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Research Article

ประสิทธิภาพของสารสกัดใบยาสูบและใบชาน้ำมันต่อการควบคุมเพลี้ยกระโดดสีน้ำตาล (*Nilaparvata lugens* (Stål, 1854)) และผลกระทบต่อมวนเขียวดูดไข่ (*Cyrtorhinus lividipennis* Reuter) ในนาข้าว

Efficacy of tobacco and tea leaf extracts for controling brown planthopper (*Nilaparvata lugens* (Stål, 1854)) and their impact on green mirids (*Cyrtorhinus lividipennis* Reuter) in rice paddy fields

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บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาประสิทธิภาพของสารสกัดจากใบยาสูบและใบชาน้ำมันในการควบคุมเพลี้ยกระโดดสีน้ำตาล (*Nilaparvata lugens* Stål, 1854) และผลกระทบต่อมวนเขียวดูดไข่ (*Cyrtorhinus lividipennis* Reuter) ในนาข้าวอำเภอองครักษ์ จังหวัดนครนายก โดยดำเนินการในช่วงเดือนมกราคม ถึง เมษายน พ.ศ. 2567 วางแผนการทดลองแบบสุ่มบล็อกสมบูรณ์ (RCBD) มี 3 ซ้ำ ชุดการทดลองประกอบด้วยสารสกัดยาสูบความเข้มข้น 5% และ 10% สารสกัดชาน้ำมันความเข้มข้น 5% และ 10% เปรียบเทียบกับสารควบคุม 3 ชนิด ได้แก่ ปิโตรเลียมออยล์ (SKN Spray 99) ความเข้มข้น 60 ซีซีต่อน้ำ 20 ลิตร ไซเปอร์เมทริน (Uptane 35) ความเข้มข้น 20 ซีซีต่อน้ำ 20 ลิตร และน้ำเปล่า ผลการศึกษาพบว่าอายุข้าว 75 วัน น้ำเปล่ามีเพลี้ยกระโดดสีน้ำตาลเฉลี่ย 11.15 ตัวต่อกอ และสารสกัดชาน้ำมัน 5% (9.73 ตัวต่อกอ) มีเพลี้ยกระโดดสีน้ำตาลหนาแน่นถึงระดับที่สร้างความเสียหายทางเศรษฐกิจ แต่หากพิจารณาการใช้สารสกัดจากพืชพบว่าสามารถควบคุมจำนวนเพลี้ยกระโดดสีน้ำตาลได้ในระดับที่ไม่สร้างความเสียหายทางเศรษฐกิจเช่นเดียวกับการใช้สารเคมี ได้แก่

สารสกัดยาสูบ 10% (3.37 ตัวต่อกอ) สารสกัดยาสูบ 5% (3.62 ตัวต่อกอ) สารสกัดชาน้ำมัน 10% (5.00 ตัวต่อกอ) ปิโตรเลียมออยล์ (60 ซีซีต่อน้ำ 20 ลิตร) (3.46 ตัวต่อกอ) และไซเปอร์เมทริน (20 ซีซีต่อน้ำ 20 ลิตร) (2.57 ตัวต่อกอ) ตามลำดับ ในขณะที่ประชากรมวนเขียวดูดไข่ (*Cyrtorhinus lividipennis* Reuter) การใช้สารสกัดจากพืชในความเข้มข้นที่แตกต่างกันมีความแตกต่างอย่างมีนัยสำคัญทางสถิติเมื่อข้าวอายุ 75 วัน น้ำเปล่ามีจำนวนมวนเขียวดูดไข่มากที่สุด (6.00 ตัวต่อกอ) รองลงมาคือสารสกัดยาสูบ 5% (4.50 ตัวต่อกอ) สารสกัดชาน้ำมัน 10% (4.25 ตัวต่อกอ) สารสกัดชาน้ำมัน 5% (4.00 ตัวต่อกอ) สารสกัดยาสูบ 10% (3.00 ตัวต่อกอ) ปิโตรเลียมออยล์ (60 ซีซีต่อน้ำ 20 ลิตร) (2.50 ตัวต่อกอ) และไซเปอร์เมทริน (20 ซีซีต่อน้ำ 20 ลิตร) (1.25 ตัวต่อกอ) ตามลำดับ อย่างไรก็ตามการใช้ไซเปอร์เมทริน (20 ซีซีต่อน้ำ 20 ลิตร) มีประสิทธิภาพในการลดจำนวนเพลี้ยกระโดดสีน้ำตาลมากกว่าสารสกัดจากพืชแต่ยังมีผลกระทบเชิงลบต่อจำนวนมวนเขียวดูดไข่ซึ่งมีบทบาทสำคัญในการควบคุมเพลี้ยกระโดดสีน้ำตาลในนาข้าว ซึ่งทุกกรรมวิธีมีความแตกต่างอย่างมีนัยสำคัญทางสถิติที่ระดับความเชื่อมั่น ($p < 0.05$)

คำสำคัญ: ยาสูบ; ชาน้ำมัน; เพลี้ยกระโดดสีน้ำตาล; มวนเขียวดูดไข่

Abstract

This study aimed to investigate the efficacy of tobacco leaf and tea leaf oil extracts in controlling brown planthoppers (*Nilaparvata lugens* Stål, 1854) and their impacts on green mirid (*Cyrtorhinus lividipennis* Reuter) in rice paddy fields in Ongkharak District, Nakhon Nayok Province, Thailand. Field experiments were conducted from January to April 2024 via a randomized complete block design (RCBD) with three replications. The treatments were composed of tobacco leaf extracts at 5% and 10% conc., tea leaf oil extracts at 5 and 10% conc., with three controls (a petroleum oil-based insecticide (SKN Spray 99) at 60 cc./20 lts of water, cypermethrin insecticide at 20 cc./20 lts of water and water). The results of the present study revealed that 75 days after transplanting (DAT), water with an average of 11.15 insects per hill and 5% tea leaf oil extract (9.73 insects per hill) resulted in a high brown planthopper density that caused economic damage. However, the use of plant extracts can control the brown planthopper population to a level that does not cause economic damage, as can the use of chemicals, namely, 10% tobacco extract (3.37 insects per hill), 5% tobacco extract (3.62 insects per hill), 10% tea leaf oil extract (5.00 insects per hill), petroleum oil (60 cc per 20 liters of water) (3.46 insects per hill), and cypermethrin (20 cc per 20 liters of water) (2.57 insects per hill). In terms of green mirid (*Cyrtorhinus lividipennis* Reuter) populations, the application of plant extracts at different concentrations resulted in statistically significant differences in their abundance. At 75 days after transplanting (DAT), the water had the greatest number of green mirids (6.00 insects per hill), followed by 5% tobacco extract (4.50 insects per hill), 10% tea leaf oil extract (4.25 insects per hill), 5% tea leaf oil extract (4.00 insects per hill), 10% tobacco extract (3.00 insects per hill), petroleum oil (60 cc per 20 liters of water) (2.50 insects per hill), and cypermethrin (20 cc per 20 liters of water) (1.25 insects per hill). However, the use of cypermethrin (20 cc per 20 liters of water) was more effective at reducing brown planthopper populations than plant extracts were, but it also had a detrimental effect on the green mirid population, which plays a crucial role in controlling brown

planthoppers. All the treatments exhibited statistically significant differences at a confidence level of $p < 0.05$

Keywords: Tobacco; Tea Leaf; Brown Planthopper; Green Mirids

Introduction

Thailand is an agricultural country that produces food with the aim of developing the country into the world's kitchen. The largest rice-growing areas in the central region are Pathum Thani, Suphan Buri, Nakhon Pathom, Sing Buri, Ang Thong, Ayutthaya, Chai Nat, and Nakhon Nayok. [1] Farmers have encountered severe pest problems during the dry season, namely, brown planthoppers in rice fields, which have a negative impact on rice yields. [2] As a result, farmers have used high levels of synthetic chemicals, which have also destroyed natural predators such as green mirids that suck the eggs of brown planthoppers, houseflies, dragonflies, and other ladybugs. [3] This has led to a decrease in insect diversity in the ecosystem and pesticide residues in the environment. On the other hand, plant extracts contain a combination of active ingredients and often have multiple modes of action, making it difficult for insects to develop resistance. [4] Related studies have focused on the efficacy of fine tobacco leaf scrap and stem for controlling some insect pests of vegetables. The application of 10% tobacco leaf extract caused 100% death of *Plutella xylostella* and *Lipaphis erysim* at 24 hours. [5] However, the use of plant extracts is another safe and environmentally friendly option that can be produced locally. Thailand, in particular, has a wide variety of plants with insecticidal properties, such as tobacco leaves, red spurge, and neem. [6] These plants contain important compounds such as nicotine in tobacco, which can control insect pest populations through a variety of mechanisms, including inhibiting larval growth and oviposition, interfering with feeding, and disrupting the nervous system, all of which have direct impacts on insect survival. [7] As a result, this study investigated the efficacy of plant extracts, tobacco leaf extracts and tea leaf oil extracts, compared with petroleum oil (SK N-Spray 99), cypermethrin, and water for controlling brown planthoppers (*Nilaparvata lugens* Stål, 1854) in rice paddy fields and their impact on natural predators, green mirids (*Cyrtorhinus lividipennis* Reuter), to develop appropriate application methods and doses that are consistent with rice production costs.

Objectives

To investigate the efficacy of plant extracts, tobacco leaf extracts, tea leaf oil extracts, compared to petroleum oil (SK N-Spray 99), cypermethrin, and water for controlling brown planthoppers (*Nilaparvata lugens* Stål, 1854) in rice paddy fields and their impact on natural predators, such as green mirids (*Cyrtorhinus lividipennis* Reuter).

Methods

Sample preparation of plant extracts

The samples for plant extract analysis included dried tobacco leaves and tea leaf oil collected from the study sites (the tea leaf oil was sourced from the plots of community farmers in the area of the Doi Tung Development Project, Ban Pang Mahan, Chiang Rai Province). [8] These samples were dried at room temperature until they reached <10% moisture content. Afterward, 95% methanol was used as a solvent in the extraction process, rotary evaporators and an IKA RV 10 D S99 vacuum pump (Germany) were used to obtain extractions from plants at 40 °C for 10 h. [9] After that, the obtained plant extracts were prepared into solutions of different concentrations, including 5% and 10% tobacco extracts and 5% and 10% tea leaf oil extracts. The crude extract used is presented in Figure 1. The research was conducted in the laboratory of the Faculty of Environmental Culture and Ecotourism.

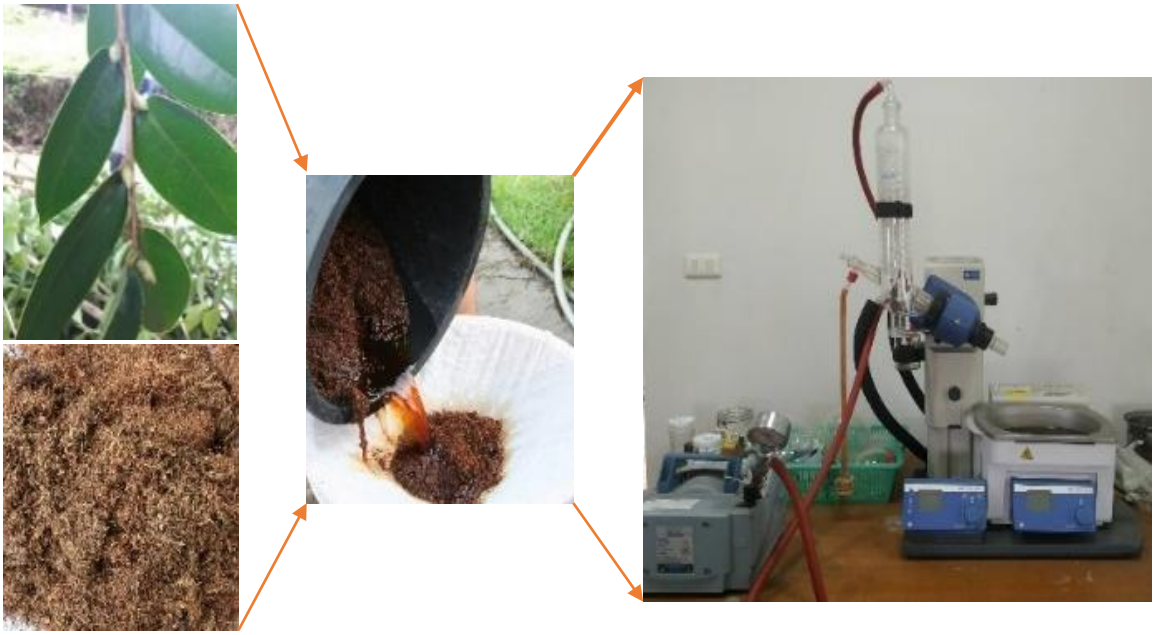

Figure 1 Crude extraction process.

Experimental design

The plant extracts were extracted with 95% methanol as the solvent with a rotary evaporator. The efficacy of the plant extracts in controlling brown planthoppers (*Nilaparvata lugens* Stål) in rice paddy fields was evaluated via a contact-killing spray method every 7 days. A number of brown planthoppers and green mirids (*Cyrtorhinus lividipennis* Reuter) were randomly sampled after spraying the plant extracts. Each type of solution was sprayed onto the rice plants in each subplot with 2 liters of solution per subplot. The equipment used was a low-pressure spray tank and a spot spray head to prevent the spread of the solution.

The treatments were composed of tobacco leaf extracts at 5% and 10% conc., tea leaf oil extracts at 5% and 10% conc., with three controls (a petroleum oil-based insecticide (SKN Spray 99) at 60 cc/20 lts.

of water, and a cypermethrin insecticide (Uptane 35) at 20 cc/20 lts. of water). In an experiment, their effectiveness in preventing and eliminating the brown planthopper was tested. [10] This trial was conducted in farm fields in Ongkharak District, Nakhon Nayok Province, from January–April 2024. The location of this study site is presented in Figure 2.

Figure 2 Study site and experimental plots in farm fields, Ongkharak District, Nakhon Nayok Province.

The experiment was planned via a randomized completely block design (RCBD) with 3 repetitions for each of the 7 methods and included 21 plots, a plot size of 3 × 5 m, and statistical data collected after receiving the material, which were divided into eight time periods: 15 days, 30 days, 45 days, 60 days, 75 days, 90 days, 105 days, and 120 days. [11]

After the solution was sprayed, a random count of brown planthoppers was carried out via a 1 square meter wooden frame placed over the rice plants in each treatment to randomly count the number of insects at the base of the rice stalks, and the statistical data were recorded. Meanwhile, the random inspection of natural enemies is the green mirid using a swooping swing that must walk in a diagonal line in the shape of an X in each subplot. The insects in the swings were then poured into a clear plastic bag lined with a hard plastic sheet to count the number of green mirrors, and the data were recorded for statistical analysis. [12]

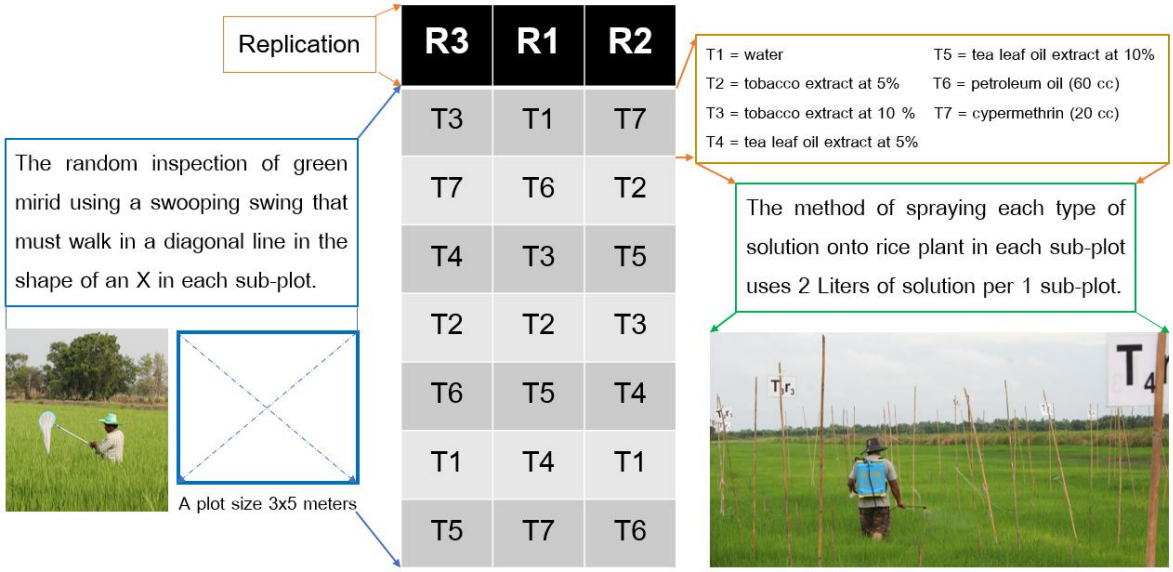

Figure 3 The experimental methods used in rice fields.

Data analysis

The collected data were analyzed via one-way analysis of variance (ANOVA), and differences were deemed significant at a confidence level of $p < 0.05$. All analyses were conducted via the Statistical Package for the Social Sciences (SPSS) v.22.

Results

The results of the study, which was conducted between January and April 2024, demonstrated that the application of plant extracts to control brown planthoppers (*Nilaparvata lugens* Stål, 1854) in rice fields resulted in statistically significant differences in brown planthopper populations at different concentrations. At 120 days after transplanting (DAT), cypermethrin (20 cc per 20 liters of water) was the most effective at reducing brown planthopper density, with an average of 3.33 insects per hill. This was followed by tobacco extract at 10% (3.75 insects per hill), petroleum oil (60 cc per 20 liters of water) (4.86 insects per hill), tobacco extract at 5% (5.15 insects per hill), tea leaf oil extract at 10% (6.60 insects per hill), tea leaf oil extract at 5% (11.86 insects per hill), and water (17.23 insects per hill). These results are summarized in Table 1.

Table 1 Average number of brown planthoppers (insects/hill) after the application of plant extracts every two weeks; the data were collected one day following the application from January–April 2024.

TREATMENTS	Average number of brown Planthoppers (insects/hill)							
	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT	120 DAT
Water	0.00	2.00	6.53 ^{d}	8.00 ^{d}	11.15 ^{e}	12.10 ^{e}	14.86 ^{e}	17.23 ^{e}
tobacco extract at 5%	0.10	1.33	2.26 ^{b}	3.55 ^{b}	3.62 ^{b}	4.53 ^{b}	4.86 ^{b}	5.15 ^{b}
tobacco extract at 10%	0.00	0.33	1.60 ^{ab}	2.57 ^{a}	3.37 ^{b}	3.00 ^{a}	3.59 ^{a}	3.75 ^{a}
tea leaf oil extract at 5%	0.33	2.13	6.25 ^{d}	7.62 ^{d}	9.73 ^{d}	9.35 ^{d}	10.15 ^{d}	11.86^{d}
tea leaf oil extract at 10%	0.20	2.00	3.35 ^{c}	4.40 ^{c}	5.00 ^{c}	6.00 ^{c}	6.53 ^{c}	6.60 ^{c}
petroleum oil (60 cc)	0.10	1.50	2.23 ^{b}	3.65 ^{b}	3.46 ^{b}	4.46 ^{b}	4.75 ^{b}	4.86 ^{ab}
cypermethrin (20 cc)	0.00	1.33	0.66 ^{a}	2.42 ^{a}	2.57 ^{a}	3.12 ^{a}	3.50 ^{a}	3.33 ^{a}
F - test	ns	ns	*	*	*	*	*	*
CV (%)	16.34	2.35	13.32	12.11	13.55	15.25	16.31	16.57

Note: *Significance ($p < 0.05$), ns = not significance ($p < 0.05$), and vertical (a, b, c, d and e) = indicate significance in confidence (95%).

Table 2 Average number of green mirids (insects/hill) after application of plant extracts every two weeks; the data were collected one day following the application from January–April 2024.

TREATMENTS	Average number of green mirids (insects/hill)							
	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT	120 DAT
water	0.00	1.00	5.25 ^{a}	5.00 ^{a}	6.00 ^{a}	5.50 ^{a}	6.75 ^{a}	5.50 ^{a}
tobacco extract at 5%	0.00	0.00	3.00 ^{b}	3.50 ^{b}	4.50 ^{b}	4.75 ^{ab}	3.75 ^{bc}	3.00 ^{b}
tobacco extract at 10%	0.00	0.00	1.50 ^{c}	2.50 ^{c}	3.00 ^{c}	3.00 ^{b}	2.50 ^{c}	2.75 ^{bc}
tea leaf oil extract at 5%	0.00	1.00	3.00 ^{b}	4.50 ^{ab}	4.00 ^{b}	4.50 ^{ab}	4.75 ^{b}	3.50 ^{b}
tea leaf oil extract at 10%	0.00	0.00	3.25 ^{b}	4.00 ^{ab}	4.25 ^{b}	3.00 ^{b}	3.50 ^{bc}	3.25 ^{b}
petroleum oil (60 cc)	0.00	0.00	2.75 ^{bc}	2.25 ^{c}	2.50 ^{c}	2.00 ^{c}	1.75 ^{cd}	1.25 ^{c}
cypermethrin (20 cc)	0.00	0.00	0.25 ^{d}	0.25 ^{d}	1.25 ^{d}	1.25 ^{d}	0.50 ^{d}	0.25 ^{d}
F - test	ns	ns	*	*	*	*	*	*
CV (%)	12.00	3.45	12.62	12.46	12.62	14.27	15.14	14.75

Note: *Significance ($p < 0.05$), ns = not significance ($p < 0.05$), and vertical (a, b, c, d and e) = indicate significance in confidence (95%).

The assessment of green mirid (*Cyrtorhinus lividipennis* Reuter) populations following the application of plant extracts at different concentrations revealed statistically significant differences in their abundance. At 120 DAT, the water treatment had the greatest number of green mirids (5.50 insects per hill), followed by the tea leaf oil extract at 5% (3.50 insects per hill), tea leaf oil extract at 10% (3.25 insects per hill), tobacco extract at 5% (3.00 insects per hill), tobacco extract at 10% (2.75 insects per hill), petroleum oil (60 cc per 20 liters of water) (1.25 insects per hill), and cypermethrin (20 cc per 20 liters of water) (0.25

insects per hill). All the treatments exhibited statistically significant differences at a confidence level of $p < 0.05$, as shown in Table 2.

Conclusions and Discussion

Effects of Plant Extraction and Synthetic Chemicals on Brown Planthopper Populations.

The results of the present study revealed that at 75 days after transplanting (DAT), water with an average of 11.15 insects per hill and 5% tea leaf oil extract (9.73 insects per hill) resulted in high brown planthopper density, which caused economic damage. However, when plant extracts are used, the brown planthopper population can be controlled to a level that does not cause economic damage or the use of chemicals. Specifically, 10% tobacco extract (3.37 insects per hill), 5% tobacco extract (3.62 insects per hill), 10% tea leaf oil extract (5.00 insects per hill), petroleum oil (60 cc per 20 liters of water) (3.46 insects per hill), and cypermethrin (20 cc per 20 liters of water) (2.57 insects per hill) were used. However, when synthetic chemicals are used, brown planthoppers may develop resistance to chemicals, with population numbers increasing from the age of rice at 30--120 days. [13] The results are summarized in Figure 4. All the treatments exhibited statistically significant differences at a confidence level of $p < 0.05$.

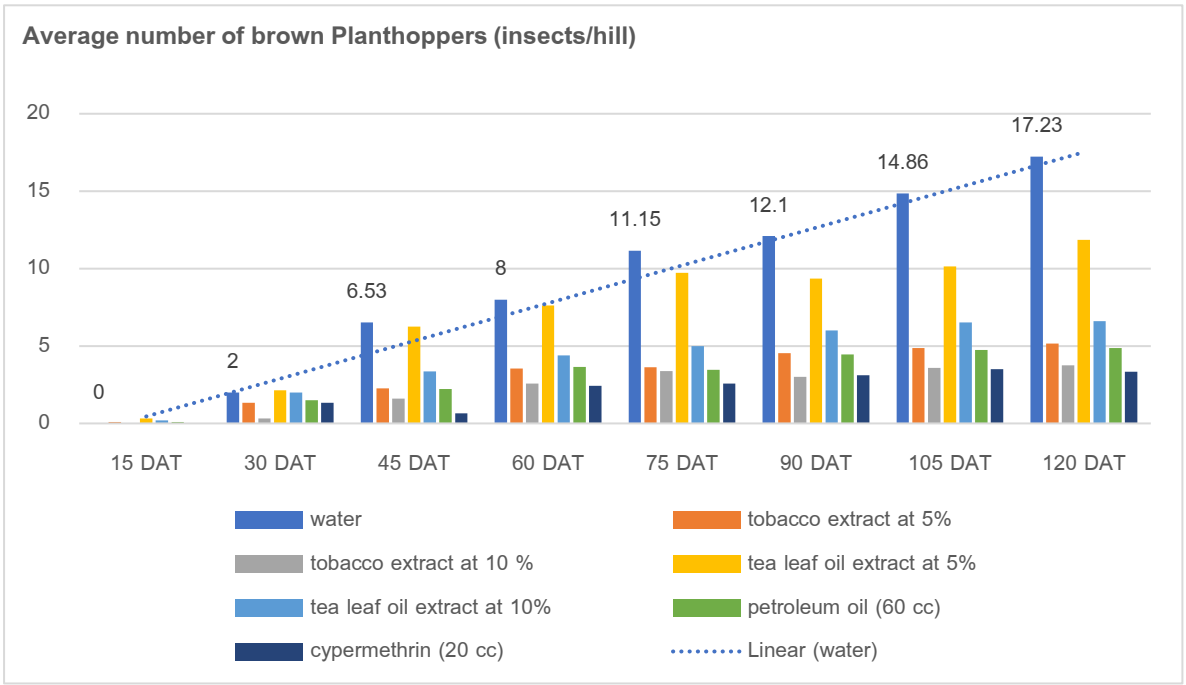

Figure 4. The data shown were determined one day following the application, from January - April 2024.

These findings are consistent with the research of Songyos and Thanonchit [14], who studied the impact of insecticides used to control brown planthoppers on the survival of the egg-eating bug *Tytthus chinensis* Stal. They reported that among 20 plant extracts evaluated for their effectiveness against brown

planthoppers, garlic, papaya, kaffir lime, and custard apple extracts were the most effective, controlling 0–33.30% of brown planthoppers. Holy basil, black soap, and pennywort provided moderate control, reducing brown planthopper populations by 46.67–53.33%, respectively.

Effects of Plant Extraction and Synthetic Chemicals on Green Mirid Populations.

The assessment of green mirid (*Cyrtorhinus lividipennis* Reuter) populations following the application of plant extracts at different concentrations revealed statistically significant differences in their abundance. [15] At 75 days after transplanting (DAT), water had the greatest number of green mirids (6.00 insects per hill), followed by 5% tobacco extract (4.50 insects per hill), 10% tea leaf oil extract (4.25 insects per hill), 5% tea leaf oil extract (4.00 insects per hill), 10% tobacco extract (3.00 insects per hill), petroleum oil (60 cc per 20 liters of water) (2.50 insects per hill), and cypermethrin (20 cc per 20 liters of water) (1.25 insects per hill). The results are summarized in Figure 5. However, the use of cypermethrin (20 cc per 20 liters of water) was more effective at reducing brown planthopper populations than plant extracts were, but it also had a detrimental effect on the green mirid population, which plays a crucial role in controlling brown planthoppers. This is because green mirids prey directly on brown planthopper eggs, helping reduce their population in rice fields, as shown in Figure 6.

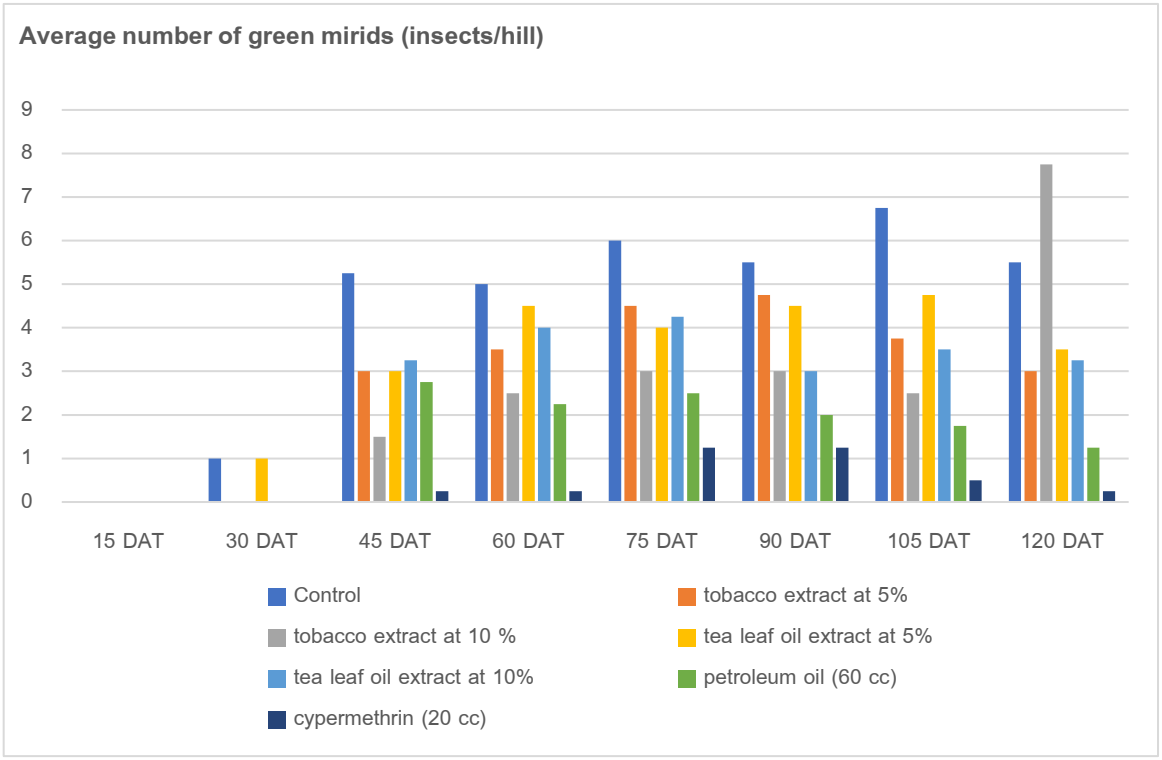

Figure 5. The data shown were determined one day following the application, from January - April 2024.

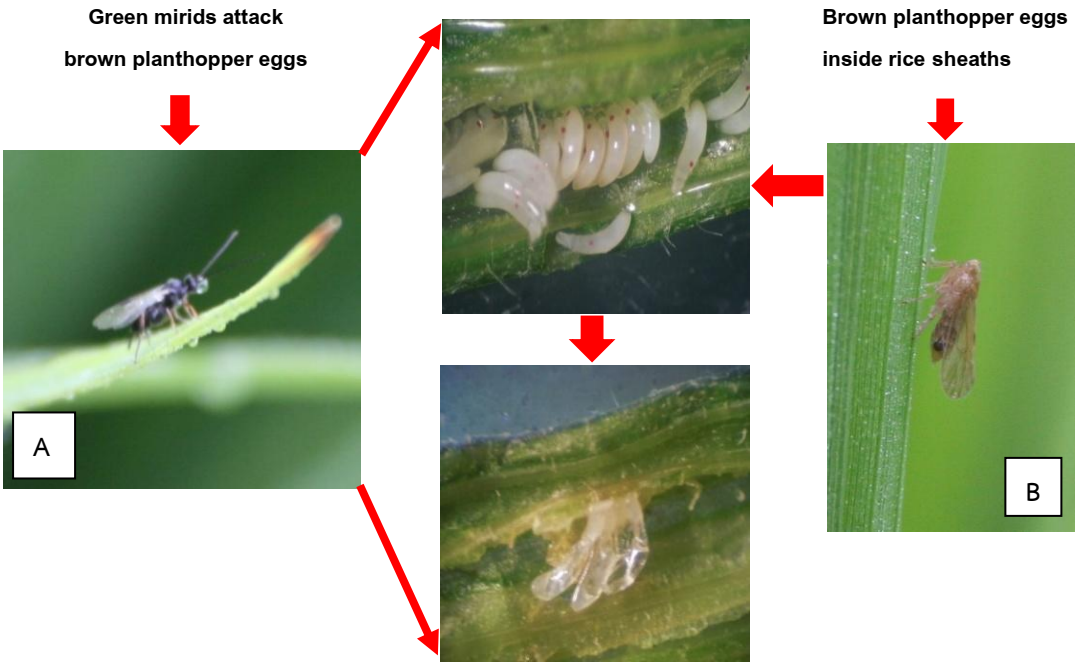

Figure 6. Appearance of brown planthopper eggs inside rice sheaths, as observed in rice fields. A: Green mirid attack brown planthopper eggs, and B: brown planthopper eggs.

The use of plant extracts, particularly tobacco, produces an important substance called nicotine, which has the ability to prevent and eliminate insects by affecting their nervous system. [16] When insects come into contact with it, it causes them to tremble, convulse, and become paralyzed. Severe symptoms can cause death [17], and a tea leaf oil extract at a concentration of 10% can effectively control brown planthopper populations without causing significant economic damage. [18] This finding is consistent with the research of Saengwan et al. (2016) [19]. The efficiency of a tobacco solution for controlling *Scirtothrips dosalis* Hood in farmer plots in Tha Muang District, Kanchanaburi Province, was statistically significantly greater at 3 days. Spraying 0.75--1.5 kilograms per liter of tobacco leaf mixture was able to reduce the number of thrips more than spraying with plain water. The results were not different from those of plants sprayed with 10% W/V SL imidacloprid, but the number of thrips increased at 5–7 days and tended to be greater than that of plants sprayed with other chemicals. Additionally, these plant extracts can help preserve or conserve natural enemies such as green mirids, maintaining a balanced ecosystem in rice fields. This natural approach to pest management not only protects crop yields but also ensures the safety of both producers and consumers. [20]

This research highlights the potential of using plant extracts as a sustainable and effective alternative to synthetic chemicals for controlling major rice pests. This study also underscores the importance of conserving natural enemies to maintain ecological balance and promote sustainable agricultural practices. [21] While this study provides promising results regarding the effectiveness of plant

extracts, further research is needed to optimize their application methods, identify the most potent plant extracts, and evaluate their long-term effects on pest populations and rice ecosystems. Additionally, exploring integrated pest management strategies that combine plant extracts with other natural control methods could offer even more sustainable solutions for rice pest management.

Acknowledgments

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