

Comparative Analysis of Organic and Synthetic Root Hormones in the Propagation of Hyacinth Bean Ornamental Plants

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Abstract

This study examined the comparative effectiveness of organic and synthetic rooting hormones, specifically Aloe vera and Alpha Naphthalene Acetic Acid (ANAA), on the growth performance of hyacinth bean ornamental plants in Barangay La Libertad. Grounded in Plant Hormone Theory, the study utilized a quantitative experimental design employing a Randomized Complete Block Design with three groups: organic treatment, synthetic treatment, and control, each consisting of 15 replicates. Data were collected over a nine-week period using growth parameters including plant height, root length, number of root branches, number of leaves, leaf length, and number of fruits, and were analyzed using mean, Kruskal-Wallis test, and pairwise comparison. Results showed that both treatments significantly improved plant growth compared to the control. Aloe vera was more effective in enhancing root development, particularly root length and branching, while ANAA produced better results in above-ground growth such as plant height, leaf production, and fruit yield. Significant differences were observed in plant height, leaf length, and fruit number, while no significant differences were found in root length, root branching, and number of leaves between treatments. The study concluded that both organic and synthetic rooting hormones are effective, with their advantages varying depending on specific growth parameters. It is recommended that growers select hormone types based on desired plant outcomes and that educational applications be integrated to enhance learning in plant propagation. The study aligns with SDG 8 (Decent Work and Economic Growth), SDG 12 (Responsible Consumption and Production), and SDG 15 (Life on Land) by promoting efficient and sustainable horticultural practices. It contributes to environmental and agricultural sustainability by supporting the use of eco-friendly alternatives and providing practical, cost-effective solutions for plant propagation within local communities.

Keywords: Aloe Vera, Alpha Naphthalene Acetic Acid, Hyacinth Bean Ornamental Plants, Plant Growth Parameters, Plant Propagation, Rooting Hormones

1. Introduction

This study examines the comparative effectiveness of organic and synthetic rooting hormones Aloe vera and Alpha Naphthalene Acetic Acid (ANAA) on the growth performance of hyacinth bean ornamental plants in Barangay La Libertad. It focuses on key growth parameters to determine sustainable and efficient plant propagation methods while addressing gaps in tropical horticultural research.

1.1 Background of the Study on Rooting Hormones and Growth of Hyacinth Bean Ornamental Plants

Ornamental plants contribute significantly to aesthetics, cultural identity, and economic development in the horticultural industry (Francini et al., 2022; Altman et al., 2022). The floriculture sector generates substantial employment and revenue globally (Faust & Dole, 2021) and continues to expand in countries such as China, the United States, and the Netherlands (Devrani et al., 2023; Gabellini & Scaramuzzi, 2022; Titisari, 2025). Plant propagation techniques, particularly the use of rooting hormones, play a crucial role in enhancing plant growth and survival. Aloe vera contains natural auxins that stimulate root and shoot development, while Alpha Naphthalene Acetic Acid (ANAA) is widely used as an effective synthetic rooting hormone (Singh et al., 2024; El-Rokiek et al., 2024; Husen, 2022; Cosep et al., 2024). Both are recognized for improving propagation outcomes (Kisvarga et al., 2022; Aryan et al., 2023). Growth indicators such as plant height, root length, root branching, and leaf development are essential in assessing plant health and performance (Husen, 2022; Hu et al., 2022). These parameters influence physiological processes including photosynthesis and nutrient absorption (Xia et al., 2021; Freschet et al., 2021), making them reliable measures of propagation effectiveness (El Amrani, 2023; Trivellini et al., 2023).

1.2 Themes and Insights from Related Literature on Organic and Synthetic Rooting Hormones

Both organic and synthetic rooting hormones enhance plant growth and development (Tambong, 2024; Kralova & Jampilek, 2021). Studies show that these hormones improve root formation, plant height, and leaf production (Gupta et al.,

2023; Chaudhary, 2022). Organic alternatives, such as Aloe vera, are increasingly recognized for their sustainability and environmental benefits, while synthetic hormones like ANAA are valued for their efficiency and consistency. However, existing literature emphasizes the need for comparative studies to determine the most effective and sustainable option (Hussain et al., 2022; Morey & Peebles, 2022). Research also highlights the role of natural rooting agents in promoting plant growth while supporting environmentally friendly horticultural practices (Panday et al., 2024; Mehrotra, 2025).

1.3 Local, National, and Global Context of Ornamental Plant Propagation Practices

Globally, the floriculture industry continues to expand, emphasizing improved propagation techniques to meet increasing demand (Devrani et al., 2023; Gabellini & Scaramuzzi, 2022; Titisari, 2025). In the Philippines, the ornamental plant industry contributes to local economic growth and agricultural development (Ismail et al., 2021). Local growers are increasingly adopting sustainable practices aligned with global trends (Gomez Jr. et al., 2023). Studies in Laguna and Davao indicate that organic rooting hormones, including Aloe vera, can be as effective as synthetic options while offering environmental advantages (Piñon et al., 2024; Reodica et al., 2022; Aquino & Poliquit, 2021). Despite these developments, challenges remain in achieving consistent propagation results across plant species, particularly in tropical contexts (Kabir et al., 2023; Leotta et al., 2023; Francini et al., 2021).

1.4 Theoretical or Conceptual Basis: Plant Hormone Theory in Hyacinth Bean Propagation

This study is grounded in Plant Hormone Theory, which explains that plant hormones regulate growth, development, and physiological responses (Edelmann, 2022; Yetgin et al., 2025). These hormones influence cellular processes such as differentiation and environmental adaptation, thereby affecting plant height, root development, and leaf production (Ali et al., 2024). Aloe vera contains natural auxins that enhance root formation, while ANAA functions as a synthetic auxin that promotes rooting success (Ahmed et al., 2023; Husen, 2022). The study framework considers rooting hormone treatments (Aloe vera, ANAA, and control) as independent variables influencing growth parameters such as plant height, root length, root branching, leaf count, leaf length, and fruit production. These relationships provide a basis for evaluating propagation effectiveness and developing educational laboratory applications.

1.5 Research Gaps and Rationale in Comparing Aloe Vera and ANAA for Hyacinth Bean Plants

Although both organic and synthetic hormones are effective, limited studies directly compare their performance under tropical conditions (Kabir et al., 2023; Leotta et al., 2023; Francini et al., 2021). Existing research also lacks focus on bean-type ornamental plants such as the hyacinth bean. This study addresses these gaps by conducting a comparative analysis of Aloe vera and ANAA in a localized setting. It aims to determine which rooting hormone provides more effective and sustainable results for ornamental plant propagation.

1.6 Alignment with Relevant Sustainable Development Goals (SDGs)

This study aligns with key Sustainable Development Goals (SDGs), particularly SDG 8 – Decent Work and Economic Growth, as the ornamental plant industry contributes to employment generation and economic development (Faust & Dole, 2021). It also supports SDG 12 – Responsible Consumption and Production by promoting the use of organic and sustainable plant propagation methods that reduce reliance on synthetic inputs (Mahesh et al., 2025; Panday et al., 2024). Furthermore, the study contributes to SDG 15 – Life on Land by encouraging environmentally sustainable horticultural practices that enhance plant growth while supporting ecological balance. Through the comparative analysis of Aloe vera and ANAA, the study promotes sustainable resource use and environmentally responsible approaches in ornamental plant propagation.

1.7 Importance of the Study to Multidisciplinary Sustainability in Horticulture and Education

This study contributes to environmental sustainability by exploring eco-friendly alternatives to synthetic chemicals. It supports agricultural and economic sustainability by identifying cost-effective and practical propagation methods for growers. It also advances educational sustainability by providing a basis for laboratory activities that enhance students' understanding of plant propagation and hormone functions. Furthermore, the findings promote community sustainability by offering locally applicable solutions for plant growers in Barangay La Libertad. Overall, the study integrates scientific, environmental, and educational perspectives to support sustainable horticultural practices and informed decision-making.

2. Material and methods

2.1 Research Design

This study utilized a quantitative experimental design using a Randomized Complete Block Design (RCBD) to compare the effectiveness of Aloe vera (organic) and Alpha Naphthalene Acetic Acid (ANAA) (synthetic) rooting hormones. Three groups were established: two treatment groups receiving Aloe vera (T1) and ANAA (T2), and a control group (T0) with no hormone application. Each group consisted of 15 replicates under uniform environmental conditions. The plants were randomly assigned based on uniform size, genetic origin, and absence of pests or diseases. Spacing was maintained at 90 centimeters between columns and 30 centimeters within blocks, with trellises provided for support. Growth parameters

were monitored over a nine-week period. The design enabled the establishment of cause-and-effect relationships between rooting hormone treatments and plant growth indicators.

2.2 Locale of the Study

The study was conducted in Barangay La Libertad, Kapatagan, Lanao del Norte, an area characterized by active agricultural practices and a tropical climate suitable for ornamental plant cultivation. The location supports year-round plant growth and aligns with local interests in sustainable farming practices. As illustrated in Figure 2, the study site provides an environment conducive to evaluating plant propagation under realistic community conditions.

2.3 Respondents of the Study

The study involved hyacinth bean ornamental plants as experimental subjects. These plants served as the primary units of analysis in assessing the effectiveness of different rooting hormone treatments.

2.4 Sample and Sampling Procedure

A total of 45 hyacinth bean seedlings were used, with 15 plants assigned to each group. The samples were selected based on uniformity in size, genetic consistency, and absence of disease or pests. Random allocation was applied to ensure unbiased distribution across treatment and control groups.

2.5 Research Instrument

The study utilized Aloe vera extract as the organic rooting hormone and ANAA as the synthetic rooting hormone. Various materials, including knives, spoons, cheesecloth, bowls, measuring tools, stirrers, containers, soil, plant boxes, notebooks, and measuring devices such as rulers or calipers, were used to prepare treatments and measure plant growth parameters.

2.6 Data Gathering Procedure

The data gathering procedures were adapted from Chen et al. (2023), with modifications to accommodate seed-based propagation instead of cuttings. The experiment was conducted from September to November 2025. During the pre-experimental phase, permission was secured from the research chairman at Saint Columban College, and materials were prepared. Hyacinth bean seeds were sown at a depth of 2–3 centimeters and maintained under controlled conditions with adequate moisture and sunlight for 10 days until seedlings developed. The organic rooting hormone was prepared by extracting Aloe vera gel, blending it with distilled water in a 1:1 ratio, straining the mixture, and storing it appropriately. The synthetic hormone was prepared by dissolving ANAA powder in distilled water under controlled conditions and storing it in a labeled container. In the experimental phase, seedlings in the treatment groups were soaked in their respective hormone solutions for 30 minutes prior to transplanting, while the control group received no treatment. Growth parameters including plant height, root length, number of root branches, number of leaves, leaf length, and number of fruits were measured and recorded over a nine-week period using standard measuring tools and manual counting. In the post-experimental phase, collected data were compiled and analyzed to determine the effectiveness of each treatment. Additionally, a laboratory activity aligned with the Department of Education (DepEd) K to 12 program was developed based on the study results to enhance student learning in plant biology.

2.7 Data Analysis Techniques

Data were analyzed using mean to determine average values of plant growth parameters. The Kruskal-Wallis test and pairwise comparison were applied to assess significant differences among treatment groups in terms of plant height, root length, number of root branches, number of leaves, leaf length, and number of fruits.

2.8 Ethical Considerations

Ethical standards were maintained throughout the study to ensure environmental responsibility and research integrity. The use of ANAA was controlled to minimize ecological impact, while Aloe vera was promoted as an environmentally friendly alternative. Proper waste management practices were followed to prevent contamination. The welfare of the plants was prioritized by selecting healthy specimens, providing appropriate support, and maintaining optimal growth conditions. Transparency and integrity were upheld through accurate data recording and appropriate statistical analysis. Compliance with institutional and local regulations was ensured by securing approval from the research chairman and adhering to established research guidelines.

3. Results and Discussion

3.1 Growth and Yield Performance of Hyacinth Bean Ornamental Plants Under Rooting Hormone Treatments

3.1.1 Plant Height Development Across Treatments

Plant height increased consistently across all treatments over the nine-week period. Plants treated with synthetic ANAA (T2) attained the highest average height of 114.35 cm, followed by Aloe vera (T1) at 106.51 cm, while the control group (T0) had the lowest average height of 81.64 cm. These results indicate that both organic and synthetic rooting hormones

enhance vertical growth, with synthetic ANAA showing greater effectiveness in later growth stages. This supports findings by Husen (2022), which reported that ANAA promotes plant height and overall health. Similarly, Singh et al. (2024) noted that Aloe vera improves plant height through natural auxins, while Cosep et al. (2024) highlighted the role of synthetic hormones in enhancing plant growth and resistance to environmental stress.

3.1.2 Root Length Development Across Treatments

Root length increased over time in all groups, with Aloe vera (T1) producing the longest average root length at 15.28 cm, followed by ANAA (T2) at 13.44 cm and the control (T0) at 13.33 cm. This suggests that organic rooting hormones are more effective in promoting root elongation and developing stronger root systems. The findings align with Chandel et al. (2025), who reported that Aloe vera enhances nutrient absorption and root growth. Similarly, Zhang et al. (2022) found that organic hormones improve root development and increase plant resilience under environmental stress conditions.

3.1.3 Root Branching Performance Across Treatments

The number of root branches increased across all treatments, with Aloe vera (T1) showing the highest average at 20.90, followed by ANAA (T2) at 18.34 and the control (T0) at 18.10. These findings indicate that organic rooting hormones enhance root branching, which improves water and nutrient absorption. This is supported by Ei et al. (2025), who reported increased root cell division with Aloe vera application, and Huang et al. (2024), who emphasized that improved root branching enhances plant adaptability to varying soil and moisture conditions.

3.1.4 Leaf Production Across Treatments

Leaf production was highest in plants treated with ANAA (T2), with an average of 43.21 leaves, followed by Aloe vera (T1) at 38.70 and the control (T0) at 34.40. This indicates that synthetic rooting hormones are more effective in stimulating foliage development. Islam & Mohammad (2022) explained that ANAA enhances cell division and chlorophyll production, leading to increased leaf growth. Meanwhile, Kurepa & Smalle (2022) noted that organic treatments improve leaf quality, supporting overall plant health.

3.1.5 Leaf Length Development Across Treatments

Leaf length was greatest in ANAA-treated plants (T2) with an average of 9.17 cm, followed closely by Aloe vera (T1) at 8.99 cm, while the control group (T0) recorded the shortest leaves at 7.20 cm. This suggests that both organic and synthetic hormones enhance leaf size, with synthetic hormones providing a slight advantage. Aguirre-Becerra et al. (2024) reported that synthetic hormones promote leaf elongation through increased cell expansion, while Jaramillo et al. (2025) highlighted the role of Aloe vera in enhancing nutrient uptake. Singh et al. (2024) further emphasized the sustainability benefits of organic treatments despite minor differences in growth outcomes.

3.1.6 Fruit Production Across Treatments

Fruit production was highest in ANAA-treated plants (T2) with an average of 16.37 fruits, followed by Aloe vera (T1) at 12.68 and the control (T0) at 6.32. These findings indicate that rooting hormones significantly enhance reproductive performance, with synthetic hormones showing greater effectiveness. Shivandu et al. (2025) explained that synthetic auxins promote cell division in fruit tissues, while Banjare et al. (2023) reported improved nutrient transport and synchronized flowering, leading to increased yield.

3.1.7 Overall Growth and Yield Performance Comparison

Overall, both organic and synthetic treatments improved plant growth and yield compared to the control. Aloe vera demonstrated stronger effects on root development, while ANAA showed greater effectiveness in above-ground growth and fruit production. These results highlight complementary advantages between organic and synthetic hormones. Sosnowski et al. (2023) emphasized that synthetic auxins enhance photosynthesis and productivity, while Singh et al. (2024) noted that Aloe vera improves root growth and nutrient absorption, supporting sustainable horticultural practices.

3.2 Differences in Growth Parameters Among Treatments

3.2.1 Overall Statistical Differences Across Growth Parameters

Statistical analysis revealed significant differences in plant height, leaf length, and fruit number, while root length, root branching, and number of leaves showed no significant differences among treatments. This indicates that rooting hormones significantly influence above-ground growth and yield but have limited effects on certain root and structural traits. Similar findings were reported by Sosnowski et al. (2023) and Jaramillo et al. (2025), who observed improvements in plant height and fruit yield. In contrast, Jia et al. (2022) and Kalra et al. (2024) noted that root traits are more influenced by environmental and genetic factors.

3.2.2 Pairwise Differences in Plant Height

Both Aloe vera (T1) and ANAA (T2) treatments significantly outperformed the control group, while no significant difference was observed between the two treatments. This suggests that both hormone types are equally effective in

enhancing plant height compared to no treatment. Samsuzzamana et al. (2023) and El Sabagh et al. (2022) explained that plant growth traits are influenced by genetic and environmental factors, which may limit differences between hormone types.

3.2.3 Pairwise Differences in Leaf Length

Both Aloe vera (T1) and ANAA (T2) significantly improved leaf length compared to the control, with no significant difference between the two treatments. This indicates that both hormones provide similar effects on leaf elongation. Chandel et al. (2025) highlighted the nutrient-enhancing effects of Aloe vera, while Islam and Mohammad (2022) emphasized the role of synthetic hormones in promoting cellular processes and chlorophyll production.

3.2.4 Pairwise Differences in Fruit Production

Significant differences were observed among all treatments, with ANAA (T2) outperforming both Aloe vera (T1) and the control (T0). This confirms the superior effectiveness of synthetic hormones in enhancing fruit production. Shivandu et al. (2025) and Banjare et al. (2023) explained that synthetic hormones improve fruit development and yield consistency, while Aryan et al. (2023) noted that organic treatments support sustainability and fruit quality despite lower yields.

3.3 Educational Application and Implications of Findings

The study results were used to design a laboratory activity that allows students to observe the effects of organic and synthetic rooting hormones on plant growth. The activity involves treating seedlings with Aloe vera, ANAA, and no hormone, and monitoring growth parameters over time. These findings contribute to practical horticultural applications by providing growers with flexible options for plant propagation. They demonstrate that both organic and synthetic hormones can be effective depending on growth objectives, while also highlighting the sustainability advantages of organic alternatives and the productivity benefits of synthetic hormones.

4. Conclusion & Recommendations

The study concluded that both organic and synthetic rooting hormones effectively support the growth of hyacinth bean ornamental plants, although their effects vary depending on specific growth parameters. Organic rooting hormone demonstrated greater effectiveness in enhancing root development, particularly in increasing root length and number of root branches, while synthetic rooting hormone showed stronger influence on above-ground characteristics such as plant height, number of leaves, and fruit production. No significant difference was observed in leaf length, indicating similar effects of both treatments in promoting leaf elongation. Overall, the findings highlight that the application of rooting hormones improves plant growth and propagation, and that selecting appropriate treatments based on desired growth outcomes can optimize horticultural practices while supporting environmentally responsible approaches.

It is recommended that gardeners and plant growers select rooting hormones based on their specific plant growth objectives, utilizing organic options such as Aloe vera for improved root development and synthetic options such as ANAA for enhanced above-ground growth. Science teachers are encouraged to incorporate laboratory activities that allow students to explore the effects of different rooting hormones on plant growth, while community leaders and environmental organizations may promote sustainable gardening practices through educational programs. Future researchers may further investigate the long-term environmental impacts of both organic and synthetic rooting hormones, and students and gardening groups may apply these findings in practical settings to deepen their understanding of plant propagation.

The study was limited to the propagation of hyacinth bean ornamental plants within a specific location and timeframe, which may affect the generalizability of the findings to other plant species or environmental conditions. The evaluation was confined to selected growth parameters, and the experimental period covered only a short-term growth cycle, which may not fully capture long-term effects of rooting hormone application. Additionally, variations in environmental factors and inherent plant characteristics may have influenced certain growth outcomes, indicating the need for further studies under different conditions.

Compliance with ethical standards

The authors affirm that the study adhered to institutional and ethical standards, with necessary authorization obtained prior to its conduct and procedures carried out in a responsible and environmentally conscious manner using non-invasive methods. The authors declare no conflict of interest and confirm that no external funding was received, while acknowledging the support of the research chairman of graduate studies and the community involved in Barangay La Libertad, Kapatagan, Lanao del Norte. The authors further assume full responsibility for the accuracy, integrity, and originality of the work in accordance with academic and publication standards, ensuring that no identifying information was disclosed.

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