International Journal of Entomology Research
www.entomologyjournals.com
E-ISSN: 2455-4758
Received: 06-10-2026, Accepted: 05-11-2026, Published: 20-11-2026
Volume 11, Issue 4, 2026, Page No. 290-295

Studies on bio-pesticide potential of some indigenous plants from Khandesh region of Maharashtra State

Kailas Dandge
School of Environmental and Earth Sciences, Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon, Maharashtra, India
DOI: https://doi.org/10.66856/ijer.2026.11.4.11400

Abstract
The widespread use of synthetic chemical pesticides has led to pest resistance, toxicity to non-target organisms, and residue accumulation in the food chain. These consequences underscore the urgent need for safer, locally sourced alternatives. This study investigated traditional pest control practices among farmers in the Khandesh region of Maharashtra and evaluated eleven native plant species for their potential as bio-pesticides. Ethanolic leaf extracts from six species—Calotropis procera, Mesosphaerum suaveolens, Acorus calamus, Albizia lebbeck, Ocimum americanum, and Datura stramonium—were assessed for larvicidal activity against third-instar Spodoptera sp. larvae at concentrations ranging from 100 to 1000 ppm over 24 and 48 hours. Mortality data were analyzed using Karber's arithmetic method to determine LC50 values. All six extracts demonstrated concentration- and time-dependent mortality, with linear regression indicating a strong dose-response relationship for each species (r = 0.95 to 0.99). Datura stramonium (LC50 = 310 ppm) and Mesosphaerum suaveolens (LC50 = 325 ppm) exhibited the highest efficacy, followed by Ocimum americanum (380 ppm) and Calotropis procera (490 ppm), while Albizia lebbeck (600 ppm) and Acorus calamus (615 ppm) were comparatively less toxic. These findings indicate that indigenous plants from the Khandesh region possess significant bio-pesticide potential and may serve as practical, environmentally sustainable, and cost-effective resources for developing botanical insecticides within integrated pest management systems.

Keywords: Indigenous plants, Khandesh region, Spodoptera sp., LC50, dose-response, botanical insecticide

Introduction
As the human population grows and food demand increases, agriculture has relied heavily on synthetic chemical insecticides and pesticides. These chemicals have helped control pests in the short term, but their toxic and non-biodegradable nature has harmed both human health and the environment. Over time, toxic residues build up in the food chain through biomagnification and bioaccumulation, leading to pollution and reduced soil fertility. Chemical pesticides also kill helpful micro-organisms and natural pest predators, upsetting the ecological balance and stability of food webs. Bio-control uses natural predators and materials from living sources instead of synthetic chemicals, providing a safer way to manage pests. Biopesticides, which come from plants, animals, bacteria, or certain minerals, are usually less toxic, more targeted, and break down quickly in the environment. This makes them an important part of Integrated Pest Management (IPM) programs. The Khandesh region of Maharashtra has many native herbs, shrubs, and weeds that are used in traditional practices, but many have not been scientifically tested for their ability to control insects. This project tested these local plants for biopesticide activity, aiming to support eco-friendly, affordable, locally sourced alternatives to synthetic insecticides. Biopesticides are often seen as a safer alternative to chemical pesticides in India and worldwide. They offer environmental safety and target pests more specifically, but challenges remain in research, production costs, and risk assessment (Basnet *et al*., 2022; Meshram *et al*., 2022) [3, 12]. Research on biopesticides is growing quickly worldwide, including new work on using nanotechnology in their development (Shen *et al*., 2021) [13]. By 2016, the US EPA had registered 299 biopesticide active ingredients and 1,401 biopesticide products (US EPA, 2022).

Study Area
Khandesh is located in the north-western part of Maharashtra State. It lies on the northwestern edge of the Deccan Plateau, within the Tapi River valley. Figure 1 Shows location map of study area northwestern corner of the Khandesh region, the Narmada River served as a natural border, and to the west, the base of the hills on the outskirts of Shahada formed another natural boundary of Khandesh. It separated Khandesh from the Akrani taluka to the north, extending into the heart of the hills where the Narmada River passes through the Satpuda. To the east and southeast, rows of pillars and some water streams marked the boundary of Khandesh from the central provinces and Berar. To the south, the Ajanta and Satmala ranges formed a rough boundary between Khandesh and the Marathwada region. To the southwest, the Arva or Making and Galna hills separate Khandesh from Nasik (Bombay (India: State), 1880) [6].

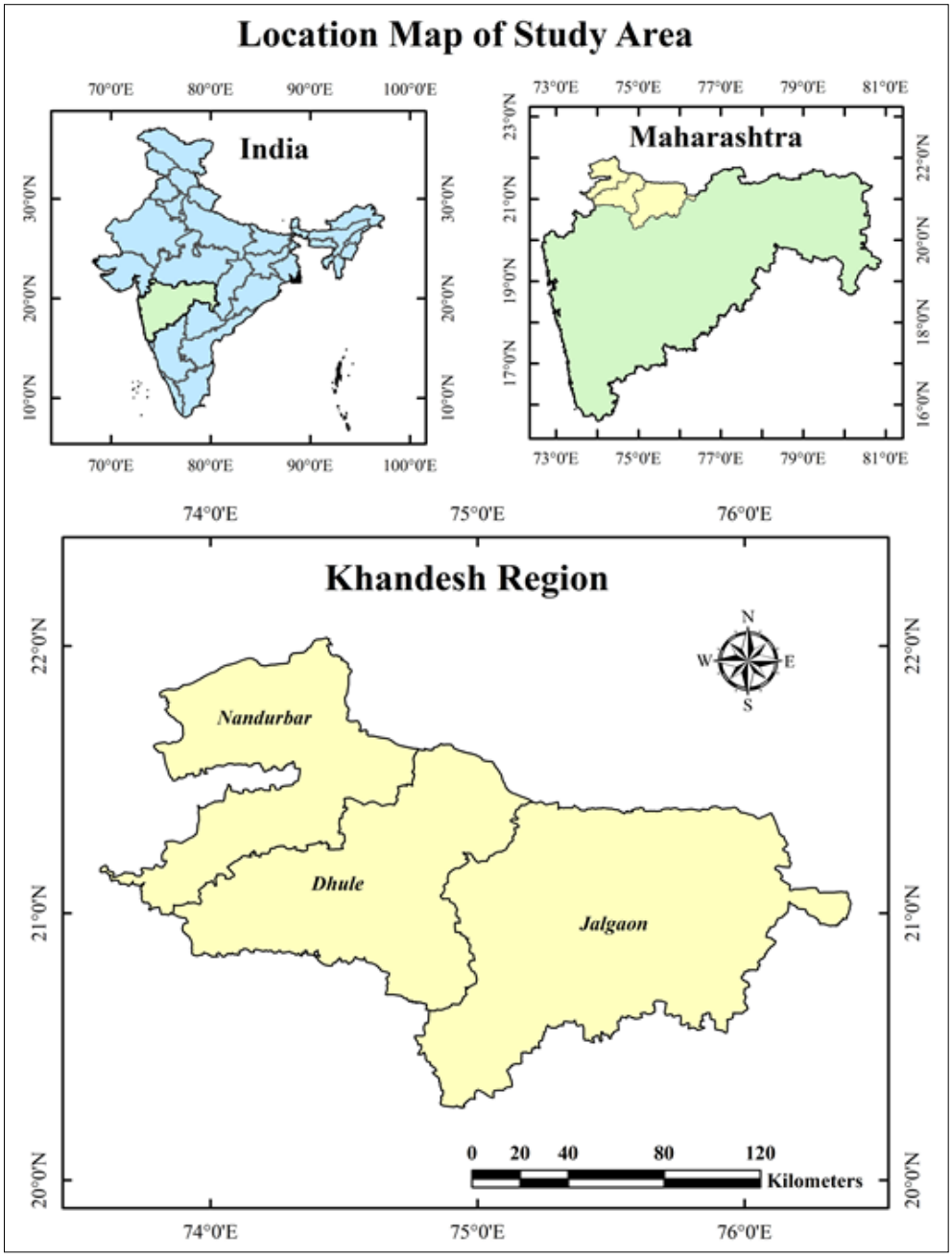


Fig 1: Location map of study area

Significance of the Study

The widespread and often indiscriminate use of chemical pesticides in agriculture leads to serious problems, such as pest resistance and the build-up of pesticide residues in agricultural and dairy products. Studies have found that over 80 percent of milk samples examined in India contained residues of DDT and HCH, and breast milk samples from mothers in Punjab revealed dangerously high levels of DDT and benzene hexachloride (Farah, 1994) [7]. These results show the urgent need for environmentally sustainable alternatives, such as biopesticides. Biopesticides are low in toxicity to birds, fish, bees, and other non-target wildlife, help conserve beneficial insect populations, break down quickly in the environment, and reduce the need for synthetic pesticide applications as part of an integrated pest management (IPM) system.

The study provides primary bioassay data on plant species available in the Khandesh area, offering specific scientific evidence for developing low-cost pest-control methods accessible to farmers. It also records the indigenous ethnobotanical knowledge which might otherwise be lost.

Materials and Methods

1. Survey and Collection of Plant Material

A field survey was conducted across villages in the Khandesh region to document traditional pest-management practices used by local farmers. We gathered information through interviews with farmers, elderly residents, and other knowledgeable people, and we surveyed villages repeatedly across seasons to account for seasonal variation in plant availability and verify the authenticity of the information. Based on this survey and literature review, eleven plant species, preferably weeds, with reported or suspected bio-pesticidal potential were selected for laboratory evaluation, as in Table 1 . Leaves and, where applicable, floral parts of the selected 11 plants (*Viz. Mesosphaerum suaveolens*,

Acorus calamus, Albizia lebbeck, Aristolochia bracteolata, Calotropis procera, Anacyclus pyrethrum, Codiaeum variegatum (Croton Tree, Ocimum americanum (Ran-tulsi), Melia azedarach (Bakan nimb), Datura stramonium, Duranta erecta) were collected from the North Maharashtra region, identified with the help of a botanical expert, and processed for extraction.

The leaves and floral parts of selected weeds were collected from the North Maharashtra region. Freshly collected plant material was shade-dried at room temperature for 10 days. Dried flower and leaf samples were then ground into a fine powder using a laboratory grinder and mixer. The extraction was carried out using maceration method, as described by (Azwanida NN, 2015; Handa SS *et al*., 2008; Yannick Stéphane *et al*., 2021) [2, 9, 17]. The dried powder from 10 selected plants was placed in a stoppered container with 90% ethanol as the solvent and left at room temperature for at least 3 days, with frequent agitation, until the soluble matter dissolved. The mixture was then clarified by centrifugation. The extracts were concentrated at 50°C and stored at 4°C. A stock solution was prepared by dissolving 1 mL of extract in 1000 mL of distilled water. This solution was used to prepare further dilutions. The extract concentrations (100, 200, 300, 400, 500, 600, 700, 800, and 900 ppm) were used for further study following trial runs with various extract concentrations.

2. Test Insects



Fig 2: Larvae of Spodoptera sp.

Leaf-eating larvae of Spodoptera species used in this study were collected from soybean, cotton, and chickpea plants in agricultural fields. The culture was maintained on soybean, cotton, and chickpea leaves at room temperature for laboratory acclimatization. Twenty Spodoptera species larvae were selected for each treatment set.

3. Toxicity Bioassay

Twenty third-instar larvae of Spodoptera sp. were used for each treatment set. Extract concentrations of 100-1000 ppm (the specific range varying by plant, up to ten concentrations per species) were prepared, along with a distilled-water control. Ten 500 mL glass beakers were used per experiment, one for each test concentration plus one control. Larvae were dip-treated in the respective test solution for two minutes and then transferred back to the rearing medium. Each treatment, including the control, was replicated three times. Larval mortality was recorded at 24 h and 48 h post-treatment, and the LC_{50} was calculated using Karber's method. The LC_{50} value was determined as follows:

$$LC_{50} = LC_{100} - \frac{\Sigma Mean\ death\ x\ Concentration\ difference}{No.\ of\ organisms\ per\ group}$$

Table 1: Plant species tested for the management of cotton leafworm (Spodoptera species) pests

Sr. No.	Common Name	Family	Plant Name	Parts Used
1	Yakand	Acoraceae	*Acorus calamus*	Leaf
2	Indian siris	Fabaceae	*Albizia lebbeck*	Leaf
3	Worm Killer	Aristolochiaceae	*Aristolochia bracteolata*	Leaf
4	Rui	Apocynaceae	*Calotropis procera*	Leaf and flower
5	Akarkara	Asteraceae	*Anacyclus pyrethrum*	Leaf and flower
6	Croton	Euphorbiaceae	*Codiaeum variegatum*	Leaf
7	Ran-tulsi	Lamiaceae	*Ocimum americanum*	Leaf
8	Bakan nimb	Meliaceae	*Melia azedarach*	Leaf and Fruit
9	Dhotra	Solanaceae	*Datura stramonium*	Leaf and flower
10	Gonj	Fabaceae	*Derris scandens*	Leaf and flower
11	Wilayati Tulsi	Lamiaceae	*Mesosphaerum suaveolens*	Leaf and flower

4. Statistical Analysis

All bioassays were conducted in triplicate, and mortality data were expressed as percentages at 24 h and 48 h. To characterise the dose-response relationship for each plant extract, simple linear regression of percentage mortality (48 h) on extract concentration (ppm) was performed, and the Pearson correlation coefficient (r) and coefficient of determination (R^2) were computed for each species to assess the strength and significance of the dose-dependent trend. LC_{50} values were used as the primary comparative index of relative toxicity among the tested plant species.

Results and Discussion

1. Toxicity Bioassay Data

Concentration-wise mortality data recorded at 24 h and 48 h for the six plant extracts for which complete dose-response bioassays were carried out against *Spodoptera sp.* larvae.

2. LC_{50} Values and Comparative Toxicity

The LC_{50} values (48 h) computed for the six plant extracts, arranged in order of increasing LC50 (i.e., decreasing toxicity), are presented in Table 2.

Table 2: LC_{50} value of the leaf extract of selected plants for 48 h.

Sr. No.	Common Name	Family	Plant Name	LC_{50} in ppm
1	Yakand	*Acoraceae*	*Acorus calamus*	615
2	Indian siris	*Fabaceae*	*Albizia lebbeck*	600
3	Rui	*Apocynaceae*	*Calotropis procera*	490
4	Ran-tulsi	*Lamiaceae*	*Ocimum americanum*	380
5	Wilayati Tulsi	*Lamiaceae*	*Mesosphaerum suaveolens*	325
6	Dhotra	*Solanaceae*	*Datura stramonium*	310

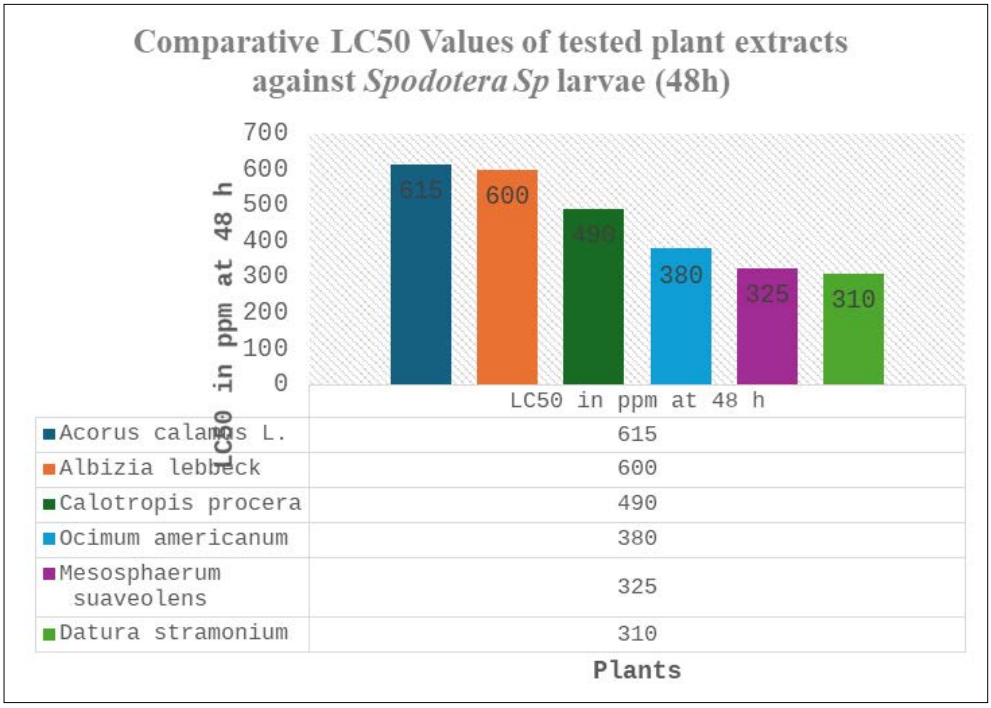


Fig 3: Comparative LC_{50} (ppm, 48 h) of the six ethanolic plant extracts tested against Spodoptera sp. larvae (lower LC_{50} = greater toxicity).

3. Dose-Response Relationship and Statistical Analysis

Linear regression of percentage mortality (48 h) against extract concentration confirmed a strong, statistically robust dose-dependent trend for every plant tested, with correlation coefficients (r) ranging from 0.95 to 0.99 (Table 3), indicating that mortality increased consistently and predictably with increasing extract concentration across the tested range.

Table 3: Linear regression statistics (% mortality at 48 h vs. concentration) for the tested plant extracts

Plant species	Slope (b)	Intercept (a)	R	R^2
Calotropis procera	0.1225	-9.00	0.9787	0.9578
Mesosphaerum suaveolens	0.1429	-3.75	0.9933	0.9866
Acorus calamus	0.1058	-14.09	0.9510	0.9044
Albizia lebbeck	0.1132	-15.68	0.9777	0.9559
Ocimum americanum	0.1327	6.67	0.9870	0.9741
Datura stramonium	0.1310	9.17	0.9735	0.9477

All six plant extracts tested caused clear, dose-dependent larval death in *Spodoptera sp.*, with higher mortality observed at 48 hours compared to 24 hours. This suggests both time- and concentration-dependent toxicity, aligning with previous findings on ethanolic plant extracts against dipteran and lepidopteran pests (Bechan Sharma, 2010a).

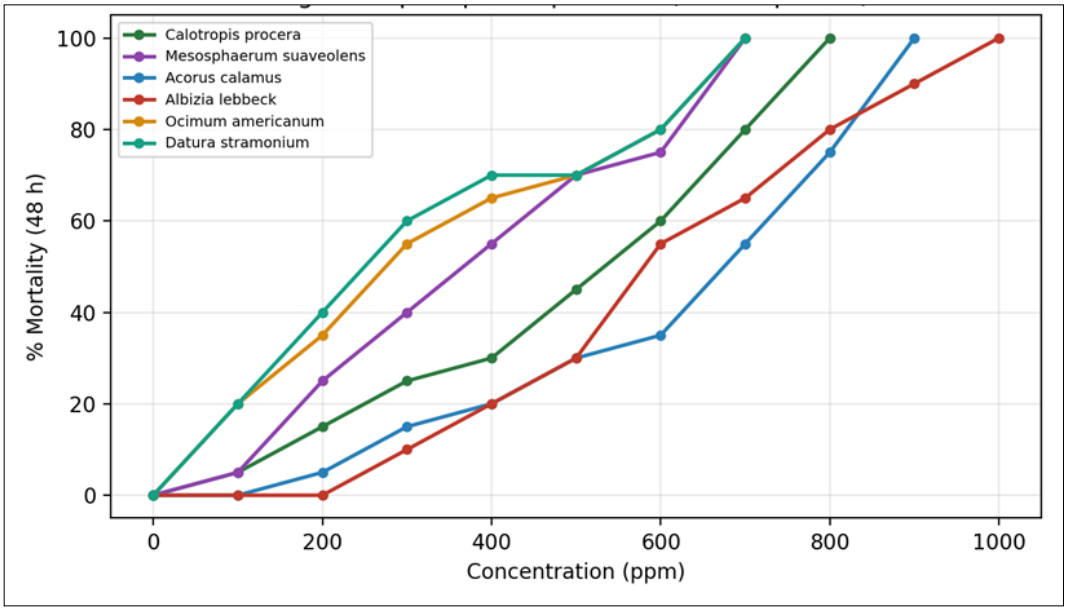


Fig 4: Dose-response (Mortality) curves of ethanolic leaf extracts against Spodoptera Sp. Larvae (48 h exposure)

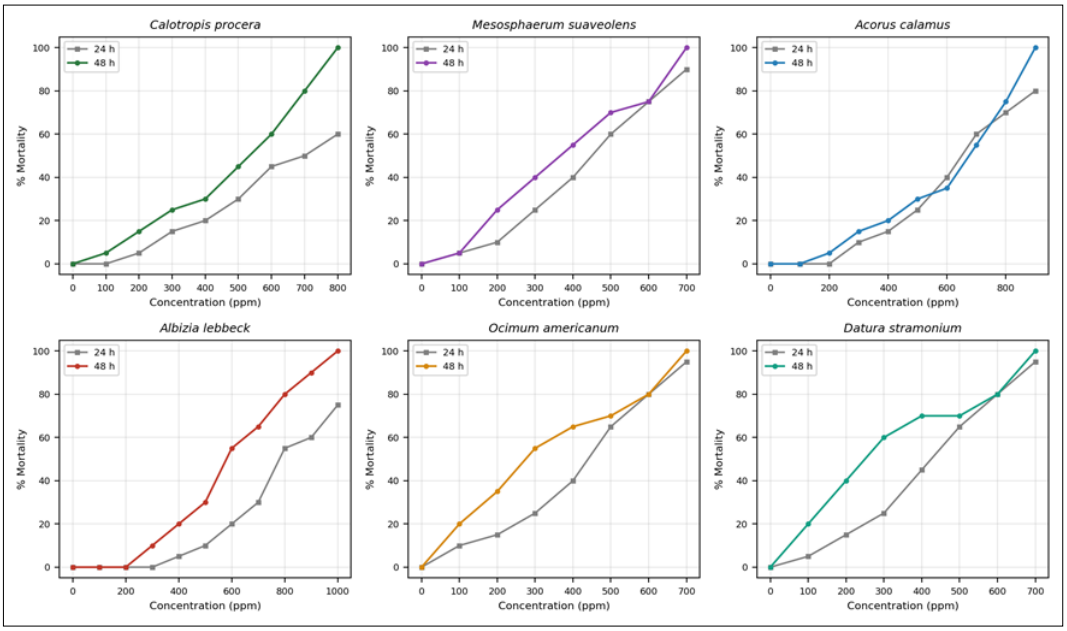


Fig 5: Individual 24 h and 48 h mortality curves for each of the six plant extracts evaluated against Spodoptera sp. larvae.

Among the tested species, Datura stramonium (LC_{50} = 310 ppm) and Mesosphaerum suaveolens (LC_{50} = 325 ppm) proved to be the most effective larvicides, with Ocimum americanum (380 ppm) and Calotropis procera (490 ppm) showing moderate potency. Albizia lebbeck (600 ppm) and Acorus calamus (615 ppm) were less toxic, requiring higher concentrations for similar mortality. The high effectiveness of D. stramonium aligns with its known content of toxic tropane alkaloids (atropine, hyoscyamine, and scopolamine), which are both insecticidal and toxic to mammals (Gaire & Subedi, 2013) [8]. Likewise, reports support the insecticidal activity of M. suaveolens, noting that its essential oil is effective against mosquito larvae (Luz *et al.*, 2020) [11] and exhibits bioactivity against various pathogenic and disease-vectoring arthropods (Almeida-Bezerra *et al.*, 2022) [1]. The relatively low toxicity of Acorus calamus observed in this bioassay is somewhat surprising, especially since its main phytochemical, β-asarone, is known for its insecticidal and antifungal properties (Venkatesan *et al.*, 2019) [16]. This could be due to differing levels of asarone-type compounds in the ethanolic leaf extract used here compared to the root or rhizome extracts that are more commonly studied, or it might indicate a slower effect on this specific pest species. The moderate activity of Calotropis procera supports previous research on its larvicidal effects against houseflies and mosquito larvae (Bechan Sharma, 2010b; Singh *et al.*, 2005) [14], aligning with the known presence of insecticidal alkaloids in its latex (Larhsini *et al.*, 1997) [10]. The strong linear correlations (r = 0.95-0.99) across all six species confirm that concentration is the primary driver of larval mortality within the tested range. This supports the reliability of the Karber-method LC_{50} estimates and provides a solid quantitative basis for comparing species' potency. Overall, the findings suggest that several native plants from the Khandesh region, particularly D. stramonium, M. suaveolens, and O. americanum, show significant potential as bio-pesticides against the pest Spodoptera sp. They warrant further study as promising plants (weeds) for developing eco-friendly, locally sourced botanical insecticides.

The findings support the premise that indigenous flora of the Khandesh region can serve as viable, low-cost, and environmentally safer sources of botanical insecticides, offering a practical alternative to synthetic chemical pesticides within an integrated pest management framework. Future work should focus on isolating and characterising the specific active phytochemicals responsible for the observed insecticidal activity, field-level validation of efficacy under actual crop conditions, and formulation development to translate these laboratory findings into farmer-usable bio-pesticide products.

Conclusion

This project documented traditional pest-management knowledge among farmers in the Khandesh region and tested eleven native plant species for bio-pesticide potential. Laboratory bioassays were conducted on six of these species against Spodoptera sp. larvae, revealing that all six ethanolic leaf extracts had significant, dose- and time-dependent larvicidal effects. The most promising plant (weed) were Datura stramonium and Mesosphaerum suaveolens, followed by Ocimum americanum and Calotropis procera, while Albizia lebbeck and Acorus calamus exhibited lower but still detectable toxicity.

Funding

This work was carried out with funding from Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon.

Acknowledgement

The author sincerely thanks Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon, for financial support under the Vice-Chancellor Research Motivation Scheme (VCRMS).

References

1. Almeida-Bezerra JW, Rodrigues FC, Lima Bezerra JJ, Vieira Pinheiro AA, Almeida De Menezes S, Tavares AB, *et al.* Traditional Uses, Phytochemistry, and Bioactivities of *Mesosphaerum suaveolens* (L.) Kuntze.

In Evidence-based Complementary and Alternative Medicine. Hindawi Limited, 2022, 2022. https://doi.org/10.1155/2022/3829180
2. Azwanida NN. A Review on the Extraction Methods Use in Medicinal Plants, Principle, Strength and Limitation. Medicinal & Aromatic Plants, 2015, 04(03). https://doi.org/10.4172/2167-0412.1000196
3. Basnet P, Dhital R, Rakshit A. Chapter 8 - Biopesticides: a genetics, genomics, and molecular biology perspective. In: Rakshit A, Meena VS, Abhilash PC, Sarma BK, Singh HB, Fraceto L, *et al*., editors. Advances in Bio-inoculant Science. Woodhead Publishing, 2022, 107–116. https://doi.org/https://doi.org/10.1016/B978-0-12-823355-9.00019-5
4. Bechan Sharma NB. Evaluation of Insecticidal Efficacy of *Calotropis Procera* and *Annona Squamosa* Ethanol Extracts Against *Musca Domestica*. Journal of Biofertilizers & Biopesticides, 2010a, 01(01). https://doi.org/10.4172/2155-6202.1000101
5. Bechan Sharma NB. Evaluation of Insecticidal Efficacy of *Calotropis Procera* and *Annona Squamosa* Ethanol Extracts Against *Musca Domestica*. Journal of Biofertilizers & Biopesticides, 2010b, 01(01). https://doi.org/10.4172/2155-6202.1000101
6. Bombay (India: State). Gazetteer of the Bombay Presidency: Khandesh. Printed at the Government Central Press, 1880, 12. https://books.google.co.in/books?id=rbUBAAAAYAAJ
7. Farah J. Pesticide Policies in Developing Countries Do They Encourage Excessive Use?, 1994. https://documents1.worldbank.org/curated/en/462871468762308339/pdf/multi-page.pdf
8. Gaire BP, Subedi L. A review on the pharmacological and toxicological aspects of *Datura stramonium* L. In Journal of Chinese Integrative Medicine. Journal of integrative medicine editorial office, Science Press,2013:11(2):73–79. https://doi.org/10.3736/jintegrmed2013016
9. Handa SS, Khanuja SPS, Longo G, Rakesh DD. Extraction Technologies for Medicinal and Aromatic Plants (1st ed.). United Nations Industrial Development Organization and the International Centre for Science and High Technology, 2008, 66.
10. Larhsini M, Bousaid M, Lazrek HB, Jana M. Evaluation of antifungal and molluscicidal properties of extract of *Calotropis procera*. Fitoterapia,1997:68:371^373 69, 68, 371–373.
11. Luz TRSA, Leite JAC, de Mesquita LSS, Bezerra SA, Silveira DPB, de Mesquita JWC, *et al*. Seasonal variation in the chemical composition and biological activity of the essential oil of *Mesosphaerum suaveolens* (L.) Kuntze. Industrial Crops and Products, 2020, 153. https://doi.org/10.1016/j.indcrop.2020.112600
12. Meshram S, Bisht S, Gogoi R. Chapter 14 - Current development, application and constraints of biopesticides in plant disease management. In: Rakshit A, Meena VS, Abhilash PC, Sarma BK, Singh HB, Fraceto L, *et al*., editors. Advances in Bio-inoculant Science. Woodhead Publishing, 2022, 207–224. https://doi.org/https://doi.org/10.1016/B978-0-12-823355-9.00004-3
13. Shen Y, Cui B, Wang Y, Cui H. 11 - Marketing strategy and environmental safety of nano-biopesticides. In: Jogaiah S, Singh HB, Fraceto LF, Lima R de B. T.-A. in N.-F. and N.-P. in A., editors. Woodhead Publishing Series in Food Science, Technology and Nutrition. Woodhead Publishing, 2021, 265–279. https://doi.org/https://doi.org/10.1016/B978-0-12-820092-6.00011-2
14. Singh R, Mittal P, Dhiman R. Laboratory study on larvicidal properties of leaf extract of *Calotropis procera* (Family-Asclepiadaceae) against mosquito larvae. The Journal of Communicable Diseases,2005:37:109–113.
15. US EPA. Biopesticides, 2022. https://www.epa.gov/ingredients-used-pesticide-products/what-are-biopesticides#:~:text=Biopesticides often are effective in,problems caused by conventional pesticides.
16. Venkatesan R, Karuppiah PS, Arumugam G, Balamuthu K. β-Asarone Exhibits Antifungal Activity by Inhibiting Ergosterol Biosynthesis in *Aspergillus niger* ATCC 16888. Proceedings of the National Academy of Sciences India Section B - Biological Sciences,2019:89(1):173–184. https://doi.org/10.1007/s40011-017-0930-4
17. Yannick Stéphane FF, Jean Jules BK, Bruno LN, El-Saber Batiha G, Ali I. Extraction of Bioactive Compounds from Medicinal Plants and Herbs. In: El-Shemy H, editor. Natural Medicinal Plants. IntechOpen, 2021. https://doi.org/10.5772/intechopen.98602