International Journal of Zoology and Applied Biosciences **ISSN: 2455-9571**
Volume 9, Issue 4, pp: 68-72, 2024
https://doi.org/10.55126/ijzab.2024.v09.i04.011 **http://www.ijzab.com**

Research Article

TOXICITY EVALUATION OF IMIDACLOPRID 17.8% SL AGAINST POPLAR DEFOLIATOR *CLOSTERA CUPREATA* (BUTLER) (LEPIDOPTERA: NOTODONTIDAE)

Jitendra Kumar and *Arvind Kumar

Forest Entomology Discipline, Forest Protection Division, Forest Research Institute, Dehradun, Uttarakhand, India, P.O. 248006

Article History: Received 19th May 2024; Accepted 22nd July 2024; Published 10th August 2024

ABSTRACT

Poplar (*P. deltoides*) is a major agroforestry species that plays a significant role in the socio-economic development of farmers in Northwestern India. The poplar leaf defoliator, *Clostera cupreata*, is a major insect pest of poplar, occurring in serious proportions and causing significant growth loss to the trees. In pursuit of chemical management for the poplar defoliator, Imidacloprid 17.8% SL was evaluated for its median lethal toxicity (LC_{50}) against *C. cupreata*. The LC_{50} was calculated as 0.0017% at 72 hours after treatment (HAT) against third instar *C. cupreata* larvae under laboratory conditions. The screening process for the toxicity of Imidacloprid against *C. cupreata* may provide a crucial step for the development of novel insecticides for managing forestry insect pests.

Keywords: Imidacloprid, LC_{50}, Lethal concentration, Poplar defoliator, *Clostera cupreata*, Insect pest.

INTRODUCTION

Poplar, *Populus deltoides* Bartr. Ex Marsh, known as poplar or eastern cottonwood, is a member of the Salicaceae family. It is extensively planted and naturally occurring species across the Northern Hemisphere (Dhillon *et al*., 2020). *P. deltoides*, introduced to India in 1958 by the Forest Research Institute, Dehradun, is considered one of the most favourable agroforestry species in the country (Kaul and Sharma, 1982), and widely planted in north-western provinces of India viz. Uttar Pradesh, Punjab, Haryana, and the lower foothills of Uttarakhand and Himachal Pradesh (Dhiman *et al*., 2017; Kumar and Singh 2012). This species has also been grow successfully in Indian subtropical climatic regions, including Assam, Tamil Nadu, Bihar, Andhra Pradesh, and Telangana. Poplar has been widely planted as block plantations, bund plantings, and agroforestry by the farmers, though it has been considered the most suitable fast growing tree species for agroforestry systems. The wood of this species is highly demanded in the wood industry as their raw material for plyboard, match sticks, plywood and packing industries, pulp and paper, furniture and the artificial limbs, etc. (Kumar *et al*., 2021; Dhillon *et al*., 2020; Saresh *et al*., 2018). Additionally, it serves essential functions in the ecosystem such as providing food, shelter, shade, and habitats for variety of fauna and livestock, and helps in protecting soil, water, crops, (Dhillon *et al*., 2020; Kumar *et al*., 2021; Pra *et al*., 2019; Saresh *et al*., 2018). *P. deltoides* is also utilized for phytoremediation to address heavy metal contamination, soil remediation, and the restoration of fragile ecosystems prone to desertification (Bergante *et al*., 2015). Approximately 9.6 million hectares dedicated to poplar cultivation world wide as of 2016, with 3.8 million hectares specifically for wood production, while the rest primarily aimed at environmental benefits. Turkey, China, France, and India are leading regions in poplar farming acreage and wood production globally (FAO, 2016; Biselli *et al*., 2022).

Insect infestations represent a widely documented issue, with numerous invasive species posing significant threats to biodiversity and the functioning of ecosystems globally (Liebhold *et al*., 2017; Seebens *et al*., 2018). *P.deltoides* also faces a wide array of threats from insect pests, which notably can hinder plant growth and lead to

*Corresponding Author: Dr. Arvind Kumar, Scientist-F & Officer in-charge Forest Entomology Discipline, Forest Protection Division, Forest Research Institute, Dehradun, Uttarakhand, India, P.O. 248006 Email: arvind.ento@gmail.com.

declines in both the quantity and quality of wood biomass (Kumar *et al*., 2022; Biselli *et al*., 2022). Noteworthy, about 65 insect pest species reported infesting to *P. deltoides* in northwestern provinces of India (Dalal *et al*., 2018). Among these insect pests, poplar leaf defoliators (PLD), *Clostera* sp., (Lepidoptera: Notodontidae), are considered the major defoliators of *P. deltoides* due to their wide distribution and regular large-scale defoliation.

Clostera cupreata (Butler), *C. restitura* (Walker) and *C. fulgurita* (Walker) are well-recognized major defoliators of *P. deltoides* and initially, larvae are gregarious feeder and later instar are solitary in nature and eat away all the tissues of the leaves, leaving only veins (Sangha & Sohi, 2007). The larvae very efficient defoliator lasts for 15 to 20 days and feed the whole leaf very fast and cause complete tree defoliation within few days during July to September. These defoliators regularly cause more than 25% defoliation in the poplar plantation (Gao *et al*., 1985; Singh 2000; Sangha 2011) and recorded to be loss of about 61.33% of tree growth (Kumar *et al*., 2022).The large-scale defoliation of *C. cupreata* larvae results in lower plant vigor and increase susceptibility to attack by other pests and diseases; therefore, repeated defoliation in young plants results in tree mortality (Singh and Pandey, 2002).

Numerous research endeavours have concentrated on devising environmentally friendly methods to control insect pests, encompassing bio-pesticides, natural predators, and bio-control as integral elements of integrated pest management strategies (Idrees *et al*., 2021; Luo *et al*., 2018; Zhang *et al*., 2019). While these eco-friendly tactics prove effective against various insect pests, their action tends to be gradual (Veres *et al*., 2020). Consequently, due to the slower response of these safer control methods, many farmers opt for synthetic insecticides as an immediate measure to manage noxious insect pests. Previously many insecticides such as BHC, DDT, lindane, chlordane, aldrin, parathion, and lead arsenate were recommended for the management of poplar insect pest (Rishi, 1981; Sen-Sharma and Gupta, 1981; Singh and Singh, 1986; Sohi *et al*., 1987, 1989) but most of these insecticides are banned. Subsequently, the insecticides viz. Quinalphos, Profenofos and Carbaryl were used to keep the population of *C. cupreata* under check (Sangha *et al*., 2017).

Utilizing innovative synthetic insecticides serves as an efficient emergency measure and could play a crucial role in integrated pest management strategies aimed at addressing the threat of the poplar defoliator *C. cupreata* in India. In the increasing poplar plantation and subsequently increase in insect pest infestation, it is important to screen the effective synthetic insecticides against *C. cupreata* in order to develop efficient insect pest management techniques for poplar farming. Thus, with the aim to evaluate few synthetic insecticides against a major defoliator of poplar trees, present experiment was undertaken.

MATERIALS AND METHODS

Field survey of poplar was conducted to collection the insect culture of *C. cupreata* in the Haridwar district of Uttarakhand, during July - August. Egg masses and larval populations of *C. cupreata* were collected and brought to the laboratory for rearing. Insects were transferred to an insect rearing chamber and fresh leaves of *P. deltoides* were provided daily basis for rearing the larval stage. After pupation insects were placed to a in ventilated cages sized 80x60x40 cm for adult emergence. Adult insects were fed with 10% sucrose solution (10 g/l) via a cotton swab. After hatching, the resulting second-generation larvae were moved to fresh poplar leaves for feeding. Third-instar larvae from this second generation were utilized for the bio efficacy study. Both insect rearing and bioassay testing were conducted at room temperature during July and August at Insect Systematics Laboratory, Forest Entomology Discipline, Forest Research Institute, Dehradun, Uttarakhand, India

Imidacloprid 17.8% SL (Manufacturer: Shivalik Crop Science LTD. India) was evaluated against third instar larvae of *C. cupreata*. Five consecutive concentrations viz. 0.1, 0.2, 0.5, 1.0 and 2.0 % prepared through repeated dilution with water. The mode of action of Imidacloprid is acetylcholine receptor stimulation. The toxicity of Imidacloprid insecticides against third instar *C. cupreata* larvae was evaluated using the leaf dip method as outlined in Paramasivam and Selvi, (2017). Leaf discs were prepared of *P. deltoides* measuring 5 cm in diameter and were immersed in a prepared concentration of the insecticide solution for 10 seconds followed and then allowed to dry on a paper towel. Leaf discs used in the control were exposed with distal water. These treated leaves were then placed in Petri dishes (90 mm) lined with moist filter paper, subsequently; a group of ten larvae of third instar of *C. cupreata* were released onto the treated leaves. The each treatment was replicated five times. Larval mortality was observed at intervals of 24, 48, and 72 hours after treatment. Data were subjected to statistical analysis with probit analysis (Finney 1971) statistical method for lethal concentrations (LC_{50}), Standard error; 95% confidential limits; Chi-square value ($\chi 2$) and degrees of freedom (df) using SPSS statistical analysis software (IBM SPSS statistical analysis software version 23.0 (Armonk, New York, USA).

RESULTS AND DISCUSSION

The toxicity results revealed that imidacloprid exhibited a concentration of 0.072% at 24 hours after treatment (HAT), while concentrations of 0.012% and 0.0017% were observed against third instar larvae of *C. cupreata* at 48 and 72 HAT, respectively (Table 1). This study represents the first toxicity evaluation of Imidacloprid 17.8% SL against *C. cupreata*. Though, Sangha *et al*. (2017) determined the lethal concentrations of quinalphos, profenofos, and carbaryl against *C. cupreata* in this field. However, Imidacloprid 17.8% SL was previously applied in soybean fields and was found to be most effective against tobacco caterpillar *Spodoptera litura*, green semilooper, and soybean blue beetle (Bhardwaj *et al*., 2018). Additionally, the results revealed that the maximum reduction in population was observed with imidacloprid 17.8% SL against rice brown plant hopper *Nilaparvata lugens* (Priyadharshini, 2023). Justin *et al*. (2015) also reported a significant reduction in the population of *Aphis craccivora* Koch, leafhopper *Empoasca kerri* Pruthi, defoliator *Spodoptera litura* (Fab.), and pod borer *Helicoverpa armigera* (Hub.) in black gram.

Table 1. Toxicity of Imidacloprid 17.8% SL against third instar larvae of poplar defoliator, *C. cupreata*.

Insecticide	LC50 (95% CL)[b] (mg L-^{1})	Regression equation	Slope ±SE[a]	χ2 (df)[c]
24HAT	0.726 (0.329-1.60)	y=1.106X + 5.18	1.06±0.17	0.84 (3)
48 HAT	0.125 (0.064-0.243)	y=1.372X + 6.24	1.42±0.14	0.90 (3)
72 HAT	0.017 (0.004-0.071)	y=0.33X + 6.65	1.02±0.31	0.67 (3)

[a] Standard error; [b] 95% confidential limits'Chi-square value ($\chi 2$) and [c] degrees of freedom (df) as calculated by probit analysis of SPSS version 23.0; The LC_{50} values of each tested insecticide corresponding 95% confidence limits ($P < 0.05$).

The chemical method stands out as the most rapid, successful, and widely used approach for controlling insect pests through the application of appropriate concentrations of insecticides. Priyadharshini (2023) reported resistance in *Nilaparvata lugens* against Imidacloprid, thus recommending the rotation of different insecticides to manage resistance in insect pests effectively. Continuously screening new insecticidal molecules against targeted insect pests is essential for ensuring bio-efficacy and incorporating newer molecules into pest management programs. However, there is limited research conducted on screening insecticides for forestry insect pests, despite *Populus deltoides* being widely planted over 2.7 lakh hectares in Northwestern states of India. The use of higher discriminating concentrations of imidacloprid 17.8% SL notably increased cumulative larval mortality among early instar *C. cupreata*. This study underscores a significant increase in early instar larval mortality with escalating concentrations of these insecticides.

CONCLUSIONS

Due to the limited number of recommended insecticides for managing the poplar defoliator *C. cupreata*, it is crucial to use imidacloprid 17.8% SL with caution and prudence in management strategies to ensure its long-term efficacy. Furthermore, after conducting additional field investigations to confirm its effectiveness, this insecticide could be deployed on an emergency basis at recommended doses against *C. cupreata* larvae. The findings of this research provide valuable insights for selecting alternative insecticides for poplar defoliator management. However, further research is needed to validate these laboratory findings under field conditions.

ACKNOWLEDGMENT

The authors express sincere thanks to the head of the Forest Entomology Discipline, Forest Protection Division, Forest Research Institute, Dehradun, Uttarakhand, for the facilities provided to carry out this research work.

REFERENCES

Bhardwaj, N., Singh, S.B., Pavithra S. and Singh K.K. (2018). Efficacy of insecticide against insect pest of soybean, *Glycine max* (l.) Merril, *Journal of Plant Development Sciences*, 10 (1), 55-60.

Biselli, C., Vietto, L., Rosso, L., Cattivelli, L., Nervo, G., & Fricano, A., (2022). Advanced breeding for biotic stress resistance in poplar. *Plants*, 11, 2032. https://doi.org/10.3390/plants11152032

Dalal, M.P., Rathee, M., Singhdoha, A., Singh, N.V., Yadav, G.S., (2018). Bionomics of *Clostera cupreata* (Butler) (Lepidoptera: Notodontidae) on poplar trees in Haryana. *International Journal of Forestry & Crop Improvement*.9, 33-36. DOI. 10.15740/HAS/IJFCI/9.1/33-36.

Dhillon, G.P.S., Sandhu, J.S. Singh P., (2020). Variations among poplar (*Populus deltoides* Bartr.) clones for growth, wood traits and tolerance to leaf spot diseases. *Current Agricultural Research Journal* 8, 128-136.http://dx.doi.org/10.12944/CARJ.8.2.08.

Dhiman, R.C., Tamak, J., Kapri, K.D., Gandhi, J.N. (2017). Growth and yield of poplar (*Populus deltoides*) growth in Telangana / Andhra Pradesh. IPPTA- *The official International Journal*. 29, 111-119.

FAO, (2016). Poplars and Other Fast-Growing Trees—Renewable Resources for Future Green Economies. Synthesis of Country Progress Reports. In Proceedings of the 25th Session of the International Poplar Commission, Berlin, Germany, 12–16 September 2016; pp. 13–16.

Finney, D.J., (1971). Probit analysis, 3rd ed. Cambridge University Press, Cambridge, London, UK pp. 1–333.

Gao, R.T., Qin, X.X., Li, J.Z., Hao, W.Q., Wang, X. Z., (1985). A preliminary study on the relationship between artificial defoliation of poplar trees and their growth. *Scientia-Silvae-Sinicae*. 21,199–205.https://doi/full/10.5555/19860607617.

Idrees, A., Qadir, Z.A., Akutse, K.S., Afzal, A., Hussain, M., Islam, W., Waqas, M.S., Bamisile, B.S. and Li, J., (2021). Effectiveness of entomopathogenic fungi on immature stages and feeding performance of Fall Armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae) Larvae. *Insects*, 12,1044.https://doi.org/10.3390/insects12111044.

Justin, CGL., Anandhi P. and Jawahar D. (2015). Management of major insect pests of black gram under dryland conditions. *Journal of Entomology and Zoology Studies*; 3 (1): 115-121.

Kaul, R.N., Sharma, K.K., (1982). Status report on poplars. Workshop on Poplars, Haldwani, 23-24 January. Proceedings. Dehradun, FRI and Colleges. pp. 21-53.

Kumar, A., Kumar, J. and Chandra, G. (2022). Effect of defoliation on tree growth of *Populus deltoides* Bartr.ex Marsh in India, *Current Science*, 123:1-6.

Kumar, A., Kumar, J., Pandey, R., (2021). Biology of poplar leaf folder, *Botyodes diniaasalis* Walk. (Lepidoptera: Crambidae) on *Populus deltoides* Bartr. Ex Marsh. *Journal of the Entomological Research Society*.45, 745-748. http://dx.doi.org/10.5958/0974-4576.2021.00119.5

Kumar, D., Singh, N.B. (2012). Status of poplar introduction in India. *Forestry Bulletin,* 12, 9-14.

Liebhold, A.M., Brockerhoff, E.G., Nunez, M.A., (2017). Biological invasions in forest ecosystems: A global problem requiring international and multidisciplinary integration. *Biology Invasions*. 19, 3073–3077. https://10.1007/s10530-017-1458

Luo, M., Zhang, H., Du, Y., Idrees, A., He, L., Chen, J., et al. (2018). Molecular Identification of Cultivable Bacteria in the Gut of Adult *Bactrocera tau* (Walker) and Their Trapping Effect. *Pest Management Science*, 74, 2842–2850. https://doi.org/10.1002/ps.5074.

Paramasivam, M., Selvi, C. (2017). Laboratory bioassay methods to assess the insecticide toxicity against insect pests-A review. *Journal of Entomology and Zoology Studies*. 5, 1441-1445.

Pra, A.,Pettenella, D., (2019). Investment returns from hybrid poplar plantations in northern Italy between 2001 and 2016: Are we losing a bio-based segment of the primary economy? *Italian Review of Agricultural Economics*. 74, 49–71. http;//DOI: 10.13128/REA-25479

Priyadharshini, E., Muthukrishnan, N., Vinothku Mar, B., sathiah and N ., Prabakar K. (2023). Toxicity of imidacloprid 17.8%SL and triflumezopyrim 10%sc to rice brown planthopper *Nilaparvata lugens*. *Indian Journal of Entomology* 85(4): 1047-1049. DoI. 10.55446/IJE.2021.140.

Rishi, N.D., (1981). Insects pests of poplars in Kashmir valley. In: Singh, R.V. (ed.), Proceedings of the symposium on silviculture, management and utilization of poplars, Srinagar 1979. Govt. of India Press, Simla, India, pp. 123–125.

Sangha, K.S., 2011. Evaluation of management tools for the control of poplar leaf defoliators (Lepidoptera: Notodontidae) in North western India. *The Journal of Forestry Research*. 22, 77-82.https:// 10.1007/s11676-011-01.

Sangha, K.S., Dhaliwal, A.K., Singh, R., (2017). Seasonal incidence and management of *Clostera cupreata* (Butler) (Lepidoptera: Notodontidae) on *Populus deltoides*. *Indian Journal of Agroforestry*. 19, 83-89.

Sangha, K.S., Sohi, A.S., (2007). Population dynamics of *Clostera fulgurita* and its principal natural enemies in Punjab. *Indian Journal of Agroforestry,* 9, 116-120.

Saresh, N.V., Verma, A., Rana, D.S., Bhardwaj, R., Mahantesh, B.H., Raghavendra, S. M., Sankanur, M.S. (2018). Poplar (*Populus deltoides*) based agroforestry systems: An economically viable livelihood option for the farmers of North India. *Climate Change and Agroforestry*. 579-593.

Seebens, H., Blackburn, T.M., Dyer, E.E.,Genovesi, P.,Hulme, P.E.,Jeschke, J.M.,Pagad, S.,Pyšek, P.,VanKleunen, M., Winter, M., et al. (2018).The global rise in emerging alien species results from increased accessibility of new source pools. *Proceedings of the National Academy of Sciences.* USA 115, E2264–E2273.

Sen-Sharma, P.K., Gupta, B.K., (1981). Insect pests of poplars. In: Singh R.V. (ed.), Proceedings of the symposium on silviculture, management and utilization of poplars, Srinagar 1979. Govt. of India Press, Simla, India, pp. 121-122.

Singh, A.P., (2000). Relative natural resistance of *Populus deltoides* clones against defoliator *Clostera cupreata* (Lepidoptera: Notodontidae) in northern India. *Agroforestry Systems*, 49, 319-326. https:// 10.1023/a: 1006323004157.

Singh, A.P., Pandey R., (2002). Natural resistance of *Populus deltoides* clones' selection to defoliator *Clostera cupreata* (Lep., Notodontidae) in northern India: relative pupal weight as an easier criterion for accurate evaluation. *Journal of Applied Entomology*, 126, 475-480.

Singh, P., Singh, S., (1986). Insects pests and diseases of poplars. F.R.I. Press, Dehradun, India. pp. 74.

Sohi A.S., Singh H., Sandhu G.S., (1987). *Clostera restitura,* Walker(Lepidoptera: Notodontidae) a defoliator of Poplar (*Populus* sp.) in Punjab and its control. *Journal of Tree Science*. 6, 30-33.

Sohi, A.S., (1989). Insect pests of Poplar. Paper presented at a Seminar on Forest Protection. Forest Research Institute, Dehradun, India. 29-30 June, 1989.

Veres, A., Wyckhuys, K.A.G., Kiss, J., Toth, F., Burgio, G., Pons, X., et al. (2020). An Update of the Worldwide Integrated Assessment (WIA) on Systemic Pesticides. Part 4: Alternatives in Major Cropping Systems. *Environmental Science and Pollution Research*. 27, 29867-29899. https://10.1007/s11356-020-09279-x.

Zhang, H.H., Luo, M.J., Zhang, Q.W., Cai, P.M., Idrees, A., Ji, Q.E, et al. (2019). Molecular Characterization of Prophenoloxidase-1 (PPO1) and the Inhibitory Effect of Kojic Acid on Phenoloxidase (PO) Activity and on the Development of *Zeugodacus tau* (Walker) (Diptera: Tephritidae). *Bulletin of Entomological Research*. 109, 236-247.