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Effectiveness of Biodegradable Wastes As An Organic Fertilizer Compared to Commercial Fertilizer on the Growth of Abelmoschus Esculentus (Okra)

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Abstract

This experimental study assessed the effectiveness of biodegradable wastes—specifically groundnut shells, powdered eggshells, and rice hulls—as organic fertilizer compared to commercial fertilizer (YaraMila) on the growth of Abelmoschus esculentus (okra). Four treatments were evaluated: Control (2.4 kg groundnut shell + 1.6 kg topsoil), Treatment 1 (2.4 kg groundnut shell, 100 g eggshell, 1.35 kg topsoil, 150 g rice hull), Treatment 2 (double concentration of T1), and Treatment 3 (8 g YaraMila + 4 kg topsoil). Parameters measured included plant length, number of branches, number of fruits, and fruit mass. Results showed that Treatment 3 produced the tallest plants, Treatment 1 yielded the highest number of fruits, and Treatment 2 produced the most branches and heaviest fruits. Significant differences were found in number of branches and fruit mass, but not in plant length and number of fruits. Post-hoc analysis confirmed that Treatment 2 significantly outperformed the Control Group in branching and fruit mass. The study concludes that biodegradable waste-based organic fertilizers, particularly at higher concentrations, can serve as effective and sustainable alternatives to synthetic fertilizers for enhancing okra growth and productivity.

Keywords: *biodegradable waste, organic fertilizer, commercial fertilizer, Abelmoschus esculentus, okra growth, groundnut shell, eggshell powder, rice hull, sustainable agriculture, YaraMila*

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Introduction

The growing need for sustainable agricultural practices has drawn attention to organic and environmentally friendly inputs, especially organic waste fertilizers. These are derived from materials like food scraps, agricultural residues, animal manure, and other animal wastes, offering a viable alternative to chemical fertilizers, which often contribute to environmental degradation and soil nutrient depletion. In addition, biodegradable waste fertilizers have gained prominence due to their ability to improve soil fertility, increase crop yields, and minimize carbon emissions associated with conventional farming. However, despite these potential benefits, the adoption and effectiveness of organic waste fertilizers remain underexplored in many agricultural sectors.

Fertilizers are substances added to soil to enhance plant growth and productivity by providing essential nutrients, thus addressing SDG 15 (Life on Land). They improve soil's natural fertility and restore nutrients depleted by previous crops. While both organic and inorganic fertilizers have been widely used to boost crop yield and quality, they differ significantly in composition and environmental impact.

For instance, organic fertilizers—derived from natural sources like animal manure, human waste, and plant matter—offer a more sustainable alternative to synthetic ones (Chew et al., 2019). These materials contain a complex blend of macronutrients and micronutrients essential for plant growth and development. In addition, they improve soil fertility, increase water retention, and promote microbial activity, leading to more resilient agricultural systems (Saudy et al., 2020; Abd-Elrahman et al., 2022).

Similarly, biodegradable wastes—such as rice hulls, groundnut shells, and powdered eggshells—can be converted into organic fertilizers that provide essential nutrients and improve soil structure and quality. As noted by Andeng (2018) in Civil and Environmental Research (as cited in Perez et al., 2024), soil is a vital natural resource with the ability to filter and absorb substances passing through it. Therefore, it is important to carefully manage what is deposited in soil to prevent long-term damage.

On the other hand, inorganic fertilizers are synthetically produced and contain specific ratios of macronutrients and micronutrients. Although effective in the short term, their excessive use can cause nutrient runoff, soil pollution, and environmental degradation (Vitousek et al., 2019). Moreover, a FAO (2023) report highlights growing reliance on inorganic fertilizers and raises concerns about their long-term sustainability.

To address these challenges, unlocking the potential of organic waste fertilizers is critical for sustainable farming, which aligns with SDG 2 (Zero Hunger) by aiming to end hunger and all forms of malnutrition by 2030. This goal shows that hunger, food insecurity, and malnutrition remain major global challenges affecting billions. To achieve it, coordinated efforts are needed to strengthen food systems, support small-scale farmers, improve diets, reduce food prices and waste, and build resilience against climate change and conflict.

For this reason, this study was proposed to evaluate the effectiveness of biodegradable waste as organic fertilizer. In particular, it assessed the impact of organic waste fertilizers—such

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as groundnut shells, eggshells, and rice hulls—on crop productivity in Abelmoschus esculentus (okra) compared to synthetic fertilizers.

Statement of the Problem

This study aimed to assess the effectiveness of biodegradable wastes as organic fertilizer compared to commercial fertilizers on the growth of Abelmoschus esculentus (Okra):

Specifically, it sought to answer the following questions:

1. What is the effectiveness of biodegradable wastes as an organic fertilizer when compared to commercial fertilizers on the growth of Abelmoschus esculentus (Okra)in terms of:
   1.1 Length of the plant at a certain period (cm)
   1.2 Number of branches
   1.3 Number of fruits and
   1.4 Mass of the fruits produce (g)
2. Is there a significant difference on the effectiveness of biodegradable wastes fertilizers when compared to commercial fertilizer?

METHODS AND PROCEDURES

Research Design

This study employed an experimental research design based on the variables stated in the objectives. The independent and dependent variable paradigm was used to assess the growth of *Abelmoschus esculentus* (okra) under different treatment mixtures of groundnut shell combined with powdered eggshell and rice hull, compared to YaraMila commercial fertilizer, as shown in the table in the next page

Table 1

Composition of the Different Treatments

Treatment	Mixtures
Control Group	(2.4 kilograms of groundnut shell and 1.4 kilograms of topsoil)
Treatment 1	2.4 kilograms groundnut shell,100 grams of powdered eggshell, 1.35 kilograms top Soil and 150grams rice hull
Treatment 2	4.8 kilograms groundnut shell, 200 grams of powdered eggshell, 2.7 kilograms top Soil and 300 grams rice hull
Treatment 3	8 grams of Yara Mila and 4 kg Top Soil

Data Analysis

The study employed the following statistical tests:

Mean and Standard Deviation for SOP 1 data analysis, and analysis of variance (ANOVA) for SOP 2 to assess treatment effects on Abelmoschus esculentus growth.

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Weighted means were calculated for the control group (2.4 kg groundnut shell + 1.6 kg topsoil) and all treatments: T1 (2.4 kg groundnut shell, 100 g eggshell, 1.35 kg topsoil, 150 g rice hull), T2 (double T1 concentration), and T3 (8 g Yara Mila + 4 kg topsoil).

1. Preparation of groundnut fertilizer
   The groundnut shells were washed and then dried at room temperature for at least 48 hours. To expedite the process, the shells were also sun-dried. Once completely dry, they were pulverized using a grinder.
2. Preparation of eggshell fertilizer
   The eggshells were thoroughly washed to remove the egg membrane. Subsequently, they were sun-dried for 48 to 72 hours. Once completely dry, they were crushed using a grinder.
3. Preparation of rice hull
   The rice hulls were carefully transported to prevent contamination and damage. After collection, any remaining debris—such as stones or twigs—was removed using a large sieve before they were completely dried under the sun.
4. Preparation of *Abelmoschus esculentus* (okra) seedlings
   To soften the seed coat and accelerate germination, the okra seeds were soaked in water. Afterward, they were planted approximately half an inch deep in seed trays. The trays were monitored daily for signs of germination and growth until the seedlings were ready to be transplanted into individual pots.
5. Preparation of fruiting pots at different treatment mixtures.
   A total of 24 seedlings of the smooth green variety of *Abelmoschus esculentus* (okra) were planted. Topsoil was collected from a 2 × 2 square meter area to a depth of 4–10 inches, then it was mixed with various organic and inorganic fertilizers at different concentrations. The control group consisted of 1.6 kg of topsoil and 2.4 kg of groundnut shell.
   The first treatment was prepared by mixing 2.4 kg of pulverized groundnut shells, 100 g of eggshells, 1.350 kg of topsoil, and 150 g of rice hull, while the second treatment was prepared by doubling the composition of Treatment 1, and the third treatment involved 8 g of YaraMila mixed with 4 kg of topsoil.
6. Transfer of Abelmoschus esculentus (okra) seedlings to its pot
   Before transplanting the seedlings, individual pots were prepared with a well-draining potting mix, and small holes were created at the center of each pot to allow water to pass through. The seedlings were transplanted at a depth of about 3 inches, ensuring that the root balls were securely covered with soil. After transplanting, the seedlings were watered thoroughly but not excessively. The pots were placed in a sunny location to provide adequate sunlight for optimal growth.
7. Harvesting of Abelmoschus esculentus
   Once flowers appeared and developed into fruits, harvesting was conducted weekly. The fruits were detached from the plants using scissors or by twisting them from the stem. The harvested fruits were measured according to the parameters outlined in the research problem.
   The experiment was conducted at the Cruz residence in Eusebio St., Balzain East, Tuguegarao City, Cagayan. Six seedlings were planted per treatment, resulting in a total of 24 seedlings for the three treatments and the control group. The plants were watered three times a week, early in the morning, throughout the 48–60-day experimental period.

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Below is the flow chart followed during the experiment:

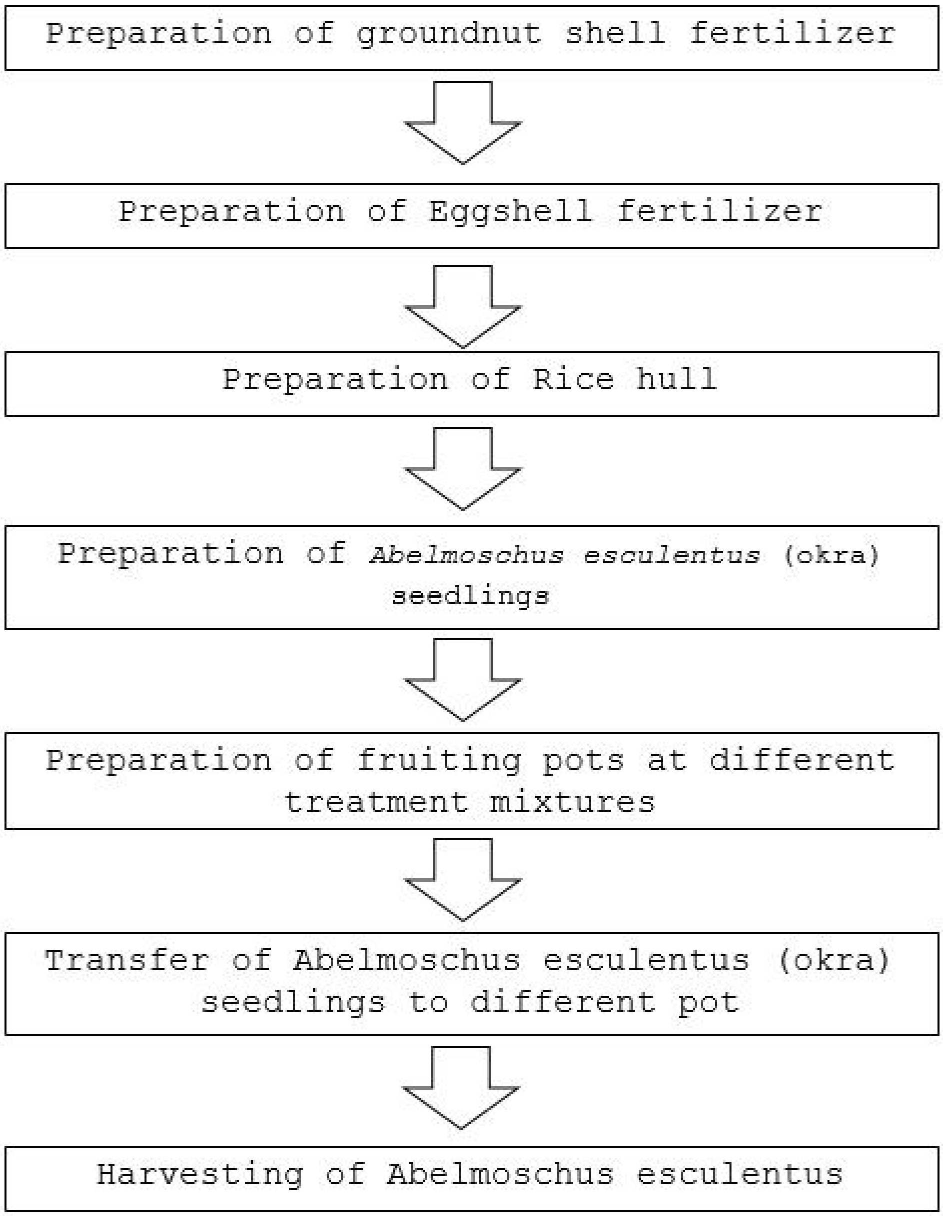

Figure 2. Flow chart of the Study

Data Analysis

The study employed the following statistical tests:

Mean and Standard Deviation for SOP 1 data analysis, and analysis of variance (ANOVA) for SOP 2 to assess treatment effects on *Abelmoschus esculentus* growth.

Weighted means were calculated for the control group (2.4 kg groundnut shell + 1.6 kg topsoil) and all treatments: T1 (2.4 kg groundnut shell, 100 g eggshell, 1.35 kg topsoil, 150 g rice hull), T2 (double T1 concentration), and T3 (8 g Yara Mila + 4 kg topsoil).

Summary of Findings

Based on the results of the analysis of the data, the following were derived:

1. Effect of the different concentration on the growth of *Abelmoschus esculentus*(okra)
   - In terms of Plant Length, Treatment 3 (YaraMila) produced the tallest okra plants. In terms of Number of Branches, Treatment 2 (highest organic concentration) yielded the most branches.
   - In terms of Number of Fruits, Treatment 1 produced the highest fruit count.
   - In terms of Mass of Fruit, Treatment 2 achieved the heaviest weight. 2.Correlation on the effectiveness of biodegradable wastes fertilizers when compared to commercial fertilizer
   - There is a significant difference in the number of branches and fruit mass.
   - There is no significant differences found in plant length fruit and number of fruit.
   - Post-hoc tests showed Treatment 2 significantly outperformed the Control Group in branches.
   - For fruit mass, Treatment 2 produced significantly heavier fruits than Treatment 1 Treatment 3, and the Control Group.

Conclusion

Based on the findings derived from the study, the researchers conclude that biodegradable wastes, rice hulls, eggshells, and groundnut shells used as organic fertilizers positively influenced okra growth. While both organic and inorganic treatments affected plant development, the organic formulations performed best in enhancing branching, fruit production, and fruit mass. Treatment 3 (Yara Mila) produced the tallest plants, Treatment 1 yielded the most fruits, and Treatment 2 with the highest organic concentration significantly increased branching and fruit mass. Significant differences were confirmed for branch number and fruit mass.

Overall, the findings demonstrate that organic fertilizers derived from biodegradable wastes can serve as sustainable and eco-friendly alternatives to synthetic fertilizers for improving okra growth and productivity.

Recommendations

The study's findings and conclusions lead to the following recommendations:

1. Agricultural waste, specifically groundnut shells, can be effectively used as an alternative fertilizer to enhance the growth and yield of *Abelmoschus esculentus*, offering a viable method to reduce environmental pollution.

2. Groundnut shells are recommended as an alternative fertilizer due to their high nitrogen, phosphorus, and potassium (NPK) content.
3. Conduct soil analysis to assess material suitability before any experiment testing raw materials as fertilizers.
4. Decompose groundnut shells before planting for better growth and yield. Pulverize shells finely to speed decomposition, and keep crushed shells moist to accelerate the process.
5. Plant seeds directly in pots to avoid root disturbance. Water early in the morning three times a week, ensuring moisture reaches 2–3 inches deep. Avoid overwatering and afternoon watering to prevent root rot and thermal shock.
6. Compare Treatment 2's effectiveness with other synthetic fertilizers (e.g., 14-14-14 and urea). Test combinations with synthetic fertilizers to evaluate potential improvements.
7. Increase the concentration of biodegradable waste used.
8. Include number of leaves, fruit length, and branch length as key assessment parameters.
9. Future researchers should determine the optimal concentration and application frequency of biodegradable waste–based nanoparticles to maximize plant growth while avoiding phytotoxic effects.
10. Future researchers should evaluate Treatment 2's effectiveness on other plant species to assess broader applicability for growth enhancement.

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