



Bio-efficacy of Selected Plant Extracts Against Fruit-Piercing Moths (*Eudocima* spp.)

Kukkadgaonkar A. P.¹, Lakhe A. D.¹ & Ghalte D. U.²

Department of Zoology, Rajmata Jijau Mahavidyalaya, Kille Dharur, Dist- Beed (M.S)

Corresponding Author - Kukkadgaonkar A. P.

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Abstract:

Fruit-piercing moths (*Eudocima* spp.) cause serious damage to fruit crops by piercing the fruit surface and feeding on juice, leading to yield loss. Due to limitations of chemical control, this study evaluated the bio-efficacy of selected plant extracts against *Eudocima* spp. Extracts of *Azadirachta indica*, *Ocimum sanctum*, *Vitex negundo*, and *Withania somnifera* were tested under field conditions. All treatments reduced moth incidence and fruit damage compared to the control. *Azadirachta indica* was the most effective, followed by *Ocimum sanctum* and *Vitex negundo*, while *Withania somnifera* showed moderate efficacy. These results suggest that plant extracts offer an eco-friendly and sustainable approach for managing fruit-piercing moths.

Keywords: Fruit-piercing moth, *Eudocima* spp., Plant Extracts, Bio-Efficacy, Eco-Friendly Pest Management

Introduction:

The order Lepidoptera, which includes moths and butterflies, is one of the most diverse insect groups, comprising nearly 10% of all described living organisms, with about 180,000 known species worldwide (Pinzari *et al.*, 2018; Corley *et al.*, 2020). Moths represent the major portion of this diversity and are grouped into more than 30 superfamilies, showing wide variation in form and ecological adaptation (New, 2004). Among these, the family Noctuidae, commonly known as owlet moths, is the largest, with approximately 35,000 described species.

Fruit-piercing moths are recognized as serious pests of fruit crops in tropical and subtropical regions extending from Africa through Southeast Asia and Australia to the Pacific Islands (Leong and Kueh, 2011). In India, important fruit-piercing species include *Othreis* (*Eudocima*) *materna*, *Eudocima* *fullonia*, *Eudocima* *homaena*, and *Eudocima* *cajeta*, which are widely distributed across the country

(Susainathan, 1924; Ayyar, 1944). These large noctuid moths belonging to the genus *Eudocima* are major adult pests that attack ripening and mature fruits by piercing the fruit rind and feeding on juice, leading to fruit drop and reduced market value (Banziger, 1982). Several species such as *Eudocima* *materna*, *Eudocima* *fullonia*, *Eudocima* *homaena*, and *Acanthodelta* *janata* are particularly important pests of citrus crops in India and can cause medium to high levels of infestation (Singh *et al.*, 2020). In most lepidopteran pest species, economic damage is caused mainly by the larval stage, as caterpillars feed directly on plant tissues (Kitching, 1984).

However, fruit-piercing moths are unique because the adult stage itself causes significant economic loss by damaging mature fruits. Management of these pests has largely depended on chemical insecticides, but excessive and indiscriminate use of chemicals has resulted in problems such as pesticide resistance, residue accumulation on fruits, destruction of beneficial

insects and pollinators, and adverse effects on the environment and human health. Due to these concerns, there is increasing emphasis on eco-friendly and sustainable pest management approaches. The use of plant-based extracts and locally available botanicals offers a safer and more sustainable alternative to synthetic insecticides, with minimal harmful effects on non-target organisms and the environment. Therefore, the present study was undertaken to evaluate the efficacy of selected plant extracts against fruit-piercing moths of the genus *Eudocima*, namely *Eudocima phalonia*, *Eudocima materna*, and *Eudocima homaena*.

Materials and Methods:

The present study was conducted in Aurangabad district, located in the Marathwada region of Maharashtra State, India. Aurangabad district, the administrative centre of Marathwada, lies at 19° 54' 3.7944" N and 75° 21' 8.9208" E. The study was carried out from June 2023 to May 2024, with the aim of investigating the efficacy of several plant extracts against fruit piercing moths

(Genus *Eudocima*). Several plant extracts such as neem (*Azadirachta indica*), tulsi (*Ocimum sanctum*), nirgundi (*Vitex negundo*) and ashwagandha (*Withania somnifera*) were prepared and applied on fruit crops to reduce the attack of fruit piercing moths. These extracts were prepared by referring the standard methodologies (Brar, 2024; Abubakar and Haque, 2020).

Fresh leaves, stems and roots of the selected plants were collected from pesticide-free areas, washed thoroughly, and shade-dried at room temperature ($28 \pm 2^\circ\text{C}$) for 7–10 days. The dried leaves were ground into fine powder and stored in airtight containers. For extract preparation, 100 g of leaf powder was boiled in 1 L distilled water for 30 minutes and filtered through muslin cloth and Whatman No. 1 paper to obtain a 10% (w/v) stock solution. For field use, the extract was diluted to 2% with water and supplemented with 0.1% liquid soap as a surfactant. The extract was applied as a foliar spray on sweet lime, guava, banana, and pomegranate during evening hours, with weekly repetitions.



Result and Discussion:

The present investigation evaluated the efficacy of eco-friendly plant extracts as a sustainable alternative for managing fruit-piercing moth populations. The over-reliance on synthetic insecticides has raised concerns regarding environmental contamination, non-target effects, and development of insecticide resistance. Therefore, exploring botanicals provides a safer, biodegradable, and environmentally compatible pest management strategy. Four plant species (*Azadirachta indica*, *Ocimum sanctum*, *Vitex negundo*, and *Withania somnifera*) were selected based on their reported bioactive properties against insect pests:

The plant extracts employed act through multiple mechanisms:

Repellency: The volatile compounds in the extracts reduce the moths' attraction to fruit

surfaces, thereby lowering the rate of fruit-piercing.

Antifeedant Effect: Bioactive constituents discourage feeding and can result in incomplete or damaged feeding behaviour.

Growth and Reproductive Interference: Certain secondary metabolites interfere with the moths' life cycle by reducing egg laying, larval development, or pupation success.

The present study indicated that the tested eco-friendly plant extracts significantly reduced fruit-piercing activity by *Eudocima* moths, demonstrating their potential as viable components of a sustainable pest management program. Among the extracts, *A. indica* and *O. sanctum* showed the highest repellency and antifeedant effects, suggesting their priority in practical applications for fruit protection.

Table 1: Efficacy of several plant extracts against fruit piercing moths (genus *Eudocima*).

Fruit Crop	Damage in Control (%)	Damage in T1 (<i>A. indica</i>)	Damage in T2 (<i>O. sanctum</i>)	Damage in T3 (<i>V. negundo</i>)	Damage in T4 (<i>W. somnifera</i>)
Sweet lime	14 %	10%	10%	11%	12%
Guava	16 %	11%	13%	14%	15%
Pomegranate	19%	13%	15%	17%	16%
Banana	13 %	09%	11%	12%	12%

According to table 11, percent fruit damage observed in control plots and in four treatments (T1 - T4) where different plant extracts were applied.

Treatments:

T1 - *Azadirachta indica* (neem)

T2 - *Ocimum sanctum* (holy basil / tulsi) T3 - *Vitex negundo*

T4 - *Withania somnifera*

(Fruit crops listed: Orange, Sweet lime, Guava, Banana).

Control damage and treatment damage (%) are shown. From those values, calculated

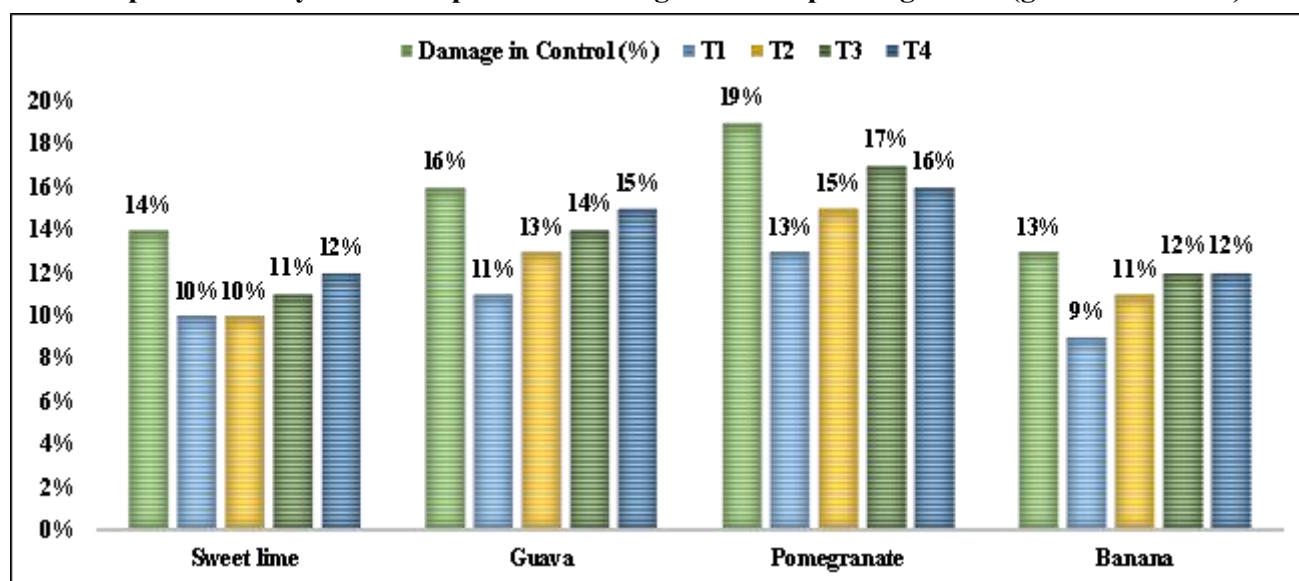
percent reduction in damage for each treatment relative to the control (reduction = (Control – Treatment) / Control × 100).

Calculated percent reduction (treatment vs control):

T1 (*A. indica*): Sweet lime - 28.57%, Guava - 31.25%, Pomegranate – 31.57%, Banana - 30.77%. **T2 (*O. sanctum*):** Sweet lime - 28.57%, Guava - 18.75%, Pomegranate - 21.05%, Banana - 15.38%. **T3 (*V. negundo*):** Sweet lime - 21.43%, Guava - 12.50%, Pomegranate – 10.05, Banana - 7.69%.

T4 (*W. somnifera*): Sweet lime - 14.29%, Guava - 6.25%, Pomegranate – 15.78%, Banana - 7.69%.

Graph 1: Efficacy of several plant extracts against fruit piercing moths (genus *Eudocima*).



During the present investigation, it was observed that all plant-extract treatments reduced fruit damage compared to the untreated control in sweet lime, guava, and banana. Neem extract (*Azadirachta indica*, T1) was the most effective, reducing fruit damage by about 28–31% across all crops. *Ocimum sanctum* (T2) showed moderate efficacy, with damage reduction ranging from 15–29%, while *Vitex negundo* (T3) and *Withania somnifera* (T4) were less effective, showing reductions of 7–16% and 6–14%, respectively. Overall efficacy followed the order: *A. indica* > *O. sanctum* > *V. negundo* > *W. somnifera*.

Neem extract showed the strongest control effect, particularly in citrus and guava, likely due to its well-known antifeedant and toxic compounds such as azadirachtin. *Ocimum sanctum* also provided useful protection, probably through its repellent essential oils, while *V. negundo* and *W. somnifera* exhibited comparatively weaker effects. These observations suggest that neem extract, in particular, has strong potential as an eco-friendly component of integrated pest management (IPM) programs for fruit-piercing

moths, with scope for further field validation and optimization.

Numerous researchers have conducted studies on the efficacy of botanicals and bio-based agents against fruit-piercing moths, and their findings strongly support the present observations. Bosch (1971) demonstrated that the application of botanical oils was effective in reducing the damaging activity of *Eudocima materna*, *E. fullonia*, and *Othreis emarginata* in apple orchards. Jayanthi *et al.*, (2010) concluded that plant oils viz., jatropa, citronella, poppy, thevetia, neem and pongamia along with neem seed kernel extract were effective in preventing *O. materna* from feeding on the treated guava and pomegranate fruits. Kulkarni *et al.*, (2017) reported that biopesticides such as *Bacillus thuringiensis*, *Photorhabdus luminescens*, and *Beauveria bassiana* can be effectively used as promising bioagents for the management of fruit-sucking moth larvae.

Similarly, Singh *et al.*, (2023) investigated bio-intensive integrated management strategies for fruit-piercing moths in citrus orchards and observed that treatments with PAU

Homemade Neem Extract (*Azadirachta indica*) and PAU Homemade Dharek Extract (*Melia azedarach*) significantly reduced moth infestation. More recently, George *et al.*, (2024) concluded that foliar applications of petroleum spray oil (2%) and neem oil (1%) effectively reduced fruit damage by deterring moth feeding and oviposition. Collectively, these studies highlight the effectiveness of botanical and eco-friendly approaches as sustainable alternatives to conventional chemical control in the management of fruit-piercing moths.

Conclusion:

Among the tested plant extracts, neem extract (*Azadirachta indica*) was the most effective in reducing fruit damage, showing its strong potential for use in eco-friendly and sustainable control of fruit-piercing moths. These results indicate that botanical pesticides can be a good alternative to chemical pesticides. Future studies should focus on improving botanical formulations, evaluating their long-term effectiveness under field conditions, and combining them with biological control methods. In addition, creating awareness among farmers and encouraging the use of eco-friendly pest management practices are important for achieving safe, sustainable, and environmentally friendly fruit production in the region.

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