
Effect of Leaf Age on the Insecticidal Activity of Mahogany (*Swietenia mahagoni* Jacq.) Leaf Extract Against *Setora nitens* Walker

Idum Satia Santi¹, Emmy Hamidah², Agus Manto³, Indra Kurniawan³, Theofilus Tejo Murti³

¹ Departement of Agrotechnology, Faculty of Agriculture, Institut Pertanian Stiper Yogyakarta

² Agrotechnology Study Program, Faculty of Agriculture, Darul Ulum Islamic University Lamongan, Lamongan

³. Akademi Komunitas Perkebunan Yogyakarta, Yogyakarta

*Corresponding author: idum@instiperjogja.ac.id

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ABSTRACT

Setora nitens Walker is an important defoliating pest in oil palm plantations. Botanical insecticides offer an environmentally friendly alternative to synthetic pesticides for pest management. This study evaluated the influence of leaf age and concentration of mahogany (*Swietenia mahagoni* Jacq.) leaf extract on the mortality of *S. nitens* larvae. Young and mature mahogany leaves were extracted using water and applied to oil palm leaflets through a spraying method. Four extract concentrations (30%, 40%, 50%, and 60%) and an untreated control were tested. Larval mortality was observed for seven days after treatment. All extract treatments increased larval mortality compared with the control. The highest average mortality (83.8%) was recorded in the 50% concentration of young leaf extract, while the lowest mortality (69.5%) occurred in the 30% concentration of young leaves and the 40% concentration of mature leaves. All extract treatments resulted in 100% cumulative mortality by the end of the observation period, whereas no mortality was observed in the control. Young leaf extracts generally produced higher mortality than mature leaf extracts. These findings indicate that mahogany leaf extract has potential as a botanical insecticide against *S. nitens*. The higher effectiveness of young leaf extracts suggests that leaf age influences the insecticidal activity of mahogany leaves.

Keywords: botanical insecticide, leaf age, mahogany, oil palm, *Setora nitens*.

INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq.) is one of the most important plantation commodities in Indonesia. However, its productivity is often constrained by insect pests, particularly defoliating caterpillars. One of the major defoliators in oil palm plantations is *Setora nitens* Walker (Lepidoptera: Limacodidae), whose larvae feed on leaf tissues and can substantially reduce the photosynthetic area of the canopy (Anggraini et al., 2025). Severe infestations may decrease plant growth and fresh fruit bunch production due to the loss of functional leaf area

Management of *S. nitens* in commercial plantations largely relies on synthetic insecticides. Although effective, intensive insecticide use may lead to environmental contamination, pest resistance, resurgence, and adverse effects on natural enemies (Sánchez-Bayo, 2021). Therefore, environmentally friendly alternatives are needed to support sustainable pest management and integrated pest management (IPM) programs (Isman, 2020)

Botanical insecticides have gained considerable attention because they contain bioactive secondary metabolites capable of disrupting insect feeding, growth, development, and survival. Several plants can be used as botanical insecticides to control *S. nitens* (Simanjuntak et al., 2020). Among potential

botanical sources, mahogany (*Swietenia mahagoni* Jacq.) is known to contain limonoids, flavonoids, alkaloids, saponins, and tannins with insecticidal properties (Syame et al., 2022). Limonoids, in particular, have been reported to act as antifeedants, growth regulators, and toxic compounds against various insect pests (Koul, 2008; Schmutterer, 1990). Mahogany leaves are a rich source of secondary metabolites and have the potential to be used as bioactive materials (Candra et al., 2024)

Previous studies have demonstrated the insecticidal activity of mahogany extracts against several insect species; however, information regarding their effectiveness against *S. nitens* remains limited. In addition, leaf age may influence the concentration and availability of secondary metabolites, resulting in different levels of insecticidal activity between young and mature leaves (Wiggins et al., 2016). Therefore, this study aimed to evaluate the effect of leaf age and extract concentration on the mortality and survival of *S. nitens* larvae. The findings are expected to provide preliminary information on the potential use of mahogany leaf extract as an environmentally friendly botanical insecticide for oil palm pest management.

MATERIALS AND METHODS

The study was conducted under laboratory conditions in Bantul, Yogyakarta, Indonesia. Fresh young and mature leaves of mahogany (*Swietenia mahagoni* Jacq.) were collected and washed with tap water. The leaves were blended with water and filtered through a fine cloth to obtain crude extracts. The extracts were subsequently diluted with water to concentrations of 30%, 40%, 50%, and 60%.

The experiment consisted of eight extract treatments representing two leaf ages (young and mature leaves) and four concentrations (30%, 40%, 50%, and 60%), together with an untreated control. Each treatment was replicated three times, with 10

larvae of *Setora nitens* per replicate, resulting in a total of 270 larvae.

Extracts were applied to oil palm leaflets using a hand sprayer until the leaf surface was evenly covered. After air-drying, the treated leaflets were provided as food to the larvae. Control larvae were fed untreated leaflets. Larval mortality was recorded daily for seven days after treatment. Larvae were considered dead when they failed to respond to gentle mechanical stimulation. Mortality was calculated as the percentage of dead larvae relative to the total number of larvae observed.

Mortality and larval death rate data were analyzed using analysis of variance (ANOVA). Significant treatment effects were further separated using

Duncan’s Multiple Range Test (DMRT) at a significance level of 5%.

DISCUSSION

The present study demonstrated that mahogany (*Swietenia mahagoni*) leaf extract possesses considerable insecticidal activity against *Setora nitens* larvae. All extract treatments resulted in

substantially higher mortality than the untreated control, indicating that mahogany leaves contain bioactive compounds capable of adversely affecting larval survival (Table 1).

Table 1. Daily mortality (%) of *Setora nitens* larvae following treatment with mahogany leaf extracts.

Mahogany extract		Mortality (%)							average
		1	2	3	4	5	6	7	
young	30%	0,0 a	40 b	67 b	80 b	100 b	100 b	100 b	70 b
	40%	13 a	60 bc	73 b	93 bc	100 b	100 b	100 b	77 b
	50%	0,0 a	87 c	100 c	100 c	100 b	100 b	100 b	84 b
	60%	0,0 a	67 bc	80 bc	100 c	100 b	100 b	100 b	78 b
mature	30%	0,0 a	60 bc	80 bc	93 bc	100 b	100 b	100 b	76 b
	40%	0,0 a	40 b	60 b	87 bc	100 b	100 b	100 b	70 b
	50%	0,0 a	53 b	73 b	100 c	100 b	100 b	100 b	75 b
	60%	0,0 a	53 b	73 b	100 c	100 b	100 b	100 b	75 b
Kontrol		0,0 a	0,0 a	0,0 a	0,0 a	0,0 a	0,0 a	0,0 a	0,0 a

Note : Means followed by the same letter within a column are not significantly different according to Duncan's Multiple Range Test (DMRT) at the 5% significance level.

Mortality increased progressively throughout the observation period in all extract treatments. Complete mortality was generally achieved between the fourth and fifth days after treatment, whereas no mortality was observed in the control.

The observed insecticidal activity is likely associated with the presence of secondary metabolites commonly found in members of the Meliaceae, including limonoids, flavonoids, alkaloids, saponins, and tannins (Schmutterer, 1990). These compounds are known to function as antifeedants, insect growth regulators, and digestive inhibitors that interfere with insect development and survival (Koul et al., 2008). Mahogany leaf extract contains various secondary metabolites and has insecticidal activity against insect pests (Khamis et al., 2023). Mahogany leaf

extract can interfere with the feeding activity and development of larvae through its secondary metabolite content (Siregar et al., 2024).

Because the extracts were applied to the larval food source, exposure occurred primarily through ingestion. Consequently, mortality did not occur immediately after treatment but increased progressively throughout the observation period. This pattern suggests that the extract acts mainly as a stomach poison and feeding deterrent rather than as a fast-acting neurotoxic compound. Similar responses have been reported for other botanical insecticides derived from Meliaceae species, which generally disrupt feeding behavior, nutrient utilization, and physiological processes before causing mortality (Isman, 2006)

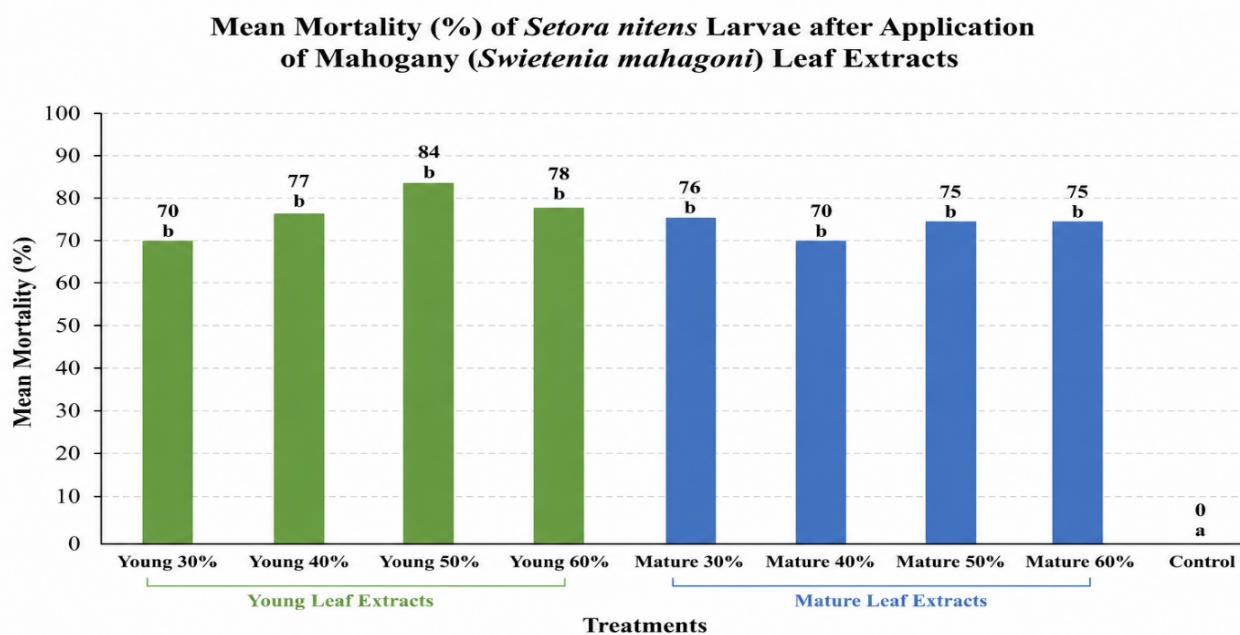


Figure 1. Mean mortality (%) of *Setora nitens* larvae following treatment with mahogany leaf extracts.

The highest mean mortality (83.8%) was recorded in larvae treated with the 50% concentration of young leaf extract, whereas the lowest mortality among treated groups was observed in the 30% young leaf and 40% mature leaf extracts (Figure 1).

Among the treatments evaluated, the 50% concentration of young leaf extract produced the highest mortality and the most rapid decline in larval survival. This finding indicates that leaf age may influence the insecticidal effectiveness of mahogany extracts. Young leaves represent actively growing tissues that contribute substantially to plant fitness and are often more vulnerable to herbivore attack. According to the Optimal Defense Theory, plants tend to allocate greater concentrations of defensive compounds to tissues with higher ecological and physiological value (Coley et al., 1985).

The higher efficacy of young mahogany leaf extracts observed in this study may be explained by the optimal defense theory, which predicts that plants allocate greater concentrations of defensive secondary metabolites to younger and more valuable tissues that are more vulnerable to herbivore attack. Previous studies have

demonstrated that young leaves generally contain higher concentrations of defensive compounds than older leaves (Barton et al., 2019). Several studies have shown that the composition and quantity of secondary metabolites change with increasing leaf age (McCall & Fordyce, 2010). However, this is not always the case for every species. Some species have higher metabolite levels in young leaves, while others peak in mature leaves (Wiggins et al., 2016). Leaf age affects phenolic and flavonoid content as in *Aquilaria beccariana* (Anwar et al., 2017). Consequently, young leaves may contain higher levels of defensive metabolites than mature leaves, resulting in greater insecticidal activity. The superior performance of young leaf extracts observed in the present study may be related to differences in the concentration or extractability of secondary metabolites between developmental stages of leaves. Previous studies have shown that *S. mahagoni* leaves contain diverse bioactive compounds, including phenolics, flavonoids, tannins, and limonoid-related compounds, while the concentration of these metabolites may vary according to plant age and tissue development

Differences in extract performance may also be influenced by the extraction process itself. Young leaf tissues are generally softer and less lignified than mature leaves, allowing bioactive compounds to be released more readily during mechanical extraction. Since water was used as the extraction solvent, differences in tissue structure may have affected the availability of active compounds in the resulting extracts. This may explain why extracts prepared from young leaves generally performed better than those derived from mature leaves.

Interestingly, increasing extract concentration did not consistently increase larval mortality. The 50% concentration of young leaf extract, for example, produced higher mortality than the 60% concentration. Such non-linear responses are not

uncommon in botanical insecticide studies because plant extracts contain complex mixtures of bioactive compounds that may interact synergistically, additively, or antagonistically at different concentrations. In addition, the use of water as an extraction solvent may limit the recovery of certain active compounds, meaning that increasing the amount of plant material does not necessarily increase the concentration of biologically available metabolites (Muhammed et al., 2022). Variations in feeding behavior, physiological condition, and detoxification capacity among larvae may further contribute to differences in susceptibility to plant-derived compounds (Sa'adah et al., 2024)

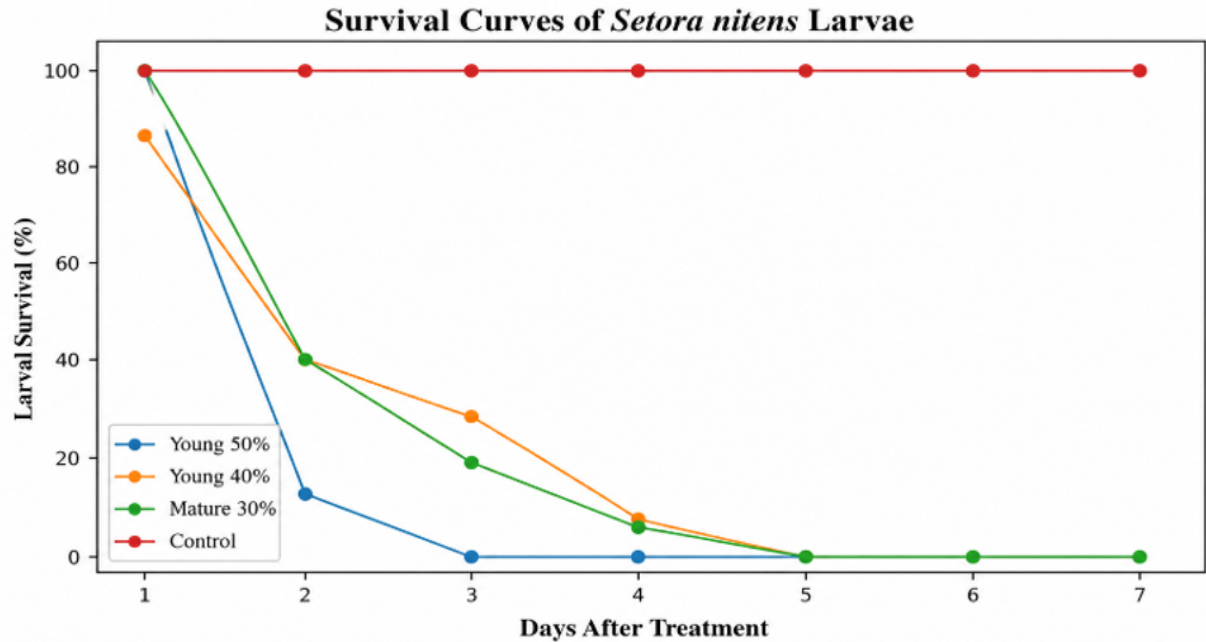


Figure 2. Survival curves of *Setora nitens* larvae treated with mahogany (*Swietenia mahagoni* Jacq.) leaf extracts during a seven-day observation period.

The survival curves further supported the mortality data by demonstrating a rapid decline in larval survival following exposure to mahogany extracts. Most mortality occurred between the second and fourth days after treatment, after which survival stabilized because few larvae remained alive. This delayed pattern of mortality is consistent with the proposed mode of action of botanical insecticides

that require ingestion before affecting physiological processes. Although no significant differences were detected in larval death rate among treatments, variations in leaf age influenced the overall effectiveness of the extracts, particularly with respect to cumulative mortality and survival reduction.

Overall, the results indicate that mahogany leaf extract has strong potential as a botanical insecticide for the management of *S. nitens*. The superior performance of young leaf extracts

highlights the importance of plant developmental stage in determining insecticidal activity and suggests that leaf age should be considered when developing mahogany-based botanical

insecticides for sustainable pest management in oil palm plantations.

CONCLUSION

Mahogany (*Swietenia mahagoni* Jacq.) leaf extract exhibited significant insecticidal activity against *Setora nitens* larvae, resulting in substantially higher mortality and reduced larval survival compared with the untreated control. The 50% concentration of young leaf extract showed the greatest effectiveness, suggesting that leaf age influences the insecticidal properties of mahogany leaf extracts. Although the response was not strictly

concentration-dependent, all extract treatments ultimately caused complete larval mortality during the observation period. These findings highlight the potential of young mahogany leaves as a promising source of botanical insecticides for the sustainable management of *S. nitens* in oil palm plantations. Further studies are needed to identify the active compounds involved and to validate the efficacy of the extract under field conditions.

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