Effectiveness Test of Natural Pesticide from Tobacco and Green Chitter Against Brown Planthopper (*Nilaparvata lugens* Stal.)

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Abstract

Overuse of synthetic insecticides in rice cultivation causes pest resistance and negative environmental impacts. An environmentally friendly alternative is plant-based insecticides derived from tobacco (Nicotiana tabacum L.), which contain nicotine, green chitter (Andrographis paniculata Burm. (Nees.), which contain andrographolide ($C_{20}H_{30}O_5$) and other secondary metabolites. This study aims to determine the effectiveness of Monster Max botanical pesticide at various concentrations on the mortality of brown planthoppers (Nilaparvata lugens). The experiment was conducted at the PT. Corteva Agriscience Laboratory in Karawang, using a completely randomized design with seven treatments consisting of six concentrations of Monster Max insecticide (20, 10, 5, 2.5, 1.5, 0.62 ml/L and control) with three replicates. The results showed that the insecticide was slow acting, with mortality starting to increase significantly after 96 hours and peaking at 168 hours. A concentration of 20 ml/L produced the highest mortality rate of 83.33%, followed by 10 ml/L (60%) and 5 ml/L (56.67%), while a concentration of 0.62 ml/L produced only 33%. The control showed no mortality. Tobacco and green chitter plant-based insecticides have the potential to be an effective and environmentally friendly alternative for pest control.

Keywords: *Botanical pesticides, CRD, integrated pest management, mortality.*

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the major food commodities that plays a vital role in supporting food security in Indonesia (Mardiantono, 2025). One of the main problems in rice cultivation is infestation by plant pests, which can hinder plant growth and reduce crop yield and quality (Muhdar et al., 2025). The main pests affecting rice include the brown planthopper (*Nilaparvata lugens*), the rice leafhopper (*Leptocorisa oratorius*), the yellow rice stem borer (*Scirpophaga incertulas*), and the rice field rat (*Rattus argentiventer*) (Hasjim et al., 2025).

Nilaparvata lugens Stal (Hemiptera: Delphacidae), commonly known as the brown planthopper, is one of the major pests of rice plants and is highly destructive due to its rapid reproductive rate, short life cycle, and tendency to migrate extensively in search of food and to reproduce(Madhuri et al., 2025). The brown planthopper is also a vector for the Rice Ragged Stunt Virus (RRSV) and the Rice Grassy Stunt Virus (RGSV), and is a pest that causes “Hopper Burn” (Kumar et al., 2022), whose attacks can lead to crop failure (Gede et al., 2024). *N. lugens* is a monophagous insect that exhibits plasticity—the ability to easily adapt to new environmental conditions (Lestari et al., 2023). This pest can complete 12 generations in a single year in tropical regions (Bragard et al., 2023). This is evidenced by the emergence of new biotypes or populations capable of overcoming the pest’s susceptibility to insecticides, which poses a challenge to control efforts (Rinaldi et al., 2022).

In recent years, pest management in rice cultivation has relied heavily on the intensive application of synthetic insecticides because of their rapid effectiveness, ease of use, and ability to minimize yield losses. However, the continuous and indiscriminate use of these insecticides has accelerated the

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development of resistance in pest populations, reducing their long-term effectiveness and increasing the risk of pest resurgence (Kumrungsee et al., 2025; Zhang et al., 2023). According to the principles of Integrated Pest Management (IPM), the use of chemical insecticides should be considered a last resort after other environmentally friendly control measures have been implemented (Government Regulation No. 6/1995). Therefore, the development and utilization of biopesticides have gained increasing attention as a sustainable alternative for rice pest management due to their lower environmental impact and reduced risk of resistance development (Harismah et al., 2022).

Biopesticides are pesticides made from natural ingredients that utilize secondary metabolite compounds. The advantages of biopesticides are that they have low toxicity, are easily degradable, and are fast-acting (Julianto et al., 2022). Biopesticides can be divided into two types: plant-based pesticides and biological pesticides (Shidiq et al., 2025). Plant-based pesticides are classified based on their source of extraction and the type of molecules/compounds used in their manufacture (Kumar et al., 2021b). Compared with synthetic pesticides, biopesticides offer several advantages, including low toxicity to humans and non-target organisms, rapid biodegradability that minimizes environmental residues, and relatively fast action in suppressing pest populations. One of the plants that can be used as a natural pesticide is tobacco (*Nicotiana tabacum L*.) (Kumar et al., 2022). Tobacco leaves contain 2-8% nicotine, which is effective in controlling plant pests (Harismah et al., 2022).

There are six types of botanical insecticides nicotinoids, rotenoids, pyrethroids, terpenoids, and other botanical insecticides (Putri et al., 2024). In besides nicotine, tobacco leaves also contain other active compounds such as alkaloids, saponins, flavonoids, and tannins, which contribute to biopesticide activity to control whiteflies (*Bemisia tabaci*). The mechanisms of action of this pesticide include repellent, antifeedant, disruption of the digestive process in insects, causing insect sterility, and inhibiting insect development (Afifah et al., 2015). The extraction was performed using the maceration method with water as the solvent, achieving a mortality rate of 85% for whiteflies at a certain concentration (Sarjan et al., 2020). Although tobacco extract has demonstrated insecticidal activity against several agricultural pests, information regarding its effectiveness against *Nilaparvata lugens*, particularly under different application doses, remains limited. Furthermore, the optimal dose capable of providing high mortality while minimizing environmental impact has not yet been clearly established.

The main active compound of *A. paniculata* is andrographolide, which is found in the whole plant, leaves, stem, and roots. Actually, this compound was first isolated by Boorsma, who named it *andrographide*. In 1911, Gorter elucidated the structure of the compound and named it andrographolide (Chakravarti. & Chakravarti., 1951; Chao & Lin, 2010; Intharuksa et al., 2022). Subsequent studies identified two major diterpenes, andrographolide and neo-andrographolide, as well as a flavone 2'-glucoside in *A. paniculata* and *A. alata,* It contains diterpenes, lactones, flavonoids, alkanes, ketones, and aldehydes distributed differently in all parts of the plant (Verma & Singh, 2024). Andrographolide is a bioactive compound with antifeedant properties that protect plants against insect feeding, larvae, and grazing organisms. Green chitter extract shows positive results against store grain pest and maintenance of seed vigor and viability in storage for economically important crops (Santra & Kundagrami, 2019).

Therefore, this study aimed to evaluate the effectiveness of different concentration of tobacco and green chitter leaf extracs against *Nilaparvata lugens* and to determine the optimum dose for environmentally friendly pest management in rice cultivation. However, its effectiveness can be influenced by environmental factors such as light intensity and humidity. The purpose of this study was to determine the effectiveness of various concentration of botanical pesticides on mortality *N. lugens*.

MATERIALS AND METHODS

Place and Time

The study on the mortality of *Nilaparvata lugens* exposed to tobacco and green chitter-based botanical insecticide was conducted at the PT. Corteva Agriscience Laboratory, Karawang Regency, West Java, Indonesia (Fig 1). The laboratory was selected because it provides controlled environmental conditions and adequate facilities for insect rearing, botanical insecticide preparation, and bioassay experiments. The research was carried out from May to August 2025, rearing and acclimatization of *N. lugens* nymphs, application of the botanical insecticide treatments at different concentrations, observation of insect mortality, and statistical analysis of the experimental data.

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Figure 1. Research Location PT. Corteva Agriscience Karawang Regency, West Java.

Materials and Tools

The brown planthopper (*Nilaparvata lugens*) population used in this study was a laboratory-maintained colony obtained from PT. Corteva Agriscience. The colony had been continuously reared under controlled laboratory conditions without exposure to synthetic insecticides and had reached the fifth laboratory generation (F5) at the time of the experiment. Maintaining the insects in an insecticide-free environment for several generations was intended to minimize prior insecticide selection pressure and ensure a relatively uniform and susceptible test population. Developmental stage were selected for the bioassay to reduce variability among treatments and improve the reliability of the experimental results.

The materials used in this study included Monster Max botanical pesticide (tobacco and green chitter), Pelita rice seeds, muddy soil, agar, and distilled water. The tools used were plastic buckets, trays, label paper, fiber, gauze, soft brushes, rubber bands, 450 ml plastic cups, tweezers, trap aspirators, 50 ml plastic bottles, 10 ml glass bottles, pipettes, plastic spoons, spatulas, shovels, digital scales, cutters, scissors, microscopes, microscope slides, cameras, a complete set of writing instruments, and thermohygrometers.

Research Method

Preparation of Test Insecticides and Rice Varieties

The botanical insecticide used in this study was Monster Max, a tobacco and green chitter-based formulation containing bioactive compounds derived from *Nicotiana tabacum* L., *Andrographis paniculate* (Burm. (Nees.) as a major compound and a minor compound of *Dioscorea hispida* Den., *Tinospora crispa* L., and *Nigella sativa* L. Prior to application, the insecticide was prepared by measuring the required volume of the formulation according to the predetermined treatment concentrations, consisting of 2×, 1×, ½×, ¼×, ⅛× the recommended concentration, and a control treatment containing only distilled water. Each treatment solution was diluted with water to obtain a final volume of 1,000 mL and mixed thoroughly to ensure a homogeneous suspension. The prepared solutions were then transferred into labeled containers indicating the treatment concentration and were used immediately during the application stage to maintain the stability and effectiveness of the active ingredients.

The rice plants used as host material were the Pelita variety, with seedlings aged 14–18 days after sowing (DAS). This growth stage was selected because young rice seedlings are preferred by *Nilaparvata lugens* for feeding and colonization, allowing uniform infestation and more reliable assessment of insecticide efficacy. The Pelita variety was chosen because it is highly susceptible to brown planthopper infestation, making it suitable for evaluating the insecticidal activity of tobacco-based botanical insecticides under controlled laboratory conditions.

Mortality Testing

The testing method used in this study followed the standards of the Insecticide Resistance Action Committee (IRAC). Mortality testing of Nilaparvata lugens was conducted according to IRAC Test Method No. 005 (IRAC, 2019), using six recommended insecticide concentrations estimated to produce mortality rates ranging between 0% and 100% in the tested insects. The experiment was arranged in a completely randomized design (CRD) consisting of seven treatments, each replicated three times.

The treatments involved the application of the botanical pesticide Monster Max at six concentration levels: T1 (20 mL L^{-1}), T2 (10 mL L^{-1}), T3 (5 mL L^{-1}), T4 (2.5 mL L^{-1}), T5 (1.25 mL L^{-1}), and T6 (0.62 mL L^{-1}), while T7 served as the control. The collected data were analyzed using analysis of variance (ANOVA) based on the F-test at the 5% significance level. When significant differences were detected, further analysis was performed using Duncan's Multiple Range Test (DMRT) at the 5% significance level with SPSS Statistics version 26.

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Fourteen-day-old rice seedlings were transplanted individually into plastic cups containing approximately 160 g of paddy soil. The seedlings were allowed to establish before the insecticide treatment was applied. Each seedling was immersed in the respective botanical insecticide solution for 10 seconds to ensure uniform coverage of the leaf surface. After dipping, the seedlings were air-dried for 10–15 minutes at room temperature to allow excess solution to drain and the insecticide residue to adhere to the plant surface. Each treated seedling was then enclosed with a transparent perforated plastic cup covered with fine gauze to provide adequate ventilation while preventing the escape or entry of insects. Subsequently, ten healthy second- to third-instar *Nilaparvata lugens* nymphs were carefully introduced. The insects were allowed to feed continuously on the treated seedlings throughout the observation period under controlled laboratory conditions. This procedure ensured that all nymphs were exposed to the botanical insecticide primarily through contact with and feeding on the treated rice plants, allowing a consistent evaluation of insecticidal efficacy across all treatments (Syahdia & Syahrawati, 2020).

Observation Variables

The first parameter observed was the mortality of *N. lugens* nymphs at 1, 3, 6, 24, 48, 96, and 168 hours after treatment application. Mortality observations were conducted at each predetermined time interval by counting the number of dead nymphs in each experimental unit. Using the following formula (Syahdia & Syahrawati, 2020):

$$M = \frac{m}{u}\ x\ 100\%$$

M = Mortality
m = Number of dead *N. lugens* nymphs
u = Number of *N. lugens* nymphs tested

RESULTS AND DISCUSSION

The primary parameter observed in this study was the mortality of *Nilaparvata lugens* nymphs following exposure to different concentrations of tobacco and green chitter-based botanical insecticide. The graph illustrating the mortality of *N. lugens* nymphs showed a gradual increase throughout the observation period, indicating that mortality was influenced by both insecticide concentration and exposure time. This pattern suggests that tobacco and green chitter-based botanical insecticides do not exhibit a rapid knockdown effect but instead act gradually. Unlike many synthetic insecticides, botanical insecticides contain natural bioactive compounds that require time to penetrate the insect cuticle, be absorbed into the insect body, and accumulate to toxic levels before causing mortality (Rismayani et al., 2023). Consequently, the toxic effects become more pronounced with prolonged exposure, resulting in a progressive increase in nymph mortality over time.

At 1–48 hours after application (HAA), the mortality rate was still very low in all treatments, indicating that tobacco and green chitter-based insecticides work slowly. An increase in mortality began to appear at 96 HAA, especially at high concentrations (T-1 and T-2), and reached its highest value at 168 HAA. Treatment T-1 showed the highest mortality (25 insects), followed by T-2 (18 insects), T-3 (16 insects), T-4 (15 insects), T-5 (11 insects), and T-6 (10 insects), while the control (T-7) showed no mortality at all. The absence of mortality in the control treatment confirms that the observed mortality was caused by the tobacco and green chitter extract rather than environmental conditions or handling during the experiment. The insecticidal activity of tobacco leaf extract is mainly attributed to nicotine, an alkaloid that acts as an agonist of nicotinic acetylcholine receptors (nAChRs) in the insect nervous system. Continuous stimulation of these receptors causes nerve overstimulation, followed by paralysis, cessation of feeding, and eventually death (Wang et al., 2016). The ethanolic crude extract of green chittr aerial parts combined with 1 g of diatomaceous earth was the most effective treatment, causing 49.70–90.15% mortality in adult rice weevils (*Sitophilus oryzae* L.) after three weeks (Sahoo et al., 2018).

The higher mortality at concentrations T-1 and T-2 indicates a dose-response relationship, where an increase in the concentration of the active ingredient increases the amount of toxic compounds entering the insect's body. This increases disruption to nerve impulse transmission, reduces feeding activity, causes gradual paralysis, and ultimately leads to death. Research on cricket mortality of 86% in cigarette butt waste sample extraction at 72 hours of observation with a solvent volume of 250 ml was 1.0014 g/ml (Erian et al., 2022). Tobacco leaf extract is also effective in killing fruit flies with a percentage

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of 41.67% when tobacco leaves are soaked for 144 hours (Setiawan et al., 2021). Conversely, low concentrations (T-5 and T-6) resulted in lower mortality because the amount of active compound absorbed was not sufficient to cause fatal physiological disturbances. The following graph shows the mortality development of *N. lugens* with observation intervals of 7 days. These findings indicate that increasing the concentration of tobacco extract enhances its insecticidal activity, although its mode of action remains relatively slow compared with synthetic insecticides. Therefore, tobacco-based botanical insecticides may be more suitable as part of an integrated pest management strategy than as a rapid knockdown treatment. The changes in *N. lugens* mortality over time are shown in Figure 2.

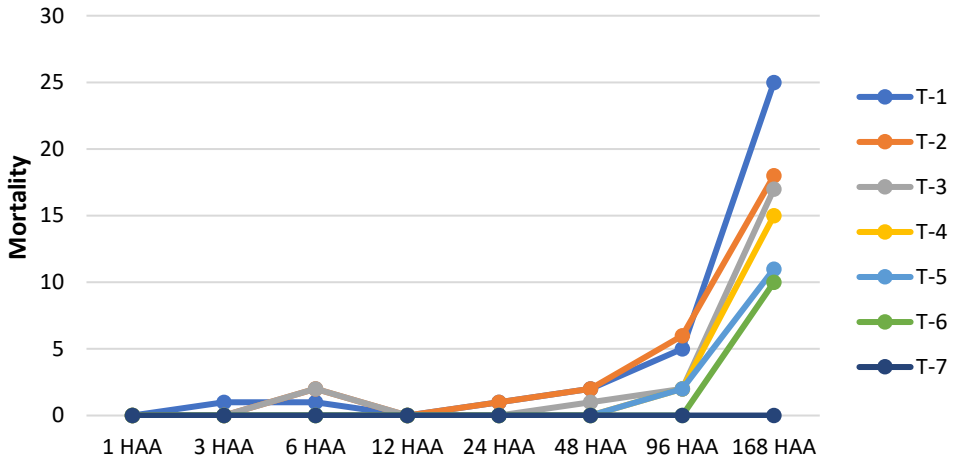


Figure 2. The Graph Shows the Mortality Development of *Nilavarvata lugens* with A 7-Day Observation Interval.

To support mortality observations, morphological documentation of brown planthoppers in the imago nymph stage was carried out. These morphological differences were used to confirm the stages of the test insects during the observation period. In the nymphal stage, *N. lugens* goes through five instars, each lasting 13–15 days. The changes in each instar are distinguished by differences in body and wing size. Adult insects have two wing forms, namely long-winged (macroptera) and short-winged (brachyptera). *N. lugens* imagoes are yellowish-brown to dark brown in color with a body length of approximately 2-4.4 mm and yellow wings. Generally, *N. lugens* brachyptera has a larger body, longer legs, and a longer ovipositor. The short-winged *N. lugens* is a sedentary, endemic population that typically reproduces and causes damage to rice plants (Fajrullah & Kristiana, 2023). *N. lugens* with long wings can fly long distances and indicate the presence of populations originating from outside the area. This occurs due to population density caused by the unavailability of food sources, usually on 40-day-old plants (Nurhidayat, 2019). The time required to complete the nymphal stage varies depending on the form of the adult that will emergent (Fig. 3) (Baehaki et al., 2016; Hidayah et al., 2024) and is also influenced by ambient temperature, ranging from 15 days at 30°C to 70 days at 10°C (Wilson & Claridge, 1991).

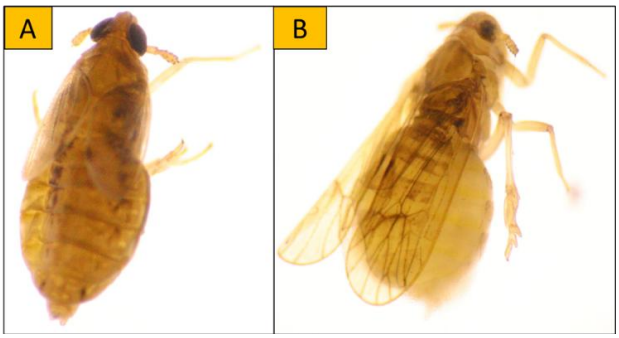


Figure 3. Morphology of *Nilaparvata lugens* in the Nymph (A) and Adult (B) Stages.

The results of Duncan's Multiple Range Test (DMRT) at the beginning of the observation (1–48 hours after application) showed that the mortality rate of *N. lugens* nymphs was still very low in the same

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letter group (a). This indicates that during this period there were no statistically significant differences between treatments, ranging from 0–6.67%. This shows that tobacco and green chitter-based botanical insecticides did not cause rapid mortality in the early phase of observation. Starting 96 hours after application, mortality began to increase at most concentrations, especially at high doses. The 10 ml/L treatment resulted in 20% mortality, while the 20 ml/L treatment reached 16.67%. This indicates a stronger initial response at high concentrations compared to low doses, although some were still in the same letter group (ab). This response indicates a transition phase, where the accumulation of active compounds began to have a physiological impact on *N. lugens* nymphs.

At 168 hours after application, there was a significant increase in mortality. The highest concentration (20 ml/L) was in a different group (a) and showed the highest mortality rate, which was 83.33%. The 10 ml/L (60%) and 5 ml/L (56%) concentration treatments were in the same group (ab), showing fairly high effectiveness, although lower than the 20 ml/L treatment. The medium concentration treatments, namely 2.5 ml/L and 1.5 ml/L, resulted in mortality rates of 50% and 36.66%, respectively. Meanwhile, the lowest concentration (0.62 ml/L) only resulted in a mortality rate of 33% in the letter group (b), which showed statistically lower effectiveness than the high concentration. The control treatment (water) did not cause any mortality, confirming that the mortality observed was solely due to the application of the botanical insecticide. In the study by Haryuni et al. (2023), on the fifth day of application, high concentrations of tobacco extract reduced the percentage and intensity of pest attacks on rice plants.

In general, these results indicate that the effectiveness of botanical insecticides from tobacco and green chitter extracts increases with increasing concentration and application time. Neonicotinoids, such as nicotine, bind to nicotinic acetylcholine receptors in cells and trigger a low to moderate response in those cells, causing nerve stimulation, while high levels cause excessive stimulation and block the receptors, causing paralysis and death (Rana et al., 2015). The crude extract and andrographolide inhibited feeding in adult females when incorporated into an artificial diet at concentrations as low as 1 ppm. The antifeedant effect of andrographolide was comparable to those of cartap and bensultap, but less pronounced than that of imidacloprid and nitenpyram(Verma & Singh, 2024; Widiarta et al., 1997). The mortality rate of *N. lugens* to botanical insecticides will vary in each region due to the long-term use of insecticides (Bhekti et al., 2025). In addition, the degradation of active ingredients by light and environmental temperature can also affect the speed and level of toxicity of botanical insecticides in the field. This pattern is in line with the report by Setiawan et al. (2021), which shows that the mortality rate of fruit flies due to tobacco bioinsecticide increases with the duration of exposure to 48% because the nicotine content works cumulatively. The toxic effect is more evident after seven days, so this insecticide can be categorized as a slow-acting active ingredient (slow acting). These results are consistent with the research by Listiyati et al., (2012) that tobacco and green chitter extract content shows bioactivity in *N. lugens*. Bioactivity functions as a repellent, antifeedant, insect growth regulator, and oviposition deterrent. This characteristic has the potential to reduce selection pressure on pest populations, thereby reducing the risk of resistance developing if applied continuously and in an integrated manner. This biopesticide has the potential to be used as an environmentally friendly alternative in the control of *N. lugens* (Siswoyo et al., 2018). The average mortality of *Nilaparvata lugens* following insecticide application, as determined by Duncan's Multiple Range Test (DMRT), is presented in Table 1.

Table 1. The Average Result of the DMRT Mortality Test for *Nilavarvata lugens*.

Concentration of Tobacco and Green Chitter Extracts (ml/L)	Hours After Application (h)							
	1	**3**	**6**	**12**	**24**	**48**	**96**	**168**
20	0^{a}	0^{a}	3.33^{a}	3.33^{a}	3.33^{a}	6.67^{a}	16.67^{ab}	83.33^{a}
10	0^{a}	0^{a}	0^{a}	6.67^{a}	3.33^{a}	6.67^{a}	20^{a}	60^{ab}
5	0^{a}	0^{a}	0^{a}	6.67^{a}	0^{a}	3.33^{a}	6.67^{ab}	56^{ab}
2.5	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	6.67^{ab}	50^{b}
1.5	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	6.67^{ab}	36.66^{b}
0.62	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{b}	33^{b}
Control	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{a}	0^{b}	0^{c}

Note: Values followed by the same letter within the same column are not significantly different according to Duncan's Multiple Range Test (DMRT) at the 5% significance level ($P < 0.05$).

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As shown in Table 1, mortality increased with increasing observation time for all treatments. Significant differences among treatments became more apparent at the later observation periods, particularly at 96 and 168 HAA, indicating differences in insecticide effectiveness against *N. lugens*. A boxplot illustrating the distribution of *N. lugens* mortality across treatments on day 7 is presented in Figure 4.

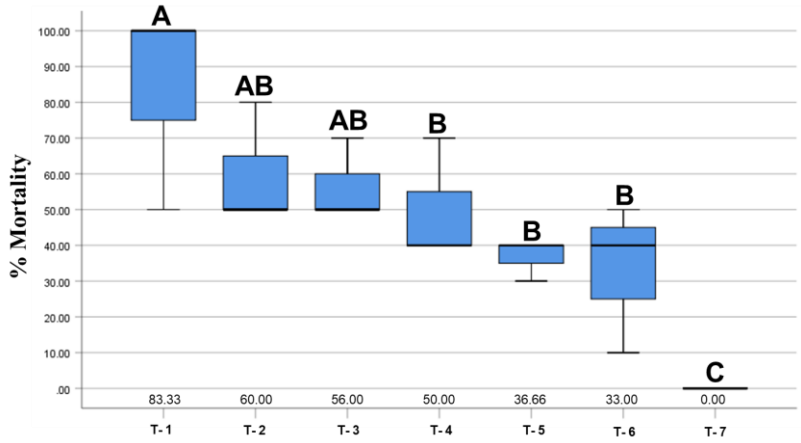


Figure 4. Boxplot of *Nilavarvata lugens* Mortality on Day 7 After Treatment with Tobacco and Green Chitter Extracts.

Figure 4, shows the percentage of insect mortality in various treatments (T-1 to T-6). Treatment T-1 produced the highest mortality rate of 83.33%, followed by T-2 (60%), T-3 (56.67%), and T-4 (50%). Meanwhile, T-5 and T-6 showed lower mortality rates of 36.67% and 33.33%, respectively. These results indicate that the effectiveness of the treatments varied, with T-1 being the most effective in increasing insect mortality compared to other treatments, in line with the study by Pradinata et al. (2024) that tobacco extract can kill 75% of *Spodoptera exigua* at 96 HAA. These results are in line with the report by Khairunnisa et al. (2019) , which shows that tobacco dust waste is effective in increasing the mortality of *Spodoptera litura* by up to 96.56% but with a relatively slow action speed compared to synthetic insecticides. This is because alkaloids, as secondary metabolites, can kill *N. lugens* at high concentrations (Nurhidayah et al., 2022).

Green chitter decoction of leaves was more effective against thrips (3.73–5.01 thrips/leaf) and efficacy was similar to 0.03% of dimethoate (Verma & Singh, 2024; Singh et al., 2010). According to Khairunnisa et al. (2019) reported physiological changes and decreased larval activity prior to death, such as slowed movement and molting failure. This mechanism is relevant to the character of the brown planthopper as a sucking insect, where disruption of the nervous system and gradual decrease in feeding activity can directly impact the survival of nymphs. The crude extract of *Andrographis paniculata* was assessed for spatial repellency, contact irritancy, and knockdown or toxic effects against five mosquito species at concentrations ranging from 0.5% to 5.0% (w/v). The extract showed strong spatial repellency against *Aedes albopictus* (96.7% escape) at 2.5% and *Aedes aegypti* (71.7% escape) at 0.5%. Moderate escape responses were observed in *Anopheles dirus* (48.2%) and *Culex quinquefasciatus* (59.7%), while *Anopheles epiroticus* showed a weak response (1.6–15.0%). No knockdown or mortality was recorded 24 hours after exposure in any of the trials (Sukkanon et al., 2020). Thus, although the target pests are different, the similarity in biological responses indicates that tobacco and green chitter plant-based insecticides have a fairly broad spectrum of activity against insect pests. Despite showing high effectiveness, this study has several limitations, including the lack of analysis of active compound residues in plants and the lack of assessment of the impact of plant-based insecticides on non-target organisms. In addition, the study was conducted under controlled conditions, so its effectiveness in the field still needs to be further tested. Further research is recommended to examine the combination of tobacco and green chitter extracts with other plant materials to increase efficacy and accelerate the time of action. In addition, studies on toxicity to natural enemies and analysis of application costs at the farmer level are also needed to support implementation in the field.

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CONCLUSION

An insecticide derived from tobacco and green chitter extract effectively suppresses the population of brown planthoppers, with mortality rates increasing in line with concentration and application time. A concentration of 20 ml/L yielded the best results, with a mortality rate of 83.33%, while the control group showed no mortality. This indicates that tobacco-based insecticides have the potential to become an environmentally friendly alternative for pest control.

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