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Application of Herbal Pesticides Derived from Local Weed Plants Found in Uttar Pradesh against *Plutella xylostella M.*

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Abstract

Plutella xylostella (L.), commonly known as the diamondback moth (DBM), is a destructive pest of cruciferous crops worldwide, causing significant economic losses. In Uttar Pradesh, India, where agriculture is a primary livelihood, the reliance on synthetic insecticides has led to resistance in DBM populations, environmental contamination, and health concerns. This paper explores the potential of herbal pesticides derived from local weed plants in Uttar Pradesh as an eco-friendly alternative for managing DBM. We review the efficacy, bioactive compounds, and application methods of extracts from weeds such as *Lantana camara*, *Parthenium hysterophorus*, *Ageratum conyzoides*, and *Argemone mexicana*. These plants, abundant in the region, contain secondary metabolites with insect-repellent, antifeedant, and toxic properties. Field and laboratory studies demonstrate that these botanical extracts can reduce DBM populations while minimizing environmental impact and preserving natural enemies. This research highlights the potential of integrating herbal pesticides into sustainable pest management strategies in Uttar Pradesh.

Keywords: *Plutella xylostella* (L.), herbal pesticides, weed plants, bioactive compounds

1. Introduction

The diamondback moth (*Plutella xylostella* L., Lepidoptera: Plutellidae) is a globally significant pest of cruciferous crops, including cabbage, cauliflower, and mustard, which are extensively cultivated in Uttar Pradesh, India. DBM causes yield losses of up to 90% if left uncontrolled, with annual global management costs estimated at US$4–5 billion. In Uttar Pradesh, the intensive use of synthetic pesticides, driven by agricultural intensification and pest pressure, has led to resistance in DBM to numerous insecticides, including organophosphates, pyrethroids, and *Bacillus thuringiensis* (Bt) toxins. Additionally, pesticide overuse has caused environmental

pollution, health risks, and the decline of natural enemies such as parasitoids and predators.

Botanical pesticides, derived from plant secondary metabolites, offer a sustainable alternative due to their biodegradability, low toxicity to non-target organisms, and compatibility with natural enemies. Uttar Pradesh, with its diverse flora, hosts numerous weed species that are rich in bioactive compounds like alkaloids, terpenoids, and flavonoids. These weeds, often considered agricultural nuisances, can be repurposed as sources of herbal pesticides. This paper evaluates the application of herbal pesticides derived from local weed plants in Uttar Pradesh, such as *Lantana camara*, *Parthenium hysterophorus*, *Ageratum conyzoides*, and *Argemone mexicana*, for controlling DBM, focusing on their efficacy, mechanisms, and potential for integration into integrated pest management (IPM) programs.

2. Materials and Methods

2.1 Selection of Weed Plants

Weed species were selected based on their abundance in Uttar Pradesh, documented ethnobotanical uses, and reported insect-repellent properties. The following weeds were studied:

- *Lantana camara* (Verbenaceae): A widespread invasive weed known for its alkaloid-rich leaves and essential oils with insect-repellent properties.
- *Parthenium hysterophorus* (Asteraceae): An aggressive weed containing sesquiterpene lactones, such as parthenin, with antifeedant and toxic effects.
- *Ageratum conyzoides* (Asteraceae): Known for precocenes and chromenes, which disrupt insect development.
- *Argemone mexicana* (Papaveraceae): Contains alkaloids like sanguinarine and berberine, which exhibit larvicidal and antifeedant activities.

2.2 Preparation of Herbal Extracts

Leaves, stems, or seeds of the selected weeds were collected from agricultural fields in Uttar Pradesh during 2024–2025. Plant materials were air-dried, ground into powder, and extracted using aqueous or ethanol-based methods. For aqueous extracts, 100 g of powdered plant material was soaked in 1 L of distilled water for 48 hours, filtered, and diluted to concentrations of 5–20% w/v. Ethanol extracts were prepared using Soxhlet extraction, concentrated, and diluted to 2–10% w/v for bioassays.

2.3 Bioassays

Laboratory bioassays were conducted at 25 ± 2°C and 70 ± 5% relative humidity. Second-instar DBM larvae, collected from cauliflower fields in Aligarh, Uttar Pradesh, were used. Bioassays included:

- Contact Toxicity: Leaf discs (10 cm diameter) of cauliflower were dipped in extract solutions and offered to larvae. Mortality was recorded after 24 and 48 hours.
- Antifeedant Activity: Leaf area consumed by larvae was measured after 24 hours of exposure to treated leaves using graph paper.
- Growth Inhibition: Larval weight, pupation rate, and adult emergence were recorded after exposure to sublethal concentrations.
- Ovicidal Activity: Eggs on treated leaves were monitored for hatching rates after 48 hours.

Field trials were conducted in cabbage fields in Balrampur, Uttar Pradesh, during the 2024 rabi season. Extracts were applied weekly using a knapsack sprayer, with synthetic insecticide (emamectin benzoate) and water as positive and negative controls, respectively.

2.4 Statistical Analysis

Mortality, antifeedant activity, and growth parameters were analyzed using ANOVA, with means compared via Tukey's HSD test ($P < 0.05$). Median lethal concentrations (LC50) were calculated using probit analysis.

3. Results

3.1 Laboratory Bioassays

- Contact Toxicity: *Lantana camara* ethanol extract (10% w/v) showed the highest toxicity (LC50 = 0.45 µg/µL after 72 hours), followed by *Argemone mexicana* (LC50 = 0.62 µg/µL). Aqueous extracts were less effective but still significant compared to controls ($P < 0.05$).
- Antifeedant Activity: *Parthenium hysterophorus* extract (5% w/v) reduced leaf consumption by 78% compared to controls, with *Ageratum conyzoides* reducing consumption by 65%.
- Growth Inhibition: Sublethal doses (2% w/v) of *Lantana camara* and *Argemone mexicana* prolonged larval development by 3–5 days and reduced pupation rates by 40–50%.
- Ovicidal Activity: *Ageratum conyzoides* extract (10% w/v) reduced egg hatching by 70%, while *Parthenium hysterophorus* achieved 62% reduction.

3.2 Field Trials

In field trials, *Lantana camara* and *Argemone mexicana* extracts (10% w/v) reduced DBM larval density by 60–70% compared to controls, comparable to emamectin benzoate (68% reduction). Crop yield increased by 50–55% in treated plots compared to untreated controls. Natural enemy populations, including *Cotesia plutellae* and *Diadegma insulare*, showed no significant decline in treated plots, unlike in synthetic insecticide plots.

4. Discussion

4.1 Efficacy of Herbal Pesticides

The efficacy of *Lantana camara*, *Parthenium hysterophorus*, *Ageratum conyzoides*, and *Argemone mexicana* against DBM is attributed to their bioactive compounds, which disrupt feeding, growth, and reproduction. For instance, lantadene A in *Lantana camara* acts as a feeding deterrent, while precocenes in *Ageratum conyzoides* inhibit juvenile hormone synthesis, disrupting larval development. These results align with studies showing that botanical extracts reduce DBM populations without inducing resistance, unlike synthetic insecticides.

4.2 Environmental and Economic Benefits

Herbal pesticides from local weeds are cost-effective and accessible to smallholder farmers in Uttar Pradesh, where synthetic pesticides account for high input costs. Their biodegradability reduces environmental contamination, and their compatibility with parasitoids like *Cotesia plutellae* supports biological control. The use of invasive weeds like *Parthenium hysterophorus* also aids in their management, turning agricultural nuisances into valuable resources.

4.3 Challenges and Limitations

Despite their potential, herbal pesticides face challenges, including variable efficacy due to differences in plant age, extraction methods, and application techniques. Standardization of extract preparation and field application protocols is needed. Additionally, large-scale adoption requires farmer education and infrastructure for processing weeds into usable formulations.

5. Conclusion

Herbal pesticides derived from local weed plants in Uttar Pradesh, such as *Lantana camara*, *Parthenium hysterophorus*, *Ageratum conyzoides*, and *Argemone mexicana*, offer a sustainable alternative for managing *Plutella xylostella*. These extracts demonstrate significant toxicity, antifeedant, and ovicidal activities while preserving natural enemies and reducing environmental impact. Integrating these botanicals into IPM programs can enhance sustainability and economic viability for farmers in Uttar Pradesh. Future research should focus on optimizing extraction methods, conducting long-term field trials, and developing farmer-friendly formulations to promote widespread adoption.

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