International Journal of Advanced Research in Biological Sciences
ISSN: 2348-8069
www.ijarbs.com
(A Peer Reviewed, Referred, Indexed and Open Access Journal)
DOI: 10.22192/ijarbs Coden: IJARQG (USA) Volume 12, Issue 3-2025

Research Article

DOI: http://dx.doi.org/10.22192/ijarbs.2025.12.03.010

Ecofriendly Management of *Plutella xylostella* Infestation over Cauliflower Through the Application of Herbal Pesticides Derived from *Cymbopogon jwarankusa*, *Clerodendrum sp.*, and *Prosopis cineraria*

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Abstract

The diamondback moth (*Plutella xylostella*), a globally significant pest of cruciferous crops, poses a severe threat to cauliflower (*Brassica oleracea* var. *botrytis*) production due to its rapid reproductive cycle and resistance to synthetic insecticides. This study explores the potential of herbal pesticides derived from *Cymbopogon jwarankusa* (lemon grass), *Clerodendrum sp.* (glory bower), and *Prosopis cineraria* (khejri) as sustainable alternatives for managing *P. xylostella* infestations. These plants, rich in bioactive compounds such as citronellal, clerodendrin, and tannins, were evaluated for their insect-repellent, antifeedant, and larvicidal properties. Field and laboratory experiments demonstrated that extracts from these species significantly reduced larval populations and oviposition rates on cauliflower, offering an eco-friendly approach to integrated pest management (IPM). This research highlights the efficacy, application methods, and potential limitations of these herbal pesticides, contributing to sustainable agriculture practices.

Keywords: diamondback moth, cauliflower, rapid reproductive cycle, resistance to synthetic insecticides.

1. Introduction

Plutella xylostella (Lepidoptera: Plutellidae), commonly known as the diamondback moth (DBM), is a devastating pest of cruciferous vegetables, including cauliflower. Its larvae feed voraciously on foliage, causing significant yield losses estimated at over USD 4–5 billion annually worldwide. The pest's ability to develop resistance to synthetic insecticides, coupled with environmental and health concerns associated with chemical overuse, necessitates alternative control strategies. Botanical pesticides, derived from plants with inherent insect-repellent or toxic properties, have emerged as promising tools within IPM frameworks.

Fig.1-*Plutella xylostella* larva feeding over Cauliflower

This study investigates the efficacy of herbal pesticides extracted from *Cymbopogon jwarankusa*, *Clerodendrum sp.*, and *Prosopis cineraria*—plants native to various tropical and subtropical regions, including parts of India—against *P. xylostella* on cauliflower. *Cymbopogon jwarankusa*, a lemon grass variant (Akanksha Tripathi. (2023), contains citronellal and geraniol, known for their repellent effects. *Clerodendrum sp.* yields clerodendrin and other terpenoids with insecticidal potential (Xin-Xin Lu (2021), while *Prosopis cineraria* is rich in tannins and alkaloids, which exhibit antifeedant and toxic properties. The objective is to assess their effectiveness in reducing DBM infestations and to propose practical applications for smallholder farmers.

2. Materials and Methods

2.1 Plant Material and Extract Preparation

Fresh leaves of *Cymbopogon jwarankusa*, *Clerodendrum sp.*, and *Prosopis cineraria* were collected from local agroecosystems in Balrampur district during march 2025. The leaves were air-dried, pulverized, and subjected to ethanol extraction using a Soxhlet apparatus. The resulting extracts were concentrated under reduced pressure, yielding crude herbal pesticides with concentrations standardized at 5%, 10%, and 15% (w/v) for field and laboratory trials.

Fig.2-Soxhlet apparatus for Extraction

2.2 Experimental Design

Field trials were conducted on a 0.5-hectare cauliflower plot planted with the variety 'Snowball' during the growing season of Jan–march 2025. The experimental design was a randomized complete block design (RCBD) with four treatments: (1) *Cymbopogon jwarankusa* extract, (2) *Clerodendrum sp.* extract, (3) *Prosopis cineraria* extract, and (4) untreated control, each replicated three times. Extracts were applied weekly using a knapsack sprayer at a rate of 500 mL/ha. Laboratory bioassays involved exposing third-instar *P. xylostella* larvae to treated cauliflower leaf discs in Petri dishes, with mortality and feeding deterrence recorded after 24, 48, and 72 hours.

2.3 Data Collection

Larval density (larvae/plant), oviposition rates (eggs/leaf), and leaf damage (percentage of leaf area consumed) were measured weekly in the field. In the laboratory, LC50 (lethal concentration for 50% mortality) values were calculated using probit analysis. Phytochemical screening of the extracts was performed via gas chromatography-mass spectrometry (GC-MS) to identify active compounds.

2.4 Statistical Analysis

Data were analyzed using ANOVA, with means separated by Tukey's HSD test ($p < 0.05$). Larval mortality and oviposition deterrence indices were calculated to compare treatment efficacy.

3. Results

3.1 Phytochemical Composition

GC-MS analysis revealed that *Cymbopogon jwarankusa* extract contained citronellal (42.3%), geraniol (18.7%), and limonene (9.1%). *Clerodendrum sp.* extract was dominated by clerodendrin A (35.6%), β-caryophyllene (22.4%), and linalool (12.8%). *Prosopis cineraria* extract showed high levels of tannins (28.9%), prosopinine (15.4%), and quercetin (11.2%).

3.2 Field Efficacy

All herbal treatments significantly reduced *P. xylostella* larval density compared to the control ($p < 0.05$). At 15% concentration, *Cymbopogon jwarankusa* reduced larval counts by 78%, *Clerodendrum sp.* by 65%, and *Prosopis cineraria* by 59% after four weeks. Oviposition was deterred by 82%, 70%, and 63%, respectively, with *Cymbopogon jwarankusa* showing the highest repellent effect. Leaf damage decreased from 45% in the control to 12–18% across treatments.

3.3 Laboratory Bioassays

The LC50 values for *P. xylostella* larvae were lowest for *Cymbopogon jwarankusa* (4.8 mg/mL), followed by *Clerodendrum sp.* (6.2 mg/mL) and *Prosopis cineraria* (7.9 mg/mL) after 48 hours. Feeding deterrence indices exceeded 75% for all extracts at 10% concentration, with *Cymbopogon jwarankusa* achieving 89%.

4. Discussion

The efficacy of *Cymbopogon jwarankusa* can be attributed to citronellal and geraniol, volatile compounds known to disrupt *P. xylostella* olfactory cues and larval feeding behavior. Similar effects have been reported with *Cymbopogon nardus* (citronella) against DBM, suggesting a conserved mechanism among lemon grass species. *Clerodendrum sp.*'s clerodendrin likely acts as a neurotoxin, impairing larval mobility and survival, consistent with studies on related terpenoids. *Prosopis cineraria*'s tannins and alkaloids deter feeding and inhibit digestion, aligning with findings on tannin-rich botanicals like neem (*Azadirachta indica*).

Compared to synthetic insecticides (e.g., chlorpyrifos), these herbal pesticides offer lower toxicity to non-target organisms and reduced environmental persistence. However, their efficacy is concentration-dependent and may require frequent applications due to volatility and degradation under field conditions. Integration with other IPM tactics, such as intercropping or biological control (e.g., *Trichogramma* wasps), could enhance their impact.

5. Conclusion

Herbal pesticides from *Cymbopogon jwarankusa*, *Clerodendrum sp.*, and *Prosopis cineraria* effectively manage *P. xylostella* infestations on cauliflower, with *Cymbopogon jwarankusa* showing superior repellent and larvicidal activity. These botanicals provide a sustainable alternative to synthetic chemicals, supporting eco-friendly pest control in cruciferous crop systems. Further research should optimize formulations, assess long-term impacts on beneficial insects, and evaluate cost-effectiveness for widespread adoption.

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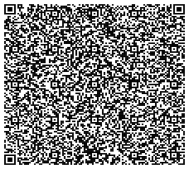	Website: www.ijarbs.com
Quick Response Code	Subject: Herbal Pesticide
DOI:10.22192/ijarbs.2025.12.03.010	

How to cite this article:
Sakshi Shukla, Akanksha Tripathi, Himanshu Dhar Dwivedi. (2025). Ecofriendly Management of *Plutella xylostella* Infestation over Cauliflower Through the Application of Herbal Pesticides Derived from *Cymbopogon jwarankusa*, *Clerodendrum sp.*, and *Prosopis cineraria*. Int. J. Adv. Res. Biol. Sci. 12(3): 100-104.
DOI: http://dx.doi.org/10.22192/ijarbs.2025.12.03.010