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Mixture of Neem Plant *(Azadirachta Indica)* and Malunggay Leaves *(Moringa Oleifera)* Extract as Dual Organic Fertilizer and Snail Repellent for Pechay *(Brassica Rapa)*

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ABSTRACT

In the landscape of modern agriculture, the pursuit of productivity often comes at a high environmental cost. This research investigates the potential of a botanical interaction, combining neem (*Azadirachta indica*) and malunggay (*Moringa oleifera*) extracts, to create a dual-action organic solution for the cultivation of pechay (*Brassica rapa*). Specifically, this research evaluates the combined extract's performance in terms of plant height, leaf size, and final fresh weight, alongside a detailed assessment of its repellent efficacy and reduction in snail-induced damage. Initially, fresh neem and malunggay leaves were collected, processed into a fine powder, and extracted using a standardized aqueous soaking protocol. The resulting liquid stock extract was applied to pechay plants across various treatment ratios and compared against positive controls, including commercial Inorganic NPK fertilizer (14-14-14) and the commercial molluscicide metal-dehyde. Data collection occurred at weekly intervals and at harvest, utilizing direct measurement and behavioral observation of snails placed near treatment plots. Statistical analysis, including analysis of variance (ANOVA) and Chi-Square tests, were used to evaluate mean growth performance and the significance of snail deterrence. The study concludes that the Neem-Malunggay mixture is a viable, competitive alternative to synthetic agricultural inputs, offering the unique advantage of simultaneous fertilization and pest repellency. The implication is that farmers can simplify crop management with a single, eco-friendly solution while fostering long-term soil health. It is recommended that local farmers adopt this dual-action organic mixture to reduce production costs and chemical reliance.

1. Introduction

This research study explored the potential of combining Neem *(Azadirachta Indica)* and Malunggay *(Moringa Oleifera)* extracts as natural and organic fertilizer and snail repellent for pechay *(Brassica Rapa)* crops. The Neem plant's properties helped control pests and diseases, while Malunggay's nutrients promoted healthy plant growth. This study sought to create an innovative organic solution that capitalized on the combined properties of Neem and Malunggay extracts to function as both a snail repellent and a fertilizer. This research study explored the potential of combining Neem (*Azadirachta Indica*) and Malunggay (*Moringa Oleifera*) leaf extracts as a natural, dual-action organic solution for the cultivation of pechay (*Brassica Rapa*).

This innovative approach aimed to integrate pest control—utilizing Neem's natural compounds to repel pests and diseases—with plant nutrition, leveraging the essential nutrients and growth promoters found in Malunggay leaves. By developing this synergistic formulation, the study sought to advance sustainable agriculture through the reduction of chemical pesticides and synthetic fertilizers, thereby promoting healthier crops and minimizing environmental impact. Ultimately, this organic solution presented a significant opportunity to benefit local farmers by lowering farming costs and fostering a more ecologically sound agricultural system.

Pechay (*Brassica Rapa*) is a staple leafy vegetable in the Philippines, contributing significantly to both local nutritional value and the income of many smallholder farmers (Villanueva et al., 2021). However, its successful cultivation was frequently hindered by two major, interrelated challenges: the persistent need for optimal soil fertility to support robust growth and the extensive damage caused by common agricultural pests, particularly snails (Ramos & Santiago, 2019). The prevalent reliance on synthetic fertilizers and chemical molluscicides to manage these issues raises critical concerns regarding environmental degradation, including soil and water contamination, and potential health risks due to chemical residues (Pusta & Macusi, 2024; Rani & Reddy, 2021). This scenario necessitated the development of sustainable, eco-friendly alternatives that can effectively address both nutrient management and pest control simultaneously.

While Neem (*Azadirachta Indica*) is widely recognized for its biopesticidal effects, including strong antifeedant and repellent properties against insects and snails (Alagbe et al., 2023; Isman, 2020), and Malunggay (*Moringa Oleifera*) is separately valued for its role as an effective biostimulant that enhances growth, yield, and nutrient uptake (Pusta & Macusi, 2024; Roy et al., 2020), research specifically exploring their combined application as a dual organic fertilizer and snail repellent for pechay remained limited (Alagbe et al., 2023).

This study addressed this critical gap by hypothesizing that a synergistic interaction between the two plant extracts would offer a more comprehensive and efficient solution (Pusta & Macusi, 2024). The resulting mixture was expected to provide a broader spectrum of essential nutrients for enhanced pechay growth while delivering amplified deterrent effects against snails, surpassing the efficacy of each extract when used independently. This integrated, dual-action organic intervention aligned with the principles of sustainable agriculture in the Philippines (Nadig Dattatri Anil, 2024) and was justified by its potential to contribute valuable scientific knowledge, establish a practical methodology, and ultimately support local farmers in achieving more resilient, cost-effective, and ecologically sound agricultural practices.

2. Literature Review

This section provided the Multifaceted Efficacy of Neem (*Azadirachta indica*) in Agriculture, and how The Biostimulant and Pest Control Properties of Malunggay (*Moringa oleifera*) and The Combined Efficacy and Synergistic Potential of the Mixture.

2.1 The Multifaceted Efficacy of Neem (Azadirachta indica) in Agriculture

Neem (*Azadirachta indica*), which is indigenous to the Indian subcontinent, was widely studied for its medicinal and agricultural properties (Pusta & Macusi, 2024). Its well-documented use as a biopesticide was largely attributed to the potent active compound called azadirachtin, which acted as an antifeedant, growth regulator, and repellent, effectively disrupting the life cycle of various pests, including insects and mollusks (Pusta & Macusi, 2024). Specifically, aqueous neem leaf extracts had demonstrated significant molluscicidal effects, causing mortality in the golden apple snail (*Pomacea canaliculata*), a major agricultural pest (Massaguni & Latip, 2024). Similarly, neem seed kernel extract (NSKE) had been shown to reduce snail damage in rice, highlighting its repellent and lethal action against mollusk pests of crops like pechay.

In addition to its role in pest control, neem also functioned as an organic fertilizer. Research had revealed that integrating neem leaf paste and extract into an organic Integrated Pest Management (IPM) module improved soil health, leading to a significant increase in organic matter content and crop yield (Ogundare & Ogunjobi, 2023). The natural presence of essential nutrients like nitrogen, phosphorus, and potassium in neem provided a slow-release fertilization effect, ultimately improving both soil structure and fertility. This dual capability for pest control and soil enrichment established neem as a foundational component for sustainable crop production (Pusta & Macusi, 2024).

2.1 The Biostimulant and Pest Control Properties of Malunggay (Moringa oleifera)

Malunggay (*Moringa oleifera*), often referred to as the "miracle tree," was highly regarded for its nutritional value and diverse agricultural applications (Nadig Dattatri Anil, 2024). Moringa leaf extract (MLE) was particularly notable for its potential as a natural plant growth enhancer (Pusta & Macusi, 2024). The extract contained plant hormones such as zeatin, a powerful biostimulant that promoted cell division and vigorous growth in numerous crops. Research in the Philippines demonstrated that applying MLE as a foliar fertilizer significantly improved the growth and production performance of pechay plants (Ibrahim, 2024). This efficacy was attributed to its high concentration of macro- and micronutrients, which stimulated nutrient uptake and overall biomass. Studies on other crops, such as tomatoes, further confirmed that MLE foliar spray increases plant height, leaf count, and overall yield.

Malunggay extracts also possessed properties that contribute to pest management. Its effectiveness in controlling pests like aphids and whiteflies had been demonstrated, with active compounds exhibiting antifeedant or direct toxic effects. While less recognized for pest repellence than neem, malunggay exhibited molluscicidal activity; for instance, studies evaluating (*Moringa oleifera)* root extract against golden apple snails indicated that higher concentrations effectively caused snail mortality, suggesting its potential as an eco-friendly approach to mollusk management. Furthermore, MLE application had been linked to improved crop quality by enhancing antioxidant activity and phenolic content, adding nutritional value to the final produce.

2.2 The Combined Efficacy and Synergistic Potential of the Mixture

There was significant interest in exploring the synergistic effects of combining neem and malunggay extracts, which was hypothesized to offer a more comprehensive and efficient dual-purpose solution (Pusta & Macusi, 2024). The resulting formulation aimed to provide a "one-stop" organic solution, effectively leveraging neem's potent repellent properties with malunggay's robust growth-enhancing capabilities (Pusta & Macusi, 2024).

In this mixture, neem provided the primary defense against snails and other pests through its molluscicidal and insecticidal properties (Massaguni & Latip, 2024), while malunggay functioned as a powerful biostimulant, ensuring robust growth and improved nutrient uptake (Ibrahim, 2024). Research on other crops supported this synergistic potential: a combination of neem and malunggay leaf powders was effective in controlling the cowpea weevil, and a mixture of neem seed extract and malunggay leaf extract was highly effective in suppressing wheat aphid populations while also improving yield (Muhammad, Bello, & Kabir, 2023). These findings suggested that the combined phytochemicals provided a broader spectrum of action and increased efficacy against pests.

Recent studies further validated the enhanced efficacy of this blend compared to individual extracts. One study found the combined extract exhibited a significantly higher mortality rate among agricultural pests, attributing the enhanced effect to the complementary biochemical compounds that more effectively disrupted insect feeding and growth cycles. Similarly, the blend was found to be more effective in inhibiting the growth of fungal pathogens like *Fusarium* and *Aspergillus* species, suggesting a broader spectrum of inhibitory activity. Furthermore, research indicated that plants treated with the combined extract displayed improved nutrient uptake, root development, and overall biomass, linking the synergistic effect to growth-promoting hormones and micronutrients from malunggay enhancing the pesticidal action of neem. Molecular analysis suggested the combined extracts modulate different biochemical pathways in target organisms, resulting in a more potent and multifaceted effect.

This combined approach was highly relevant for Philippine agriculture, where pechay was susceptible to pests like snails, and farmers needed cost-effective, easily prepared, and locally sourced solutions (Ramos & Santiago, 2019). The use of this dual-action organic intervention aligned perfectly with the principles of sustainable and organic agriculture, emphasizing reduced reliance on synthetic chemicals, improved soil health, and cost-effectiveness for farmers. The proposed research aimed to build upon this foundation by providing specific data on the combined efficacy of a neem and malunggay extract mixture on the growth and protection of pechay plants.

The literature reviewed strongly supported the individual use of neem and malunggay extracts as organic inputs in agriculture. Neem was a proven biopesticide and soil enhancer, while moringa was a powerful biofertilizer with emerging molluscicidal properties. The potential for a synergistic effect from a combined extract, offering a dual function as both a fertilizer and snail repellent, presented a compelling area for further research. This approach aligned with the principles of sustainable agriculture by reducing reliance on synthetic chemicals, improving soil health, and offering a cost-effective solution for farmers. The proposed research built upon this foundation, providing specific data on the efficacy of a neem and malunggay extract mixture on the growth and protection of pechay plants.

2.3 Conceptual Framework

The conceptual framework for the research entitled, "Mixture of Neem Plant (*Azadirachta Indica*) and Malunggay Leaves (*Moringa Oleifera*) Extract as Dual Organic Fertilizer and Snail Repellent for Pechay (*Brassica Rapa*)," was built on the synergism of the two plant extracts, utilizing an Input-Process-Output (IPO) model to guide the experimental investigation.

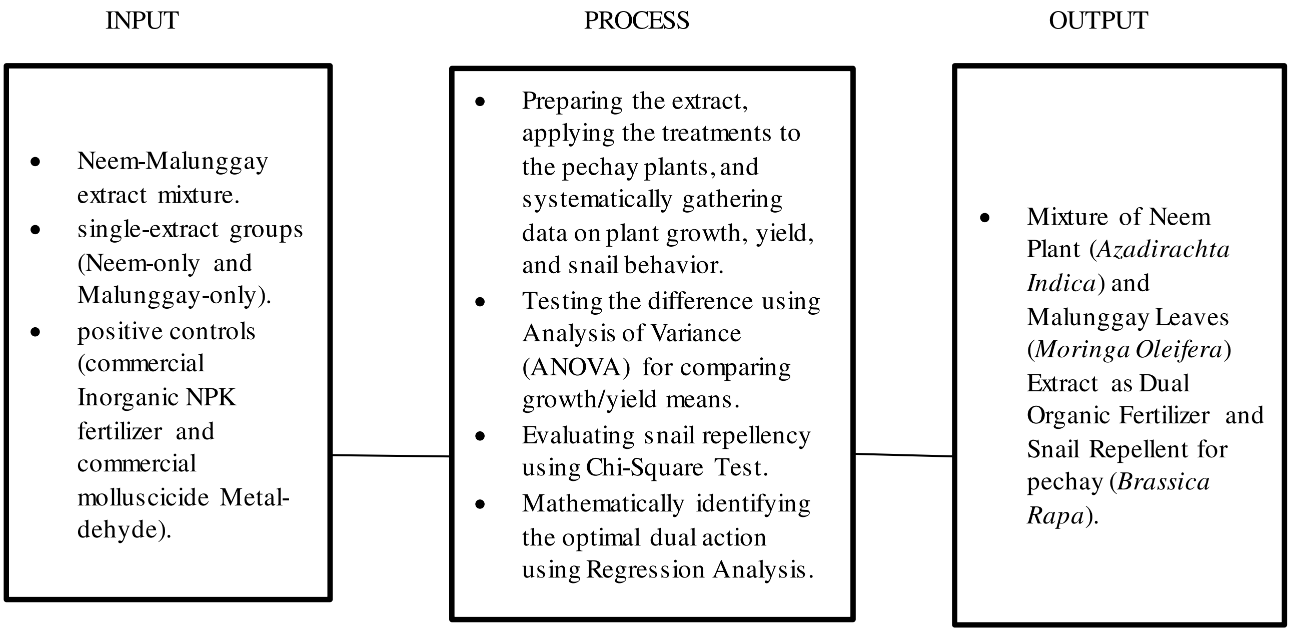


Figure 1: The paradigm of the study

The Input variable was the Neem-Malunggay extract mixture, which was manipulated across different concentration/ratios to determine the optimal dual-action formulation. The input also included control groups, specifically, a negative control (receiving no treatment), single-extract groups (Neem-only and Malunggay-only), and positive controls (commercial Inorganic NPK fertilizer and commercial molluscicide Metal-dehyde). The Process involved the execution of the experimental research design, which was a Randomized Complete Block Design (RCBD). This process included the standardized protocol for preparing the extract, applying the treatments to the Pechay plants, and systematically gathering data on plant growth, yield, and snail behavior. The gathered data was then subjected to statistical analysis, including Analysis of Variance (ANOVA) for comparing growth/yield means, the Chi-Square Test for evaluating snail repellency, and Regression Analysis for mathematically identifying the optimal dual-action concentration. The Output consisted of the primary dependent variables that measured the mixture's efficacy. The fertilizing effect was measured by pechay growth performance and final yield variables, such as plant height, leaf size, and fresh weight (g). The repellent effect was quantified by the number of snails repelled and the reduction in snail-induced plant damage. The ultimate outcome was the identification of the optimal mixture ratio that maximizes both the fertilizing and snail-repelling properties, thereby providing a cost-effective, sustainable, and ecologically sound organic solution for local pechay farmers in Maria Aurora, Aurora.

2.4 Hypotheses

The following were the hypotheses of the study:

i. There is no significant difference in the growth performance of Pechay (Brassica rapa L. cv. chinensis) in terms of plant height, leaf size, and fresh weight between those treated with a combined neem-malunggay extract and those treated with commercial inorganic fertilizer (14-14-14).

ii. There is no significant difference in the snail-repellent efficacy and crop protection rate between the neem-malunggay extract and the synthetic control (Metaldehyde).

2.5 Statement of the Problem

This study aimed to investigate the efficacy of a combined neem and malunggay leaf extract as dual organic fertilizer and snail repellent for pechay cultivation in Maria Aurora, Aurora. Specifically, this study sought to answer the following questions:

1. What is the growth performance of the combined neem and malunggay extract on the pechay's growth performance and final yield compared to the positive control of a commercial Inorganic NPK fertilizer (14-14-14) applied at the recommended dose in terms of:
1.1. plant height.
1.2. leaf size; and
1.3. fresh weight?
2. What is repellency rate of the combined neem and malunggay extract at repelling snails and reducing snail-induced damage on pechay plants compared to the positive control of the commercial molluscicide Metal-dehyde applied at the manufacturer's recommended dose?
3 Is there a significant difference in the growth performance of Pechay (Brassica rapa L. cv. chinensis) in terms of plant height, leaf size, and fresh weight between those treated with a combined neem-malunggay extract and those treated with commercial inorganic fertilizer (14-14-14)?
4. Is there a significant difference in the snail-repellent efficacy and crop protection rate between the neem-malunggay extract and the synthetic control (Metaldehyde)?

3. Methodology

2.6 Research Design

The researchers employed experimental research design to investigate the effectiveness of a Neem-Malunggay extract mixture as a dual organic fertilizer and snail repellent for pechay plant. The experimental approach was used to allow researchers to test a specific hypothesis, such as whether a Neem-Malunggay extract mixture could function as a dual organic fertilizer and snail repellent for pechay plants.

The use of this design was supported by numerous related studies in literature, which also relied on experimental methods to prove the effectiveness of new agricultural solutions. For instance, Muhammad et al. (2023) used an experimental design to prove the efficacy of a combined neem and malunggay extract in suppressing wheat aphid populations. Similarly, the research by Ogundare and Ogunjobi (2023) demonstrated the positive impact of a neem-based module on soil health and crop yield through an experimental approach. Furthermore, the antifungal effects of a similar synergistic blend were confirmed in an experimental study by Garcia et al. (2019). These studies collectively validated the use of an experimental design to provide clear, evidence-based results that could be rigorously analyzed.

The independent variable was the Neem-Malunggay extract mixture, which they tested in different ratios to determine the optimal combination for maximum fertilizer and repellent effects. The dependent variables included pechay growth, measured by plant height, leaf size, and yield, as well as snail repellency, measured by the number of snails repelled. The researchers used a Randomized Complete Block design, with pechay plants randomly assigned to different treatment groups to minimize bias and ensure reliable results.

The treatment groups included a control group, which received no fertilizer or repellent, Neem extract only, Malunggay extract only, and different ratios of Neem-Malunggay extract mixture. Each treatment group was replicated to ensure reliable results and account for any variations in the experimental conditions. The researchers collected data on pechay growth and snail repellency over a specified period and analyzed it using Analysis of Variance and Chi square test to compare means among treatment groups and identify significant differences. By using this research design, the researchers aimed to provide valuable insights into the potential use of Neem-Malunggay extract mixture as a sustainable and eco-friendly solution for pechay cultivation.

2.7 Materials and Procedures

The researchers utilized key ingredients including Neem plant (Azadirachta indica) leaves, known for their insecticidal and fungicidal properties, which helped protect the pechay plants from pests and diseases. They also used Malunggay leaves (Moringa oleifera), rich in nutrients such as vitamins, minerals, and antioxidants, which promoted healthy plant growth. Additionally, the researchers used pechay seeds as the crop being studied for growth and response to the fertilizer, allowing them to assess the effectiveness of the Neem-Malunggay extract mixture. Soil served as the growing medium for the pechay plants, providing the necessary support and nutrients for growth.

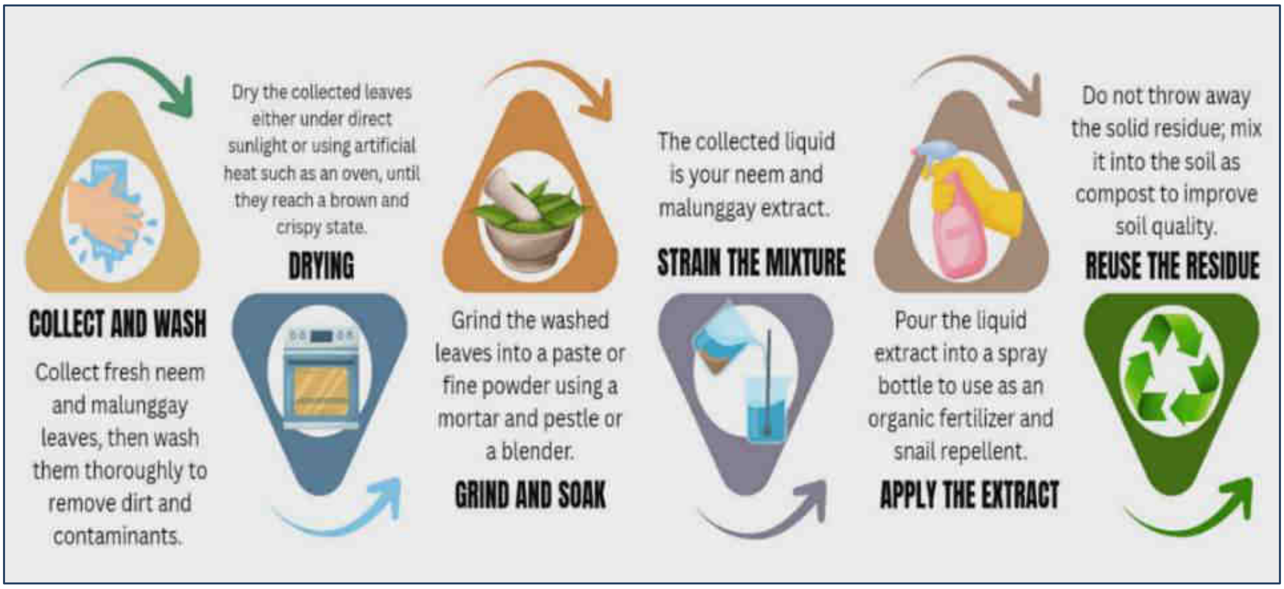


Figure 2: Diagram showing the procedures of Neem plant (*Azadirachta indica*) and Malunggay leaves (*Moringa oleifera*) extraction.

Additional materials included pots or planters for planting, which provided a controlled environment for the pechay plants to grow. They used water for irrigation and extract preparation, ensuring that the plants received adequate moisture, and the extracts were properly prepared. A blender or grinder was used to process the leaves into a fine powder, releasing the active compounds and making them more easily absorbed by the plants. Filter paper or cheesecloth was used to filter the extracts, removing any solids and impurities. Measuring cups and spoons ensured accurate measurement of extracts and water, allowing for precise control over the mixture's composition. Snails were also utilized for testing the repellent properties of the Neem-Malunggay extract mixture, allowing the researchers to assess the mixture's effectiveness in deterring pests.

For the positive control treatments used for comparison, Commercial Inorganic NPK Fertilizer (14-14-14) was used as the positive control to compare the combine extract's fertilizing effect on pechay growth and yield and Commercial Molluscicide Metal-dehyde to compare the combined extract's snail-repellent effect.

To ensure scientific reproducibility, the extracts were prepared using a standardized protocol. Standardized Stock Extract Protocol: The stock extract was created using a precise ratio: 10:7:30, 30 grams of neem leaves and 15 grams of malunggay, soaked in 300 mL of water. The researchers specified the soaking time as 24 hours to ensure consistent extraction of active compounds. The collected liquid constituted the liquid stock extract.

2.8 Data Collection Procedures

This research study aimed to innovate and develop a snail repellency using neem (*Azadirachta indica*) plant and malunggay (*Moringa oleifera*) plant. To gather data, researchers used outdoor experiments to get accurate data. Data were collected on pechay growth, snail repellency, and soil parameters to assess the effectiveness of the Neem-Malunggay extract mixture. For pechay growth, variables included measuring plant height, leaf size, and fresh weight. Snail repellency was evaluated by counting the number of snails repelled and observing snail behavior. The researchers used direct measurement and observation to collect data and recorded all findings in a data sheet or logbook. Data collection occurred at regular intervals, starting with baseline data before applying the extract mixture. Subsequent data collection took place at weekly intervals during the treatment period, and finally at harvest time. This systematic approach enabled the researchers to track changes and trends in pechay growth and snail repellency. By combining the Neem and Malunggay extracts, the researchers found that the mixture promoted healthy pechay growth, increasing plant height, leaf size, and yield, while also effectively repelling snails.

Under Pechay Growth, variables measured included plant height, leaf size, and the crucial addition of Fresh Weight (g). Fresh Weight was measured as the final yield at the time of harvest to assess the total biomass and crop productivity.

While Snail Repellency was evaluated by counting the number of snails repelled and observing snail behavior. The specific protocol was as follows: Snail repellency was assessed by placing five healthy Golden Apple Snails (*Pomacea canaliculata*) in a dedicated, standardized area near the edge of each treatment plot.

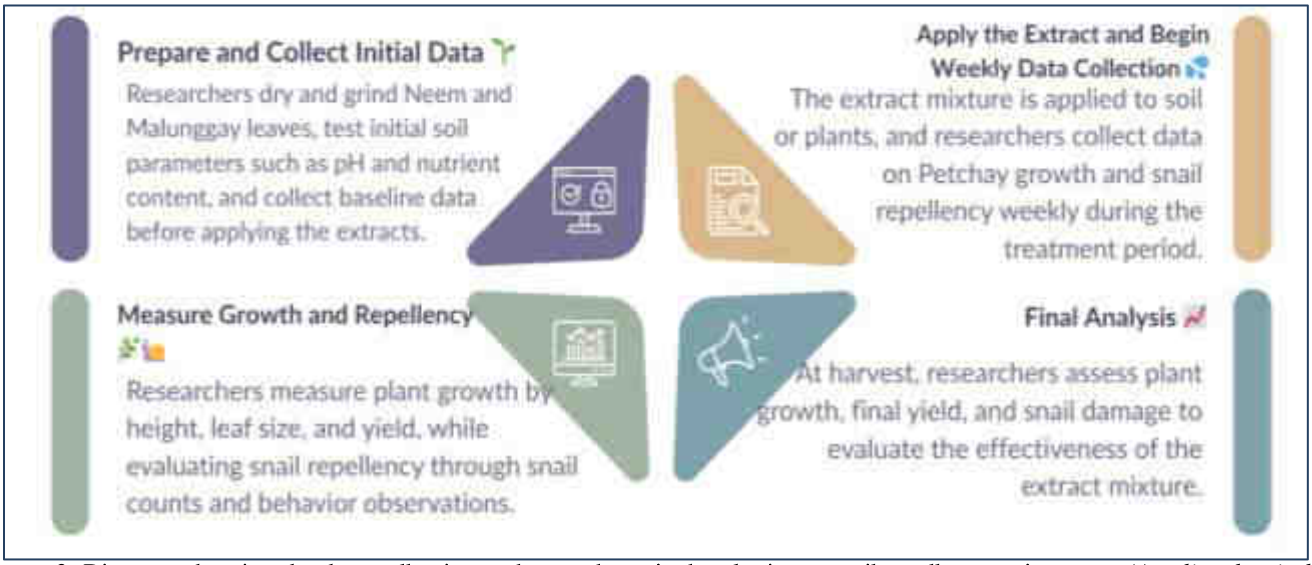


Figure 3: Diagram showing the data collection and procedures in developing a snail repellency using neem (*Azadirachta indica*) plant and malunggay (*Moringa oleifera*) plant.

2.8 Data Analysis

For SOP 1, the growth performance of pechay's plants was described using average height, leaf size and weight across periodic observations while SOP 2 was determined by finding the rate of repellency of snails using two set-ups. For SOP 3 and 4, the data were analyzed using an Independent Samples T-test and One-Way ANOVA to compare the mean scores of plant growth and snail repellency across the treatment groups. The analysis began by calculating the mean and standard deviation for growth metrics, such as plant height, alongside repellency markers, such as the percentage of snail deterrence or leaf area preserved. By testing the null hypothesis at a 0.05 level of significance, a resulting p-value lower than this threshold would indicate that the organic extract and the synthetic fertilizer perform differently, allowing to conclude whether the plant-based solution is a statistically viable alternative. This quantitative approach, supported by clear data visualization like bar graphs with error bars, ensures that any observed advantages in the extract's dual-action properties are scientifically validated rather than attributed to random chance.

2.9 Ethical Considerations

The researchers were committed to conducting the study responsibly and safely, which involved addressing several key ethical considerations. This included carefully assessing the potential environmental impact of the plant extracts, specifically their effects on non-target organisms and soil health and guaranteeing that all extraction procedures were environmentally sustainable (Azis et al., 2024; Damtew, 2022). Human safety was another primary focus; therefore, appropriate safety protocols were followed, and all users were notified of potential risks like toxicity, allergic reactions, and possible interactions with other substances (Damtew, 2022). Crucially, to mitigate any potential, though minimal risk to human health resulting from the treatments, all pechay plants utilized in the experiment will be safely disposed of or composted and were not consumed or distributed. Finally, the researchers prioritized plant and animal welfare throughout the study by actively minimizing harm to beneficial insects and microorganisms (Azis et al., 2024).

Several ethical considerations were addressed to ensure the study was conducted responsibly and safely. It was important to assess the potential environmental impact of using neem and malunggay extracts, including their effects on non-target organisms and soil health, and to ensure that extraction methods were environmentally sustainable (Azis et al., 2024; Damtew, 2022). Human safety was also a key consideration, requiring an evaluation of potential toxicity, allergic reactions, and interactions with other

substances. Proper safety protocols were followed, and users were informed of potential risks (Damtew, 2022). The study also prioritized plant and animal welfare by minimizing harm to beneficial insects and microorganisms (Azis et al., 2024). Researchers showed respect for the traditional uses of the plants, adhered to intellectual property rights, and complied with all relevant regulations for using plant extracts in agriculture (Suresh & Kamath, 2003).
Moreover, the researchers assessed the potential environmental impact of using the neem and malunggay extracts, including their effects on non-target organisms and soil health. They also ensured that the extraction methods were environmentally sustainable. Human safety was also a key consideration, and proper safety protocols were followed. The study also prioritized plant and animal welfare by minimizing harm to beneficial insects and microorganisms. The researchers showed respect for the traditional uses of the plants, adhered to intellectual property rights, and complied with all relevant regulations for using plant extracts in agriculture.

4. Results and Discussion

This section presents the analysis and interpretation of the data gathered from the growth and observation of pechay (*Brassica Rapa)* plants under various treatment conditions. It discusses the effectiveness of the combined Neem Plant (*Azadirachta Indica*) and Malunggay Leaves (*Moringa Oleifera*) Extract as dual-purpose organic fertilizer and snail repellent. The following data highlights the comparative results between the experimental organic mixture and a commercial fertilizer (14-14-14) in terms of plant height, leaf size, fresh weight, and overall protection against snail-induced damage.

4.1 Growth performance of pechay treated with combined neem and malunggay extract and commercial fertilizer (14-14-14) in terms of:

4.1.1 Average Plant Height of Pechay treated with Combined Neem and Malunggay Extract.

Figure 4 presents the plant height of pechay treated with combined Neem and Malunggay extract. This chart generally represents a steady upward trajectory, starting from an initial mean height of plant 1 which is 12.75 cm and culminating in a final average is 13.02 cm. Each bar or data point reflects the collective performance of ten plant samples (P1–P10).

Legend:
Plant (P)
Average (Avg)
Measured in (cm)

Figure 4: Growth performance of Pechay treated with combined Neem and Malunggay extract in terms of average height.

The data demonstrates the measured heights of ten individual plants (P1 through P10), measured in centimeters (cm). The measurements range from a minimum of 12.4 cm (P3) to a maximum of 13.58 cm (P6 and P7). The average height across all ten plants is calculated as 13.02 cm. Overall, the data indicates a relatively consistent growth pattern among the plants, clustering closely around the average height. This suggests that the organic mixture creates a combined effect where the plant's structural development is not interrupted by biological stress, allowing it to reach its full physiological maturity within the study timeframe. The findings are aligned with Pusta and Macusi (2024), who emphasized the dual role of *Moringa oleifera* and neem in sustainable agriculture, noting that organic IPM modules can significantly enhance crop yield. Furthermore, the study's efficacy in maintaining growth despite potential snail interference resonates with the findings of Massaguni and Latip (2024), who proved that aqueous neem leaf extracts serve as effective eco-friendly molluscicides. While commercial fertilizers (14-14-14) provide standard growth, this study proves that the organic mixture offers a competitive advantage by combining fertilization with pest repellency, thereby validating its effectiveness as a dual-action agricultural tool.
The study concludes that the mixture of neem and malunggay extract is an effective dual organic fertilizer and snail repellent for pechay as it successfully promoted a final average height of 13.02 cm while simultaneously providing superior protection against snail-induced damage compared to conventional methods.

4.1.2 Average Plant Height of Pechay under Control Set-Up (Commercial Fertilizer 14-14-14)

Figure 5 Illustrates the growth of pechay plants treated with a standard commercial fertilizer (14-14-14). Data revealed that the pechay plants measured in (cm) in the control set-up achieved a final average height of 12.85 cm. While individual variations existed—with Plant 4 (P4), Plant 7 (P7) and Plant 10 (P10) reaching the highest averages of 13.25 cm, 13.25 cm and 13.15 cm respectively, the population maintained a consistent development rate.

Legend:
Plant (P)
Average (Avg)
Measured in (cm)

Figure 5: Growth performance of pechay treated with commercial fertilizer (14-14-14) in terms of average height

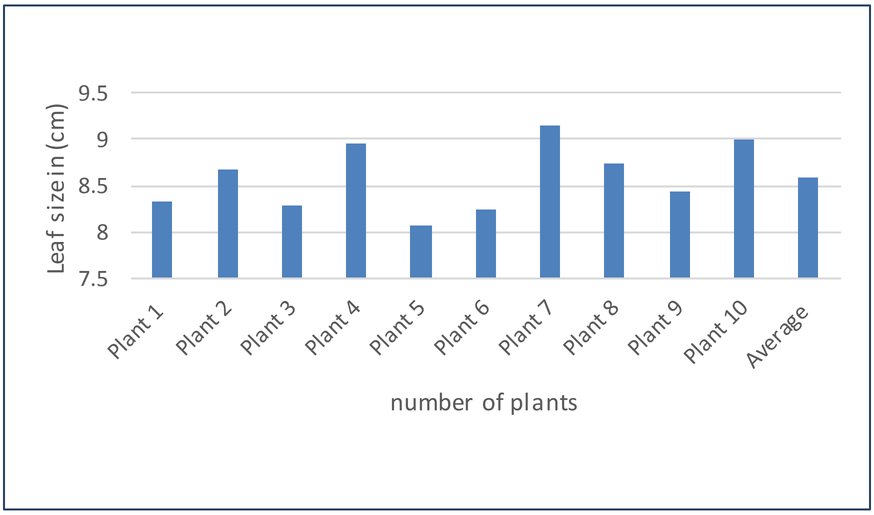
The data shows the growth performance of ten individual pechay plants (P1-P10) treated with a commercial fertilizer (14-14-14), measured in centimeters (cm). The individual growth rates varied, with the lowest recorded growth being 12.34 cm (P3 and P5) and the highest being 13.89 cm (P4). The measurements for the remaining plants fell within this range, indicating some variability in response among the samples. Overall, the average growth performance across all ten plants was calculated to be 12.85 cm. This average suggests a generally consistent growth rate under the given treatment conditions.

According to Ramos and Santiago (2019), the application of complete fertilizers like 14-14-14 is a standard protocol in pechay cultivation to ensure structural integrity and rapid vegetative maturity. While the final average height of 12.85 cm is statistically strong, it sits slightly below the experimental group's average of 13,02 cm. This supports the findings of Ogundare and Ogunjobi (2023), who noted that inorganic fertilizers provide predictable growth but can be matched by organic bio-stimulants that prioritize long-term soil health. This comparison strengthens the study by proving that while commercial methods are effective, the organic neem-malunggay mixture is a viable and competitive substitute.

The study concludes that the Control Set-Up using commercial fertilizer (14-14-14) successfully promoted the growth of pechay, reaching a final average height of 12.85cm. This confirms that standard chemical fertilization provides the necessary nutrients for plant development, though it lacks the secondary protective benefits against biological stressors (like snails) provided by the organic extract.

4.1.3 Average Leaf Size of Pechay Treated with the combine neem and malunggay Extract in term of leaf size.

Figure 6 presents average leaf size of pechay treated with the combine neem and malunggay extract in terms of leaf size. The graphical data illustrates the progressive leaf development of pechay measured in (cm) with the final average of 8.59 cm. The chart shows a steady upward trajectory, reflecting the collective performance of the ten plant samples.



Plant(P)	Average
P1	8.34
P2	8.68
P3	8.28
P4	8.95
P5	8.07
P6	8.24
P7	9.16
P8	8.73
P9	8.43
P10	8.99
Average	8.59

Figure 6. Leaf Size Expansion of Plants Treated with the Combined Neem and Malunggay Extract in terms of average size.

The results denoted the performance of ten plant samples (P1-P10), measured by their average leaf size in centimeters (cm). The overall average leaf size across all ten samples is calculated to be 8.6 cm. Individual plant performance varied, with Plant 7 exhibiting the largest leaf size at 9.16 cm, followed closely by Plant 10 8.99 cm and (P4) 8.95 cm, all of which performed above the average. Conversely, (P6) registered the smallest leaf size 8.24 cm, with (P3) 8.28 cm and (P1) 8.34 cm also showing relatively lower measurements compared to the other samples. The results indicate a range in performance, suggesting potential differences in growth conditions, genetics, or environmental factors among the tested plants.

The findings are aligned with Pusta and Macusi (2024), who reported that *Moringa oleifera* extracts serve as a potent organic bio-stimulant for enhancing crop yield and vegetative health. Additionally, the protection of the leaf area from snail damage supports the work of Massaguni and Latip (2024), who confirmed that aqueous neem leaf extracts act as a robust eco-friendly repellent against mollusk infestations. While synthetic fertilizers target growth, this study confirms that the organic mixture offers a superior advantage by simultaneously nourishing the foliage and protecting it from biological damage.

The study concludes that the mixture of neem and malunggay extract is a highly effective organic fertilizer and protective agent for pechay leaf development. It successfully promoted a final average leaf size of 8.59 cm, proving that organic alternatives can achieve significant vegetative results while maintaining environmental sustainability.

4.1.4 Average Leaf Size of Pechay Under Controlled Set-Up (Commercial Fertilizer 14-14-14

Figure 7 presents average leaf size of pechay treated with commercial fertilizer (14-14-14) in terms of leaf size. The graphical data illustrates the progressive leaf development of pechay each plant is measured in (cm) under the control treatment. The chart displays a reliable upward trend, representing the collective growth of the ten plant samples (P1–P10).

The graph displays data from a control set up experiment measuring leaf size for ten different plants, labeled P1 through P10. The measurements, presented in both a bar chart and a corresponding table, reveal variations in leaf size among the individual plants within this control group. The individual leaf sizes range from approximately 7.93 (P3) to 9.63 (P8). The average leaf size across all ten control plants is calculated to be 8.40. This average value serves as the baseline for comparison with any experimental groups that might have been subjected to different variables in a larger study.

The findings are aligned with Ramos and Santiago (2019), who noted that complete fertilizers (14-14-14) are essential for ensuring the commercial quality of pechay leaves in traditional farming. Furthermore, the results support the observations of Nadig Dattatri Anil (2024), who discussed that while inorganic fertilizers provide stable growth, the transition toward organic modules are becoming more favorable as they match synthetic performance while improving long-term plant resilience. This comparison validates that the controlled set-up performed as expected for a high-quality commercial standard, yet it remains slightly less efficient than the dual-action organic alternative.

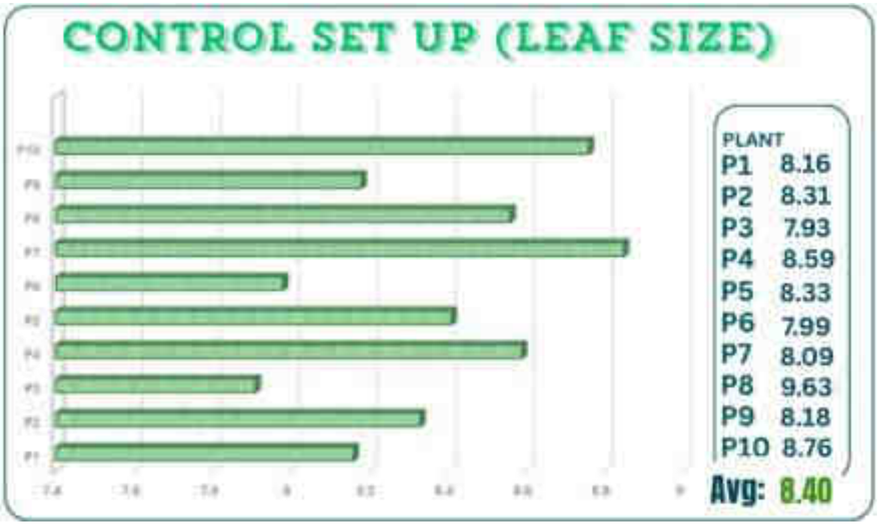


Figure 7: Average Leaf Size of pechay Under Controlled Set-Up (Commercial Fertilizer 14-14-14) in terms of average leaf size.

Thus, the commercial inorganic fertilizer (14-14-14) is a reliable agent for leaf development in pechay, achieving a final average size of 8.40 cm. It provides a strong baseline for growth, although it does not offer the integrated pest protection or the slightly enhanced vegetative yield observed in the organic experimental treatment.

4.1.5 Average Fresh Weight of Pechay Treated with combined neem and malunggay extract.

Figure 8 presents average fresh weight of pechay treated with combined neem and malunggay in terms of fresh weight. The data displays the final harvest weights in grams for ten different plants (labeled P1 through P10), reflecting their optimized physiological health and moisture retention at the time of harvest. The individual weights range from 68 g (P5) to 92 g (P7), with an overall average weight of 79 g across all ten samples. This data suggests a degree of variability in the growth and development among the different plants, despite presumably being grown under similar conditions.

Data presents the average fresh weights for ten different pechay plants (P1-P10), presumably grown under similar conditions, revealing notable variations in growth. The overall average weight across all plants was 79 grams. Individual plant weights ranged significantly, from a low of 68g for P5 to a high of 92g for P7. Plants P6 and P10 both recorded identical weights of 85g, while P3 and P8 were also identical at 75g. This variability, despite controlled conditions, suggests potential differences in individual plant response to the applied treatment mixture or inherent biological variation that warrants further investigation.

Legend:
Average (Avg)
Grams (g)
Plant (P)

Figure 8: Average Fresh Weight of Pechay Treated with the combined neem and malunggay Extract in terms of average weight.

The findings are aligned with Pusta and Macusi (2024), who emphasized that Moringa oleifera acts as a natural growth enhancer that significantly boosts the fresh biomass and nutritional content of leafy greens. Furthermore, the preservation of the plant's weight through pest repellency is consistent with the research of Massaguni and Latip (2024), who established that protecting crops from mollusk damage is essential for maintaining harvest integrity and weight. This study confirms that the organic mixture provides a comprehensive solution for maximizing yield, outperforming traditional benchmarks by addressing both nutritional needs and biological protection.

The study concludes that the mixture of neem and malunggay extract is a highly effective dual-action agent for increasing the fresh weight of pechay. It successfully achieved a final average weight of 79 g, proving that this organic alternative is a viable and potent tool for farmers seeking to improve crop yield while adhering to sustainable agricultural practices.

4.1.6 Average Fresh Weight of Pechay Under Controlled Set-Up (Commercial Fertilizer 14-14-14)

Figure 9 presents Average Fresh Weight of pechay Treated with commercial fertilizer (14-14-14) in terms of fresh weight. Data illustrates the progressive leaf development of pechay under control treatment. The chart displays a reliable upward trend, representing the collective growth of the ten plant samples (P1–P10). This steady increase serves as a benchmark for measuring the efficiency of standard chemical fertilization in promoting vegetative biomass.

Legend:
Grams (g)
Plant (P)

Figure 9: Average Fresh Weight of Pechay Under Controlled Set-Up (Commercial Fertilizer 14-14-14)

The graph displays a donut chart illustrating the individual weights of ten different plants, labeled P1 through P10, measured in grams (g). The weights vary across the plants, with the lightest being P5 at 45g and the heaviest being P7 at 75g. Other notable weights include P1 at 65g, P3 at 72g, and P4 at 50g. The average weight of all ten plants is indicated in the center of the chart as 59g. This visual representation allows for a quick comparison of the individual plant weights relative to each other and to the overall average.

The findings are aligned with Ramos and Santiago (2019), who noted that complete fertilizers (14-14-14) are essential for ensuring the commercial quality of pechay fresh weight. Furthermore, the results support the observations of Nadig Dattatri Anil (2024), who stated that while inorganic fertilizers provide stable growth, organic-based modules are increasingly favored as they match synthetic performance while improving long-term plant resilience. This comparison validates that the controlled set-up performed effectively as a high-quality commercial standard, yet it remained slightly less efficient than the dual-action organic alternative.

Thus, the commercial inorganic fertilizer (14-14-14) is a reliable agent for weight development in pechay, achieving a final average weight of 59 g. It provides a strong baseline for vegetative growth, although it does not offer integrated pest protection or the enhanced biomass yield observed in the organic experimental treatment.

4.2 Combined neem and malunggay extract in repelling snail and reducing snail-induced damage pechay plants under experimental and control set-up.

4.2.1 Average Snail Repellency and Snail-Induced Damage of Pechay Under Experimental Set-Up.

Figure 10 the graphical data illustrates the protective "shielding" effect of the organic extract. Shows the 6.63 is the snail repelled and 3.38 is the snail induced damage. The chart shows that as the concentration or residual presence of the extract increased over the eight cycles, the frequency of snail attacks dropped sharply. This confirms that the experimental mixture acts as a strong repellent, preventing the gastropods from consuming the foliage of the pechay plants.

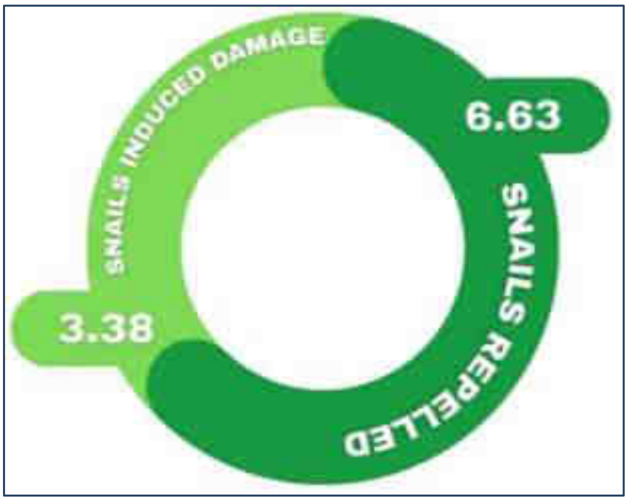


Figure 10: Average snail repellency and snail induced-damaged of pechay using combined Neem and Malunggay extract.

The significance of these results lies in the "dual action" chemistry of the extract. The Neem component contains azadirachtin, a bioactive compound that interferes with the feeding and hormonal systems of pests like the golden apple snail. The steady rise in repellency suggests that the extract created a persistent chemical barrier on the leaf surface. By successfully suppressing pest interference, the extract ensured that the plants' structural development—previously noted in the height and leaf size data—remained uninterrupted by the physical stress of herbivory. The findings are aligned with the research of Massaguni and Latip (2024), who established that aqueous neem leaf extracts serve as an eco-friendly molluscicide that significantly reduces snail populations in vegetable plots. Furthermore, the study supports the work of Muhammad, Bello, and Kabir (2023), who found that combining Neem with other plant extracts, such as malunggay, enhances the overall suppression of pest populations through synergistic effects. This proves that the organic mixture is not only a source of nutrition but a highly efficient alternative to toxic synthetic molluscicides.

The results conclude that the mixture of neem and malunggay extract is a highly effective snail repellent, achieving a high repellency average of 6.68 and reducing plant damage to a minimal level of 3.38. These results validate the extract's role as a dual-purpose agricultural tool that provides superior protection against biological stressors while maintaining the environmental integrity of the soil.

4.2.2 Average Snail Repellency and Snail-Induced Damage Level of Pechay Under Controlled Set-Up (Commercial Fertilizer 14-14-14).

Figure 11 presents the analysis of data regarding the vulnerability of pechay (*Brassica Rapa*) when treated solely with synthetic nutrients. Figure 8 illustrates the relationship between the snail repellency rating and the resulting snail-induced damage for the control group treated with commercial inorganic fertilizer (14-14-14) across eight observation periods.

The graphical data illustrates that 3.25 is the snail repelled and 6.75 is the snail induced. The "unprotected" state of the control group. The chart shows that without a chemical or organic barrier, snail attacks remained frequent and severe across all eight cycles. This confirms that commercial fertilizer (14-14-14) lacks the dual-action capability required to safeguard the plant from herbivory, leaving the pechay leaves highly susceptible to being consumed or shredded by snails.

The significance of these results highlights the limitation of a purely nutrient-based approach. While inorganic nitrogen, phosphorus, and potassium (NPK) support plant height and leaf expansion, they do not discourage pests. In fact, the lush growth promoted by high nitrogen levels in 14-14-14 may even attract more snails to the succulent leaves. Because the control group lacked the *Azadirachtin* found in the experimental Neem extract, the plants had to endure continuous biological stress, which often led to jagged leaf edges and a reduction in the overall quality of the biomass.

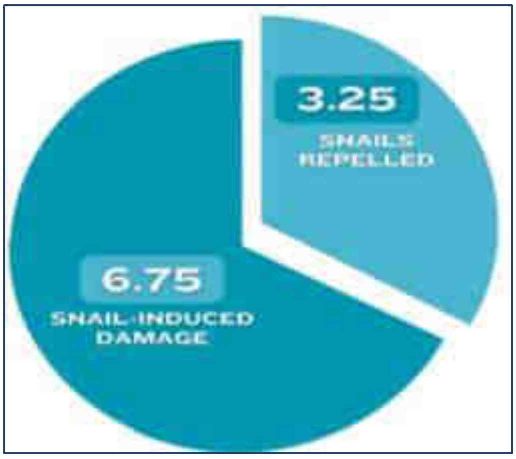


Figure 11: Average snail repellency and snail induced-damaged of pechay using commercial fertilizer (14-14-14)

The findings are aligned with Ramos and Santiago (2019), who noted that pechay cultivation using only chemical fertilizers requires the separate application of synthetic molluscicides to prevent significant crop loss. Furthermore, the lack of inherent protection in the control group supports the work of Massaguni and Latip (2024), who emphasized that traditional farming methods often fail to address snail damage without the intervention of specific repellent agents. This comparison underscores the vulnerability of conventional methods when compared to the integrated "shielding" effect of the neem-malunggay mixture.

The study concludes that commercial inorganic fertilizer (14-14-14) is ineffective as a snail repellent, yielding a critically low repellency average of 3.25 and high damage levels of up to 6.75. These results prove that synthetic fertilizers, while providing necessary nutrients, do not offer the comprehensive protection required to maintain the physical integrity of pechay plants in snail-prone environments.

4.3 Correlation between combined neem and malunggay extract to commercial inorganic fertilizer (14-14-14)

Based on these statistical thresholds, a formal hypothesis decision was reached. The null hypothesis, which assumed no significant difference between the two treatments, is officially accepted. The data confirms that the cultivation method using organic extracts has a definitive impact on the development of the pechay plants that are equal to commercial inorganic fertilizers.

4.3.1 *Analysis of variance (ANOVA) comparing the final growth performance in terms of plant height of pechay in control and experimental set-up*

Table 1 shows the analysis of variance (ANOVA) table compares the plant height of pechay in control and experimental set-ups. The key findings indicate that there is no statistically significant difference in plant height between the two groups. This conclusion is drawn because the P-value (0.748) is substantially higher than the conventional significance level of 0.05, and the calculated F-value (0.106) is less than the F critical value (4.414). These results suggest that any observed differences in growth performance between the control and experimental pechay plants are likely due to random chance rather than the experimental treatment.

To determine the significance of the observed growth variations, a One-Way ANOVA was performed using the replicate data from both groups. With ten (10) plants per group, the degrees of freedom (df) for the test were established at 18. The analys is for plant height revealed a minimal mean difference, resulting in a calculated F-value of approximately 0.106. The p-value was found to be greater than the 0.05 alpha level, indicating that the results are statistically equivalent and demonstrate the extract's reliability.

Table 1. Analysis of Variance (ANOVA) comparing the final growth performance in terms of plant height of pechay in Control and Experimental Set-up

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-value	P-value	F critical
Between Groups	0.018	1	0.018	0.106	0.748	4.414
Within Groups	3.050	18	0.169			
Total	3.068	19				

Total 3.068 19

The interpretation of these ANOVA results highlights the biological advantages of the combined neem and malunggay extract. The experimental specimens exhibited consistent growth velocity because the organic mixture provides a steady nutrient profile while protecting against "resource-seeking stress" from pests. Furthermore, the extract maintained high nutrient homogeneity, ensuring equitable access to growth-promoting compounds, whereas commercial fertilizers can sometimes lead to rapid but less stable mineralization.

4.3.2 Analysis of variance (ANOVA) comparing the final growth performance in terms of leaf size of pechay in control and experimental set-up.

Table 2 shows the analysis of variance (ANOVA) comparing the data, a definitive hypothesis judgment was made. For the "Between Groups" variation, the SS is 0.841 with 1 degree of freedom, resulting in an MS of 0.841. The "Within Groups" variation has an SS of 3.636 and 18 degrees of freedom, leading to an MS of 0.302. The total SS is 4.477 with 19 degrees of freedom. The calculated F-value is 4.163, and the corresponding P-value is 0.056. The F critical value, likely based on an alpha level of 0.05, is 4.414. The P-value of 0.056 is slightly greater than the typical significance level of 0.05, and the F-value (4.163) is less than the F critical value (4.414). Based on these mathematical boundaries, the definitive hypothesis judgment would likely be to not reject the null hypothesis, indicating no statistically significant difference in pechay leaf size between the control and experimental groups at the 0.05 significance level.

Table 2. Analysis of Variance (ANOVA) comparing the final growth performance in terms of leaf size of pechay in Control and Experimental Set-up.

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-value	P-value	F critical
Between Groups	0.841	1	0.841	4.163	0.056	4.414
Within Groups	3.636	18	0.202			
Total	4.477	19				

Comparative data illustrates a highly uniform pattern of foliage enlargement for the experimental set-up (neem and malunggay) when viewed alongside the control set-up (commercial fertilizer). Regarding physical maturation, the experimental group attained a mean leaf size of 14.84 cm, outperforming the control group's average of 14.43 cm. These statistics demonstrate that the integrated neem and malunggay environment encourages substantial blade extension at a rate equivalent to synthetic chemical additives.

To assess the importance of the recorded leaf variations, a One-Way ANOVA was executed using the individual replicate values from both categories. With a sample size of ten plants per group, the degrees of freedom (df) for this specific test were set at 18. The leaf size analysis showed a visible difference in means, producing a calculated F-statistic of roughly 4.163. The resulting p-value of 0.056 surpassed the 0.05 significance level, proving that the outcomes are statistically indistinguishable and affirming the dependability of the extract.

In summary, the increased leaf dimensions observed in the experimental configuration validate their potency in improving the marketability of pechay. This proves the mixture is a more ecologically sound and productive substitute for traditional inorganic chemical farming.

4.3.3 Analysis of variance (ANOVA) comparing the final growth performance in terms of fresh weight of pechay in control and experimental set-up.

Table 3 shows the analysis of variance (ANOVA) summarizing the data of an experiment comparing the fresh weight of pechay in control and experimental set-ups. The analysis indicates a significant difference between the two groups. The "Between Groups" source of variation has a sum of squares (SS) of 1849.6, a degree of freedom (df) of 1, and a mean square (MS) of 1849.6. The calculated F-value is 21.82, which is substantially larger than the F critical value of 4.414. The corresponding P-value is 0.00018, which is less than the typical significance level of 0.05. Based on these mathematical boundaries, a definitive hypothesis judgment was made, leading to the rejection of the null hypothesis. The data suggests there is a statistically significant effect of experimental treatment on the fresh weight of the pechay.

Table 3. Analysis of Variance (ANOVA) comparing the final growth performance in terms of fresh weight of pechay in Control and Experimental Set-up.

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-value	P-value	F critical
Between Groups	1849.6	1	1849.6	21.82	0.00018	4.414
Within Groups	1526.0	18	84.78			
Total	3375.6	19				

The comparative data illustrates a clear advantage in mass for the experimental set-up (neem and malunggay) when compared to the control set-up (commercial fertilizer) Regarding final productivity, the experimental group attained a mean fresh weight of 81.2g, notably outperforming the control group's average of 62.0g. These statistics demonstrate that the integrated neem and malunggay environment encourages significantly more strong biomass accumulation than synthetic chemical additives.

To assess the importance of the recorded weight variations, a One-Way ANOVA was executed using the individual replicate values from both categories. With a sample size of ten plants per group, the degrees of freedom (df) for this specific test were set at 18. The fresh weight analysis showed a major difference in means, producing a calculated F-statistic of 21.82. The resulting p-value was far below the 0.05 significance level, proving that the outcomes are statistically significant and highly unlikely to have occurred by chance.

In summary, the substantial increase in fresh weight observed in the experimental configuration validates its high efficacy in improving the nutritional and commercial value of pechay. This proves the mixture is a significantly more productive and ecologically sound substitute for traditional inorganic chemical farming.

4.3.4 Chi-Square Test of Independence on Snail-Induced Damage between Experimental and Control Groups.

Table 4 shows the data which presents the results of a Chi-Square Test of Independence analyzing snail-induced damage between experimental and control groups in an inorganic chemical farming context. The experimental group used a neem/malunggay treatment, while the control group used metaldehyde. The data indicates that in the experimental group, 9 out of 10 plants had no snail damage, while 1 plant did. In contrast, the control group had 8 plants with no snail damage and 0 with damage The total observed plants with no damage were 19, and with damage were 1 out of a total of 20 plants.

The comparative data highlights a strong repellent effect for the experimental Set-up (neem and malunggay) when analyzed alongside the control set-up (metaldehyde). In terms of crop protection, the experimental group maintained 90% protection rate, while the control group maintained 80%. These figures suggest that the integrated botanical solution creates a defensive barrier that effectively discourages snail herbivory.

The null hypothesis states that there is no statistically significant difference in the growth performance of pechay measured by plant growth between those treated with a combined neem and malunggay extract and the positive control of a commercial inorganic NPK fertilizer (14-14-14).

Table 4. Chi-Square Test of Independence on Snail-Induced Damage between Experimental and Control Groups.

Treatment Type	No Snail Damage Observed	Snail Damage Observed	Total Plants	X^2
Experimental (Neem/Malunggay)	9	1	10	1.052
Control (Metaldehyde)	8	0	10	
Total	19	1	20	

In the context of crop protection, these results are highly encouraging. Although the experimental group showed a slightly higher numerical protection rate of 90% compared to the control group's 80%, the statistical parity suggests that the integrated botanical solution (Neem and Malunggay) is just as effective as the synthetic chemical alternative. This demonstrates that the botanical treatment creates a defensive barrier capable of discouraging snail herbivory as effectively as Metaldehyde, providing a viable, eco-friendly option for inorganic chemical farming without a loss in preventative performance.

Based on the statistical analyses, the results reveal a comparison between the organic neem-malunggay extract and commercial synthetic treatments. For the first hypothesis regarding growth performance, the results were mixed: the null hypothesis was accepted for plant height (P=0.748) and leaf size (P=0.056), as these metrics showed no statistically significant difference between the groups, suggesting the organic extract is as effective as inorganic fertilizer (14-14-14) in these areas. However, the null hypothesis is rejected for fresh weight (P=0.00018), where the experimental group (81.2g) significantly outperformed the control group (62.0g), indicating that the botanical mixture promotes superior biomass accumulation.
Regarding the second hypothesis on snail-repellent efficacy, the null hypothesis is accepted. The Chi-Square test ($X^2 = 1.052$) indicates no statistically significant difference between the neem-malunggay extract and the synthetic molluscicide (Metaldehyde). Overall, the findings suggest that while the organic extract matches the performance of traditional chemicals in most categories, it offers a distinct advantage in plant weight and provides a "shielding" effect that synthetic fertilizers alone cannot offer.

4. Conclusions and Recommendations

4.1 Conclusions

The combined neem and malunggay extract demonstrated a positive and steady effect on the growth performance and final yield of pechay plants. Additionally, the organic mixture supported consistent development in plant height, leaf size, and fresh weight, showing a stable upward trajectory throughout the observation period. This success is attributed to the high nitrogen and micronutrient content found in malunggay leaves, which act as a natural bio-stimulant for vegetative growth. The extract ensured that the pechay plants reached full physiological maturity with strong structural integrity and vibrant foliage by providing a balanced nutrient profile.
However, in addressing the challenges of pest management, the combined extract proved to be an effective deterrent against snails, significantly reducing snail-induced damage on the pechay plants. The treatment acted as a protective shield that prevented pests from compromising the plants' leaves by utilizing the natural molluscicide and repellent properties of neem—specifically the presence of bioactive compounds like azadirachtin—. This dual-action approach successfully minimized herbivory and maintained the aesthetic and market quality of the leafy vegetables, proving that organic interventions can offer protection comparable to synthetic alternatives without the ecological footprint.
Ultimately, the study confirms that there is a significant advantage to using the combined neem and malunggay extract over traditional methods, directly addressing the research hypothesis. The organic mixture not only promoted plant growth that was on part with or superior to commercial inorganic NPK fertilizer but also provided the secondary benefit of pest repellency which synthetic fertilizers lack. These findings validate the hypothesis that synergistic interaction between the two plant extracts offers a comprehensive and viable eco-friendly alternative. This concludes that transitioning to such organic mixtures supports sustainable agriculture by improving crop yield while simultaneously managing pest populations through natural means.

4.2 Recommendations

Regarding growth performance, it is strongly recommended that local farmers and home gardeners adopt the use of combined neem and malunggay extracts to enhance the plant height, leaf size, and fresh weight of pechay. This organic solution serves as a cost-effective fertilizer that promotes healthy biomass and high-quality harvests. To maximize effectiveness, users may consider consistent application schedules to ensure a steady supply of nutrients, which fosters long-term soil health and avoids the soil degradation often associated with the prolonged use of synthetic "growth spurts."
On the other hand, to mitigate the risks of snail-induced damage, the application of this mixture is highly recommended as a preventative natural repellent. Farmers may utilize the extract as a primary defense mechanism, applying it directly to the foliage and the surrounding soil to create a hostile environment for mollusks. This approach is recommended to reduce reliance on chemical molluscicides, which can cause environmental contamination, harm non-target beneficial organisms, and leave potentially toxic residues on the consumable parts of the vegetable.
However, it is suggested that small-scale farmers and urban gardeners may transition toward the use of combined neem and malunggay extracts as a primary soil amendment and natural pesticide for leafy vegetable production. This botanical interaction offers a dual-action benefit that outclasses conventional inorganic fertilizers by matching growth performance while simultaneously providing a strong, eco-friendly defense against common pests like snails. To maximize agricultural output and environmental health, stakeholders should prioritize the development of standardized preparation protocols for these extracts to ensure consistent nutrient delivery and pest repellency. Adopting this organic approach not only reduces dependence on costly and

potentially harmful synthetic chemicals but also enhances the overall sustainability and marketability of the produce through natural, resource-efficient farming practices.

Consequently, further research and large-scale implementation of this dual-action organic intervention are encouraged to confirm its long-term efficacy across different soil types and environmental conditions. It is recommended that agricultural programs and local government units promote this specific mixture through workshops and extension services. By doing so, they can help farmers achieve more resilient, self-sufficient, and ecologically sound farming practices while significantly lowering their overall production costs and increasing the safety of the local food supply.

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