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# POTENTIAL OF METHANOLIC BOTANICAL EXTRACTS IN THE CONTROL OF DIAMONDBACK MOTH, *PLUTELLA XYLOSTELLA* L.

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**ABSTRACT**

The bio efficacy of methanolic plant extracts and latexes against *Plutella xylostella* L. was assessed under laboratory conditions. Mortality was low after 24 hours, with no significant variation among leaf extracts, while latexes showed minimal effects. *Azadirachta indica* latex performed better than other latexes but remained less effective overall. After 48 hours, extracts of *Sesbania grandiflora* (46.67%), *Swietenia macrophylla* (43.33%), *Nerium oleander* (43.33%), *Tagetes erecta* (36.67%), and *Plumeria rubra* (36.67%) showed mortality comparable to the treated check (43.33%). At 72 hours, *S. grandiflora* recorded the highest mortality (76.67%), followed by *S. macrophylla* (66.67%), *T. erecta* (63.33%) and *N. oleander* (56.67%). Antifeedant assays indicated maximum deterrence in *S. grandiflora* (83.99% at 24 h; 67.27% at 48 h; 61.36% at 72 h), with *S. macrophylla* and *A. indica* also effective. Latex extracts exhibited the lowest antifeedant activity (<36.63%). Overall, *S. grandiflora* and *S. macrophylla* demonstrated superior insecticidal and antifeedant properties, highlighting their potential as eco-friendly alternatives for diamondback moth management.

***Key words*:** Botanicals, Methanol, Toxicity, Antifeedant, *Plutella xylostella*

## Introduction

The diamondback moth, *Plutella xylostella* L. (Lepidoptera: Plutellidae), is one of the most destructive pests of cruciferous crops worldwide. First recorded in India by Fletcher (1914), the species is believed to have originated in Europe, South Africa, and the Mediterranean region, but has now spread globally (Wei *et al*., (2013)). It is an oligophagous pest feeding exclusively on Brassicaceae crops such as cabbage, cauliflower, broccoli, mustard, radish, and kale (Talekar and Shelton, (1993)). These vegetables are vital dietary sources of vitamins (A, B1, and C) and minerals, in addition to containing bioactive compounds like glucosinolates, which serve as natural defence chemicals against herbivores and pathogens while providing health benefits in humans (Cavaiuolo and Ferrante, (2014)).

A major challenge in managing *P. xylostella* is its extraordinary ability to develop resistance to insecticides. The indiscriminate use of chemical pesticides has led to increased fecundity, rapid generational turnover, and genetic plasticity in field populations (Negahban *et al*., (2006)). In India, resistance was first reported against DDT and parathion in Punjab (Verma and Sandhu, (1968)), followed by resistance to fenitrothion, quinalphos, and malathion (Chawla and Joia, (1992)). To date, *P. xylostella* has developed resistance to nearly 95 conventional insecticides, including newer chemistries such as cyantraniliprole in Australia, Brazil, China, and Japan (Evans (2008); Ribeiro *et al*., (2017); Qin *et al*., (2018); Jouraku *et al*., (2020)). This increasing resistance

emphasizes the urgent need for alternative, eco-friendly management strategies, including botanicals, biopesticides, and integrated pest management approaches.

## Materials and Methods

### Collection of plants for screening study

Ten plant species were selected for screening bioactive compounds against *Plutella xylostella*. Different plant parts were used, including leaves of Malabar nut (*Adhatoda vasica* (L.) Nees., Acanthaceae), wild jasmine (*Clerodendrum inerme* (L.) Gaertn., Lamiaceae), physic nut (*Jatropha curcas* L., Euphorbiaceae), oleander (*Nerium oleander* L., Apocynaceae), frangipani (*Plumeria rubra* L., Apocynaceae), humming bird tree (*Sesbania grandiflora* (L.) Poiret., Fabaceae), Honduran mahogany (*Swietenia macrophylla* King, Meliaceae), and marigold (*Tagetes erecta* L., Asteraceae). In addition, unripe fruits with latex of neem (*Azadirachta indica* A. Juss., Meliaceae) and bitter cucumber (*Citrullus colocynthis* (L.) Schrad., Cucurbitaceae) were included. For latex collection, four plant species—*A. indica*, *J. curcas*, *N. oleander*, and *P. rubra*—were selected**.** Crude latex was obtained by cutting the green stems and leaves of selected plants with sterile razor, the oozing milky white latex was collected in the screw cap vials. Freshly collected latex was employed for maceration extraction.

The plant parts were collected from the campus of Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai (Narasingam, Tamil Nadu – Lat N 9° 58' 33.4668", Long E 78° 12' 20.1132").

### Cold maceration extraction

Fresh plant sample (20 g) was collected, ground using mortar and pestle to obtain fine paste and macerated with 100 ml of 99.8 per cent methanol in conical flask covered with aluminium foil for seven days at room temperature. In case of plant latex, the 4 ml of collected latex was soaked in 20 ml of methanol for seven days at room temperature. After a week, the samples were filtered through Whatman No. 40 filter paper and the solvents were removed completely under water bath @ 45°C. The weight of residue was recorded.

### Bio-efficacy Studies of Botanical Extracts on *P. Xylostella*

#### Leaf dip bioassay

The toxicity and antifeedant bioassay of cold macerated botanical extracts were carried out using leaf dip method under no choice condition (Ingle *et al.*, (2017)). The untreated fresh cabbage leaves were washed with distilled water followed by air drying for 30 min. Leaf discs were cut (5 cm dia) and then dipped in 5 per cent test solution (0.1% Triton × 100 used as surfactant) for about 30 sec. to facilitate uniform treatment of active ingredient. The leaf discs were placed in slant position for about two minutes in a tray to drain excess solution and then allowed for drying 30 min. at room temperature.

Second instar larvae (10 nos. pre-starved for 2 h) were released on each treated disc in a plastic container lined with moist filter paper. There were 16 treatments *viz.*, 10 plant extracts, four latex extracts, treated check (Azadirachtin 1% @ 2ml/l) and untreated check, the experiment was replicated three times.

Observations were made on larval mortality, where the number of dead larvae was recorded up to 72 h of treatment @ 24 h interval and calculated percentage mortality using the formula. Leaf area fed by the larvae was recorded at 24 h interval for 72 h and antifeedant index was estimated using the formula (Sadek (2003)).

$$\text{Mortality (\%)} = \frac{\text{Number of dead insects}}{\text{Total number of insects released}} \times 100$$

#### Antifeedant Index (%)

$$\text{AI} = \frac{\text{(Leaf area consumed in untreated - Leaf area consumed in treated)}}{\text{(Leaf area consumed in untreated + Leaf area consumed in treated)}} \times 100$$

### Statistical analysis

All of the bioassay trials in the laboratory were done in a Completely Randomized Design (CRD). Before analysing, the data collected from the *in vivo* investigation, the per centage values were arc sine transformed, and the numbers were converted to square root values. For all the experiments, three replications were maintained. Data were analysed using SPSS 22 version {Corp, 2013 #262} software to perform ANOVA and grouping using Duncan's Multiple Range Test (DMRT) for the remaining studies (Gomez and Gomez (1984)).

## Results and Discussion

Methanolic leaf and latex extracts varied in their bio efficacy. After 24 hours, larval mortality was low, with

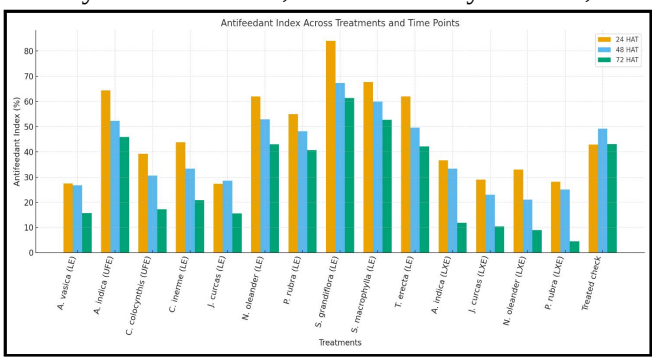


**Fig. 1:** Efficacy of methanolic macerated plant extracts on antifeedant index of *P. xylostella.*

**Table 1:** Efficacy of methanolic macerated plant extracts on mortality of *P. xylostella*.

| Treatments | Dose (%) | Cumulative Mortality* (%) | | |
|---|---|---|---|---|
| | | 24 HAT | 48 HAT | 72 HAT |
| $T_1$- *A. vasica* (LE) | 5 | 13.33±0.08(21.42)$^{ab}$ | 23.33±0.08(28.88)$^{cd}$ | 26.67±0.08(31.09)$^{fg}$ |
| $T_2$- *A. indica* (UFE) | 5 | 16.67±0.08(24.09)$^{ab}$ | 26.67±0.08(31.09)$^{bc}$ | 53.33±0.08(46.91)$^{cd}$ |
| $T_3$- *C. colocynthis* (UFE) | 5 | 13.33±0.08(21.42)$^{ab}$ | 23.33±0.08(28.88)$^{cd}$ | 33.33±0.08(35.26)$^{ef}$ |
| $T_4$- *C. inerme* (LE) | 5 | 16.67±0.08(24.09)$^{ab}$ | 23.33±0.08(28.88)$^{cd}$ | 36.67±0.08(37.27)$^{e}$ |
| $T_5$- *J. curcas* (LE) | 5 | 13.33±0.08(21.42)$^{ab}$ | 26.67±0.08(31.09)$^{bc}$ | 36.67±0.08(37.27)$^{e}$ |
| $T_6$- *N. oleander* (LE) | 5 | 23.33±0.08(28.88)$^{a}$ | 43.33±0.08(41.17)$^{a}$ | 56.67±0.08(48.83)$^{bc}$ |
| $T_7$- *P. rubra* (LE) | 5 | 23.33±0.08(28.88)$^{a}$ | 36.67±0.08(37.27)$^{ab}$ | 53.33±0.08(46.91)$^{cd}$ |
| $T_8$- *S. grandiflora* (LE) | 5 | 26.67±0.08(31.09)$^{a}$ | 46.67±0.08(43.09)$^{a}$ | 76.67±0.08(61.12)$^{a}$ |
| $T_9$- *S. macrophylla* (LE) | 5 | 23.33±0.08(28.88)$^{a}$ | 43.33±0.08(41.17)$^{a}$ | 66.67±0.08(54.74)$^{b}$ |
| $T_{10}$- *T. erecta* (LE) | 5 | 16.67±0.08(24.09)$^{ab}$ | 36.67±0.08(37.27)$^{ab}$ | 63.33±0.08(52.73)$^{bc}$ |
| $T_{11}$- *A. indica* (LXE) | 5 | 13.33±0.08(21.42)$^{ab}$ | 23.33±0.08(28.88)$^{cd}$ | 43.33±0.08(41.17)$^{de}$ |
| $T_{12}$- *J. curcas* (LXE) | 5 | 10.00±0.14(18.43)$^{b}$ | 23.33±0.08(28.88)$^{cd}$ | 33.33±0.08(35.26)$^{ef}$ |
| $T_{13}$- *N. oleander* (LXE) | 5 | 6.67±0.08(14.96)$^{b}$ | 16.67±0.08(24.09)$^{de}$ | 26.67±0.08(31.09)$^{fg}$ |
| $T_{14}$- *P. rubra* (LXE) | 5 | 6.67±0.08(14.96)$^{b}$ | 13.33±0.08(21.42)$^{e}$ | 23.33±0.08(28.88)$^{g}$ |
| $T_{15}$- Treated check (Azadirachtin 1%) | 2ml/l | 23.33±0.08(28.88)$^{a}$ | 43.33±0.08(41.17)$^{a}$ | 63.33±0.08(52.73)$^{bc}$ |
| $T_{16}$- Untreated check | - | 0.00±0.00(0.91)$^{c}$ | 0.00±0.00(0.91)$^{f}$ | 0.00±0.08(0.91)$^{h}$ |
| SEd | - | 5.004 | 2.908 | 2.714 |
| F-value | - | 7.089 | 37.721 | 78.516 |
| p(significance) | - | 0.00 | 0.00 | 0.00 |

**UFE**-Unripen Fruit Extract, **LE**-Leaf Extract, **LXE**-Latex Extract, **HAT** – Hours after treatment

*Mean values of three replications are represented as mean ± standard deviation; Figures in parentheses arc sine transformed values; In a column, mean followed by same letter not significantly different from each other, DMRT (F-test; $p \leq 0.05$; n=10); SEd: Standard error of the difference.

no significant differences among leaf extracts, while latexes showed minimum effect, though *A. indica* latex performed better than others. At 48 hours, mortality increased, with *S. grandiflora* (46.67%), *S. macrophylla* (43.33%), *N. oleander* (43.33%), *T. erecta* (36.67%), and *P. rubra* (36.67%) comparable to the treated check. By 72 hours, *S. grandiflora* recorded the highest mortality (76.67%), followed by *S. macrophylla* (66.67%), *T. erecta* (63.33%), and *N. oleander* (56.67%). Latex treatments remained weak, not exceeding 43.33%. Mortality increased with exposure time, consistent with earlier reports on sustained botanical toxicity (Mohammed *et al*., (2015)) Table 1.

Antifeedant assays also highlighted *S. grandiflora* as most effective (83.99% at 24 h), followed by *S. macrophylla*, *A. indica*, *T. erecta*, *N. oleander*, and *P. rubra*, all superior to the treated check. Although activity declined with time, *S. grandiflora* and *S. macrophylla* consistently showed strong deterrence across exposure periods. Latex extracts exhibited poor feeding deterrence (<36.63%). The superior performance of *S. grandiflora*, *S. macrophylla*, *T. erecta*, and *N. oleander* is attributable to their diverse phytochemicals, including flavonoids, glycosides, saponins, alkaloids, triterpenes, fatty acids, and cardenolides (Mohammed *et al*., (2015); Tiwari & Singh (2004); Salinas-Sánchez *et al*., (2012); Semiz (2017); Moustafa *et al*., (2018)). Interestingly, this is the first report of insecticidal and antifeedant effects of unripe *A. indica* fruit latex, suggesting an additional source of neem-derived bioactivity (Fig. 1).

Overall, *S. grandiflora*, *S. macrophylla*, *T. erecta*, and *N. oleander* demonstrated consistent mortality and antifeedant effects, highlighting their potential for botanical pest management.

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