forms which inhibited the germination of *L. sativa*. Zhang et al (2014) found that aqueous extract of *L. camara* leaves inhibited the seed germination of *L. sativa*. In comparison to the control, the seedling growth of the plants in the experimental pot developed longer roots and shoots which increased their biomass significantly and the experimental pot showed better vegetative growth than the control. This shows that the soil of experimental pot has favorable allelopathic effect on the plant by enhancing the fertility and soil moisture retention property (Sharma and Acharya 2000). This may be due to the fact that allelochemicals are responsible for the suppression of *L. sativa* might be present in deficient amount, which in fact enhance the growth of the bioassay plant. Tadele (2014) also observed that varying concentrations of lantana leaf extract encouraged the growth of food crops (e.g., maize roots and shoots and roots of finger millets), however decreased when present in very high concentrations. Negi and Kandpal (2003) found that lantana mulch or residue improves soil fertility owing to fast decomposition and nutrient release. Various bioassay studies also showed inhibitory effects exerted by aqueous extracts of lantana leaf at variable concentration levels (Bhattacharya et al 2020, Talhi et al 2020). The sustainable management opportunities for lantana may be explored for its sustainable management, especially in biodiversity hotspots (Rai 2012, Rai and Singh 2015, Rai 2015, Rai and Kim 2020, Sakachep and Rai 2021a, b, Vanlalruati and Rai 2021, Rai 2022). In nutshell, plants generally have a stimulatory allelopathic effect on crops at low concentrations of allelochemicals, whereas large or excess amounts can restrict the life cycle i.e., growth and germination of surrounding plants (El-Kenany and El-Darier 2013).

Table 2. Morphological characteristic of *Lactuca sativa* plants grown on *Lantana camara* invaded soil (experimental) and healthy soil (control)

Parameters	Experimental	Control
Number of *L. sativa* seed sown	15	15
Number of seed germinate after 3 days	13	14
Number of seeds germinate after 7 days	12	14
Seedlings heights (H)	32.35 cm	26.4 cm
Root length (RL) (Mean)	4.75 cm	4.8 cm
Shoot length (SL) (Mean)	27.6 cm	21.6 cm
Seedling biomass (BM) (Mean)	1.559 g	0.893 g
Germination Percentage (GPe)	80 %	93.33%
Germination Potential (GPo)	0.86	0.93
Germination Index (GI)	4.33	4.66
Germination Rate Index (GRI)	346.66	435.55
Vigor Index (VI)	6.75	4.16

CONCLUSION

L. camara showed both positive and negative allelopathic effect on *L. sativa.* The Lantana showed negative effect on germination of *L. sativa* by inhibiting the germination process, however, demonstrated positive response on the other growth parameters of the food crop. Thus, low concentrations of allelochemicals in the soil can be beneficial to crop growth, however may be detrimental in higher concentrations. However, further studies are warranted for explicit elucidation of chemical ecology and allelopathic effects of *L. camara*.

REFERENCES

Ahmed R, Uddin MB, Khan MASA, Mukul SA, Hossain MK 2007.

Allelopathic effects of *Lantana camara* on germination and growth behavior of some agricultural crops in Bangladesh. *Journal of Forestry Resource* **18**: 301-304.

Bais HP, Weir TL, Perry LG, Gilroy S and Vivanco JM 2006. The role of root exudates in rhizosphere interactions with plants and other organisms. *Annual Review of Plant Biology* **57**: 233-266.

Bertin C, Yang X and Weston LA 2003 The role of root exudates and allelochemicals in the rhizosphere. *Plant Soil* **256**: 67-83.

Bhattacharya S, Namasudra S, Debnath S and Saha AK 2020. Comparative Allelopathic Effects of Two Weed Extracts on Seed Germination and Seedling Growth of *Vigna unguiculata* (L.) Walp. and *Abelmoschus esculentus* L. *Defence Life Science Journal* **5**(3): 204-210.

Craig M, Gerber E and Krebs C 2011. Invasive Knotweed affects plants through allelopathy. *American Journal of Botany* **98**(1): 38-43.

Day MD, Wiley CJ, Playford J and Zaluck MP 2003. Lantana: current management status and future prospects. *Australian Centre for International Agricultural Research, Canberra*. (No. 435-2016-33733).

Enyew A and Raja N 2015. 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 Journal of Agricultural Science* **7**(1): 4-10.

El-Kenany E and El-Darier S 2013. 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* **7**: 64-71.

Gantayet PK, Adhikary SP, Lenka KC and Padhy B 2014. Allelopathic impact of *Lantana camara* on vegetative growth and yield components of green gram (*Phasoelus radiatus*). *International Journal Current Microbiology and Applied Science* **3**(7): 327-335.

Gindri D M, Coelho CMM and Uarrota VG 2020. Physiological and biochemical effects of *Lantana camara* L. allelochemicals on the seed germination of *Avena sativa* L. *Pesquisa Agropecuaria Tropical* **50.**

Gopie-shkhanna V and Kannabiran K 2007. Larvicidal effect of *Hemidesmus indicus*, *Gymnema sylvestre*, and *Eclipta prostrata* against *Culex quinquifaciatus* mosquito larva. *African Journal of Biotechnology* **6**(3): 307-311.

Goyal N, Esler KJ and Sharma GP 2018. What drives performance potential of *Lantana camara*. *(sensu lato)* in the invades range. *Lantana camara* invasion in India and South Africa **59**(1): 57-58.

Hossain MK and Alam MN 2010. Allelopathic effects of *Lantana camara* leaf extract on germination and growth behavior of some agricultural and forest crop in Bangladesh. *Pakistan Journal Weed Science Research* **16**: 217-226.

Kato-Noguchi H and Kurniadie D 2021. Allelopathy of *Lantana camara* as an invasive plants. *Plants* **10**: 1028.

Kruse M, Strandberg M and Strandberg B 2000. Ecological effects of allelopathic plants: A review. *National Environmental Research Institute Technical Report* **315**: 66.

Kumar V, Brainard DC and Bellinder RR 2009. Suppression of Powell amaranth (*Amaranthus powellii*) by buckwheat residues: Role of allelopathy. *Weed Science* **57**: 66-73.

Ma WJ, Xiao DJ and Deng SZ 2004. Terpenoids constituents of the leaves of *Lantana camara*. *Guangzhou Chemistry* **29**: 14-19.

Maiti P, Bhakat RK and Bhattacharjee A 2008. Allelopathic effects of *Lantana camara* on physiobiochemical parameters of *Mimosa pudica* seeds. *Allelopathy Journal* **22**(1): 59-67.

Mawal S and Patil DS 2019. Assessment of allelopathic potential of *Lantana* species on some selected agricultural crops. *International Journal of Botany Studies* **4**(1): 15-20

Nasrollahi P, Razavi S M, Ghasemian A and Zahri S 2018. Physiological and Biochemical Responses of Lettuce to Thymol, as Allelochemical. *Russian Journal of Plant Physiology* **65**(4): 598-603

Negi GCS and Kandpal KD 2003. Traditional methods of water management in the Central Himalayan agriculture. *Indian Journal of Traditional Knowledge* **2**(3): 256-264.

Negi GCS, Sharma S, Vishvakarma SCS, Samant S, Maikhuri R K, Prasad MS and Palni MS 2019.Ecology and use of *Lantana camara* in India. *The Botanical Review* **85**: 109-130.

Ogunsanya BG, Egberongbe RK and Awodoyin RO 2018. Allelopathic effect of aqueous extracts of *Lantana camara* L. on the germination of seeds and growth of seedlings of *Amaranthus cruentus* L. *Proceedings of the 36th Annual Conference of Horticultural Society of Nigeria (Hortson), Lafia 2018.* Faculty of Agriculture Shabu-Lafia Campus, Nasarawa State University, Keffi, Nasarawa State, Nigeria.

Qasem JR 2006. Response of onion (*Allium cepa* L.) plants to fertilizers, weed competition duration and planting times in the central Jordan Valley. *Weed Biology and Management* **6**: 212-220.

Rai PK 2012. Assessment of multifaceted environmental issues and model development of an indo-Burma hot spot region. *Environmental Monitoring and Assessment* **184**: 113-131.

Rai PK 2015. Paradigm of plant invasion: multifaceted review on sustainable management. *Environmental Monitoring and Assessment* **187**: 759.

Rai PK and Kim KH 2020. Invasive alien plants and environmental remediation: A new paradigm for sustainable restoration ecology. *Restoration Ecology* **28**: 3-7.

Rai PK and Singh MM 2015 *Lantana camara* invasion in urban forests of an Indo-Burma hotspot region and its eco sustainable management implication through biomonitoring of particulate matter. *Journal of Asia-Pacific Biod*iversity **8**: 375-381.

Rai PK and Singh MM 2020. Fe- wetland plant's chemical ecology of a Ramsar Site in an Indo-Burma hotspot: in-situ bio-accumulation and phytoremediation implications. *Nature Environment and Pollution Technology* **19**: 1607-1615.

Rai PK and Singh JS 2020. Invasive alien plant species: their impact on environment, ecosystem services and human health. *Ecological Indicator* **111**: 106020.

Rai PK 2022. Environmental Degradation by Invasive Alien Plants in the Anthropocene: Challenges and Prospects for Sustainable Restoration. *Anthropocene Science* **1**: 5-28.

Rai PK and Vanlalruati 2022. Societal perception on environmental and socio-economic implications of *Tithonia diversifolia* (Hemsl.) A. Gray invasion in an Indo-Burma biodiversity hotspot. *Environmental & Socio-economic Studies,* **10**(3): 59-66.

Sakachep ZK and Rai PK 2021a. Influence of invasive alien plants on vegetation of Hailakandi district, Assam, North-East, India. *Indian Journal of Ecology* **48**(1): 261-266

Sakachep ZK and Rai PK 2021b. Impact Assessment of invasive alien plants on soil organic carbon (SOC) status in disturbed and moderately disturbed patches of Hailakandi District in an Indo Burma Hotspot region *Indian Journal of Ecology* **48**(6): 1698-1704.

Saxena MK, Gupta SJ and Singh N 2013. Allelopathic potential of callus extract of *Lantana camara*. *International Journal of Recent Scientific Research* **4**:1628-1630.

Sharma PK and Acharya CL 2000. Carry-over of residual soil moisture with mulching and conservation tillage practices for sowing of rainfed wheat (*Triticum aestivum* L.) in north-west India. *Soil and Tillage Research* **57**: 43-52.

Singh HP, Batish DR, Dogra KS, Kaur S, Kohli RK and Negi A 2014. Negative effect of litter of invasive weed *Lantana camara* on structure and composition of vegetation in the lower Siwalik Hills, northern India. *Environmental Monitoring and Assessment* **186**(6): 3379-3389.

Tadele D 2014. 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* **6**(1): 111-119.

Talhi F, Gherraf N and Zellagui A 2020. Allelopathic effect of the aqueous extract of *Lantana camara* L. on the germination and development of four vegetable species. *IJCBS* **18**: 116-121.

Vanlalruati and Rai PK 2021. The impact of *Tithonia diversifolia* (Hemsl.) A. Gray on phytosociology and native plants diversity of Aizawl, Mizoram, North East India. *Ecology Environment & Conservation* **27:** S211-S216.

Veraplakorn V 2017. *In vitro* micropropagation and allelopathic effect of Lantana (*Lantana camara* L). *Agriculture and Natural Resources* **51** (6): 478-484.

Wahab A 2004. *Studies on the chemical constituents of Lantana camara L.* Thesis University of Karachi, Pakistan.

Wang R, Kang X, Quan G and Zhang J 2015. Influence of *Lantana camara* on soil II. Effects of *Lantana camara* leaf litter on plants and soil properties. *International Allelopathy Foundation* **35**(2): 207-216.

Yi Z, Zhang M X, Ling B, Xu D and Ye JZ 2006. Inhibitory effects of *Lantana camara* and its contained phenolic compounds on *Eichhornia crassipes* growth. *Chinese Journal of Applied Ecology* **17**: 1637-1640.

Zhang Q, Zhang Y, Peng S and Zobel K 2014. Climate warming may facilitate invasion of the exotic shrub *Lantana camara. PLoS ONE* **9**(9): e105500

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