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Comparative analysis of decomposition rates and organic matter inputs from diverse plant species

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Abstract

This study evaluated the decomposition rates and nutrient dynamics of four abundant plant by-products: corn stover, sugarcane bagasse, rice straw, and pineapple crown as organic amendments for soil improvement and sustainable agriculture. It was conducted in a nursery setting. The decomposition rates were measured at 30 and 60 days via weight loss, while soil nutrient parameters, including pH, total nitrogen (N), phosphorus (P), potassium (K), and organic matter, were analyzed. Significant differences showed in the result of decomposition rates among materials: rice straw and pineapple crown decomposed fastest, followed by corn stover, while sugarcane bagasse decomposed slowest. Soil pH generally decreased, and sugarcane bagasse buffered soil acidity better than other residues. The nitrogen levels decreased significantly over a period of time, indicating microbial immobilization during breakdown. Potassium and phosphorus were relatively stable, with the highest amount derived from sugarcane bagasse. Over time, organic matter retention marginally improved, especially with treatments using sugarcane bagasse and pineapple crown. Significant effects of the type of organic material on soil pH and decomposition were confirmed by ANOVA with some interaction effects over time. Results show that while sugarcane bagasse is beneficial for balancing soil pH and retaining vital nutrients despite slower decomposition, rice straw and pineapple crown are appropriate for rapid nitrogen release to improve soil fertility. As a means to lessen dependency on synthetic fertilizers and support sustainable agriculture in the region, this study offers a better understanding of the best way to determine suitable plant-based organic amendments.

Keywords: Decomposition rate; Nutrient dynamics; Organic amendments; Plant by-products; Soil improvement

1. Introduction

The widespread use of synthetic fertilizers in crop production has raised concerns about possible adverse effects on human health and environmental degradation. Despite successfully increasing crop yields, synthetic fertilizers have created significant concerns about their environmental impact, including soil erosion, greenhouse gas emissions, and water contamination. This approach may lead to several issues, including soil acidification, ecological deterioration, and health impacts (P. Kopittke et al., 2019). The excessive utilization of synthetic fertilizers and pesticides has compromised human health and the environment. Consequently, the most significant concern for humanity is the growing deterioration of environmental aspects. The excessive usage of chemical fertilizers has resulted in several interconnected issues, including pollution of the environment, water, and soil (Hiren Das et al., 2023). Residues of synthetic fertilizers can remain on crops, potentially leading to human consumption and associated health risks (Om Prakash et al., 2019). Excessive use of nitrogen-rich fertilizers can contaminate groundwater with nitrates, causing health problems (N. Kazakis et al., 2020). Synthetic fertilizer runoff into water bodies can degrade the ecosystem by causing eutrophication, a condition in which an abundance of nutrients results in algae blooms that lower oxygen levels and endanger aquatic life (US EPA, 2024). Application of fertilizers over time can impact plant growth, lower soil fertility, and lead to soil acidity. Greenhouse gases like nitrous oxide are released during the production and usage of

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synthetic fertilizers, which contributes to climate change. Finding environmentally acceptable and sustainable alternatives is imperative to increase soil health and lessen reliance on synthetic inputs. Organic enhancements made from plant waste are an effective way to address these issues. By using organic enhancements, farmers could reduce the application of hazardous chemical fertilizers to the environment and the cost of fertilizer purchases. These materials can create healthier and more productive soils by improving water retention, nutrient availability, and soil structure.

For many years, much discussion has been about the growing use of pesticides and fertilizers in agriculture. These chemical compounds affect people negatively, even though they aim to protect crops from illnesses and promote their growth. Chemical fertilizers and pesticides have recently caused several environmental and water pollution issues. The primary sources of exposure to these chemicals are food, water, and the environment, which all indirectly or directly affect human health (N. Dhankhar et al., 2023).

The deterioration of soil fertility is a major constraint to agricultural production and food security, and most of the population relies on subsistence farming for livelihood. Unfortunately, synthetic fertilizer used as a significant soil nutrient replenishment is unsustainable, causing adverse environmental effects, including soil acidification and pollution of water bodies. Therefore, finding alternative, more sustainable, low-cost nutrient management systems is vital (J.K. Kabasiita et al., 2022).

Reusing and recycling agricultural waste has the potential to boost local economies, lowering the impact on the environment. The synergy between industries may be upgraded by recycling and reusing agricultural waste, considering farm or cooperative moving aspects have the potential to enhance output even as reducing the impact on the environment (Teresa Rodriguez-Espinosa et al., 2023). An innovative approach must emphasize lowering the use of fertilizers and identifying a potential natural solution (S. Kabalan et al., 2022). One potential solution would be to use plant waste as an alternative and a different way to obtain the soil's essential nutrients. The abundance of organic content in plant wastes can improve the soil's structure, ability to hold water, and availability of nutrients. They are also abundant in minerals crucial to plant growth, such as potassium, phosphorus, and nitrogen. Further research is necessary to identify potentially beneficial plant species, given that neem, guava, moringa, lantana, and Gliricidia sepium leaves have been the focus of numerous studies considering how different plant materials affect soil health, plant growth, and productivity. When underutilized or relatively abundant species are incorporated in the context of plant residue, the number of possible alternatives expands.

Decomposition rates play an important role in determining the effectiveness of organic amendments. The rate at which plant by-products decompose influences nutrient release timing and plant availability. Aeration, temperature, pH, moisture content, and organic matter composition are some parameters that affect the rate at which organic matter decomposes (R. Srinivasan et al.,2020). Another critical aspect of this research is nutrient analysis. Releasing nutrients from decomposing plant by-products can increase soil fertility while lowering the demand for artificial fertilizers (Tshikovhi N. et al., 2023). By analyzing the nutrient content of these by-products at different stages of decomposition, we can identify the optimal timing for their application and contribution to soil nutrient cycling.

The growing importance of creating sustainable fertilizer alternatives has an adverse impact. There is a pressing need to develop sustainable and environmentally friendly alternatives to improve soil health and reduce reliance on synthetic inputs. Organic amendments derived from plant and animal waste offer a promising solution to these challenges. These materials can enhance soil structure, improve water retention, and increase nutrient availability, leading to healthier and more productive soils. Microbial activity and nutrient availability are two characteristics of soil that are significantly impacted by organic amendments. Several organic supplements improved soil fertility by increasing microbial decomposition rates and nitrogen mineralization, according to (Vallejera et al., 2023). Similarly, (Baldock et al., 2021) emphasized that the composition of organic amendments affects their decomposition rates and subsequent nutrient release in soils. Corn, sugarcane, rice, and pineapple are the four levels of the categorical variable plant by-products.

Decomposition rate and nutrient analysis of diverse plants by-products used as soil amendments in plant cultivation could improve soil health, increase productivity and quality, and provide a better knowledge of sustainable agriculture. The research results could contribute to more profitable and sustainable plant development strategies, benefiting farmers, consumers, and the environment. Findings could be useful to farmers, researchers, consumers, and policymakers. It embraces the ability to facilitate the development of a more sustainable and productive agricultural sector that benefits individuals and the environment by improving soil health, promoting sustainable waste management, and increasing output.

This study aims to evaluate the decomposition rates and nutrient content of four diverse plant species: corn, sugarcane, rice, and pineapple plant by-products. These by-products were selected based on their availability, abundance, and potential for use as organic amendments. By understanding these materials' decomposition dynamics and nutrient release patterns, we can assess their suitability as sustainable alternatives to synthetic fertilizers. Corn (Zea mays) is a versatile crop with a high yield potential and a relatively rapid decomposition rate. Its by-products, such as stalks and leaves, are rich in organic matter and nutrients, including nitrogen, phosphorus, and potassium (BAR, 2024; Vejelis S., 2023). Corn stover can decompose in just as two to three months under optimal conditions, such as when added to a composter (PhycoTerra 2023). However, a 2019 study by Mahdi Al-Kaisi found that, under different tillage systems, 34–49% of the corn residue remained on the soil surface after 12 months, indicating that environmental factors have a significant impact on the breakdown process. Sugarcane (Saccharum officinarumis) is another high-yielding crop with much residual biomass. While its nutrient-rich composition can increase soil fertility, its fibrous texture can improve soil aeration and water retention (SRA 2024). According to Bhadha et al. (2020), sugarcane bagasse biodegrades in 60 to 90 days in an atmosphere, with temperature, moisture, and the diversity and population of microorganisms in the soil all impacting its rate of decomposition. Reusing these products would be beneficial, as sugarcane bagasse is a waste product. Incorporating rice straw can improve soil organic carbon (C) and recycle nutrients, lowering the amount of fertilizer needed for the next crop. Rice straw includes about 80, 40, and 30% potassium, nitrogen, and phosphorus (P. Chivenge et al., 2020). The first two months following burial in soils showed a higher rate of rice straw decomposition and nutrient release, which slowly decreased as the experiment's duration increased (X. Wang et al., 2022). Pineapple (Ananas comosus) pomace, peels, core, and crown compose the waste, which can potentially serve as a helpful bioresource (R.A. Abraham et al., 2023). Utilizing pineapple waste has been revealed in the study of (N F H Kamaruddin., et al. 2023) to improve the chemical composition of the soil in addition to plant growth. The total composting process takes around four months, according to Sossa et al. (2024), which implies that pineapple crowns can decompose efficiently in this period duration under optimum composting conditions. Both completely and partially biodegradable materials are used in a wide range of applications, which aligns with the present trend of replacing synthetic materials. A great source of raw material for producing products that are ecologically (Md Arif Mahmud et al., 2021).

These studies are being conducted to determine how these results affect the nutritional analysis and soil decomposition rate. The decomposition rate quantifies how plant waste breaks down in the soil. A set of quantitative variables known as nutrient analysis is used to evaluate the levels of different nutrients in the soil after plant waste has been applied. Factors including age, substance content, and nutrient composition affect the rate at which plant by-products decompose (Zhang et al., 2020). The decomposition rates of organic materials are determined by their biochemical composition, specifically their carbon-to-nitrogen (C/N) ratios. Zhao et al. (2019) state that lower C/N ratios promote microbial activity and nutrient release, while higher ratios often slow decomposition rates. This study will build on these findings by focusing on specific plant species and their by-products.

1.1. Objectives of the Study

To evaluate the decomposition rates and organic matter inputs such as corn stover, sugarcane bagasse, rice straw, and pineapple crown as potential organic amendments for soil improvement and sustainable agriculture.

Specifically, it aims to:

- To determine the decomposition rates (%) of corn stalks, sugarcane bagasse, rice straw, and pineapple crowns under a nursery setting.
- To analyze the following nutrient content dynamic of diverse plant species in 30 days and 60 days:
  - Soil pH
  - Total N
  - Total P
  - Total K
  - Organic matter
- To determine the significant difference among different plant species.

1.2. Significance of the Study

This study will contribute to sustainable agriculture and environmental conservation. Exploring various plant by-products' decomposition rates and nutrient content aims to provide valuable insights for farmers, policymakers, and researchers. This study could have a significant impact on the promotion of sustainable agriculture by reducing reliance on synthetic fertilizers, improving soil health, and increasing crop yields and their quality. It has environmental benefits through reducing pollution, carbon sequestration, and biodiversity conservation. Several economic advantages to this study could enhance market access as consumers increasingly demand sustainably produced food that can be converted into valuable products and cost-effective farming. By raising awareness of plant decomposition and detecting nutrient release patterns in plant by-products, findings can help researchers and policymakers develop sustainable agriculture practices and regulations.

This research has the potential to make significant contributions to the transformation of agricultural systems that are more resilient and sustainable. Exploring the potential benefits of using plant wastes as organic fertilizers can support conservation efforts, increase food security, and promote farming's profitability.

1.3. Scope and Limitations

The study aimed to investigate the potential of plant species as organic amendments for soil improvement and sustainable agriculture. It specifically focused on the decomposition rates and how quickly different plant by-products decompose in the soil. This also focused on the nutrient content and the decomposition of fresh and decomposed by-products.

The experiment was conducted in a nursery setting. The study focused on four (4) plant species (corn, sugarcane, rice, and pineapple by-products), which were investigated to identify the most suitable options for agricultural inputs. The study was conducted from December 2024 to February 2025, which did not capture the long-term effects of plant by-products on soil health and crop productivity. It was conducted on a specific soil type, which limited its generalization to different soil conditions. Evaluating nutrient content and decomposition rates overlooked other variables like crop variety, soil texture, and application rate that affected plant by-products' effectiveness. This provided a valuable foundation for recognizing the potential benefits of using plant waste as organic input for crop productivity.

2. Materials and Methods

2.1. Materials

The equipment and materials used in this study were thirty-two - 5-gallon round water dispensers (containers) of the same size, moisture meter, pH meter, weighing scale, 2 mm sieve screen wire (fine), nets, galvanized steel, grinder, and shredder machine.

The primary materials in this study were corn stover (Zea Mays), sugarcane bagasse (Saccharum officinarum), rice straw (Oryza Sativa L.), and pineapple crown (Ananas comosus) by-products. The supplies were the soil, loamy soil from local farms, ziplock plastic bags, sacks, gloves, protective gear, a shredder machine, and statistical software for data analysis.

2.2. Experimental Design and Treatments

The study was utilized Split Plot Design–CRD where time intervals of 30 days and 60 days serves as main plot and treatments with different plant species. The experiment was conducted in a nursery. The main plots consist of two time intervals: 30 days (Treatment A1) and 60 days (Treatment A2), which serve as the primary factors influencing the experiment. Each main plot was divided into sub-plots representing four different plant species: Corn Stover (Treatment B1), Sugarcane Bagasse (Treatment B2), Rice Straw (Treatment B3), and Pineapple Crown (Treatment B4) with a total of eight treatment combinations: A1B1 (30 days, Corn Stover), A1B2 (30 days, Sugarcane Bagasse), A1B3 (30 days, Rice Straw), A1B4 (30 days, Pineapple Crown), A2B1 (60 days, Corn Stover), A2B2 (60 days, Sugarcane Bagasse), A2B3 (60 days, Rice Straw), and A2B4 (60 days, Pineapple Crown). Each treatment combination was replicated four times across a total of 32 experimental units.

Factor A (Main Plot)

- 1 - 30 days collection
- 2 - 60 days collection

Factor B Different Plant Species (Sub-Plot)

- 1 – Corn Stover
- 2 – Sugarcane bagasse
- 3 – Rice straw
- 4 – Pineapple crown

30 Days				60 Days			
A1B1	A1B3	A1B2	A1B4	A2B1	A2B3	A2B2	A2B4
A1B3	A1B4	A1B1	A1B2	A2B3	A2B4	A2B1	A2B2
A1B2	A1B1	A1B3	A1B1	A2B2	A2B1	A2B3	A2B1
A1B4	A1B2	A1B4	A1B3	A2B4	A2B2	A2B4	A2B3

Legend:Treatment A1B1 - (30 days, Corn Stover); Treatment A1B2 - (30 days, Sugarcane Bagasse);Treatment A1B3 - (30 days, Rice Straw); Treatment A1B4 - (30 days, Pineapple Crown); Treatment A2B1 - (60 days, Corn Stover); Treatment A2B2 - (60 days, Sugarcane Bagasse);Treatment A2B3 - (60 days, Rice Straw); Treatment A2B4 - (60 days, Pineapple Crown)

Figure 1 Experimental Lay-out

2.3. Containers Preparation

Thirty-two - 5-gallon closed-top water dispensers (containers) were fully opened on the top using a grinder to ensure uniform cutting size. Four (4) drainage holes were formed at the bottom of all containers using an electric drill to prevent water logs or allow excess water to drain out.

2.4. Soil Preparation

The soil was gathered before the start of the study with loamy soil texture (garden soil), which was taken from agricultural sites. The topsoil, at most 10 cm deep, was taken. The soil was pulverized, air-dried, and sieved through a 2mm sieve screen wire to remove undecomposed materials. The soil samples were collected to analyze soil pH, N, P, K, and organic matter.

The study was needed a volume of 350 kilograms of soil, which was used for thirty-two (32) containers and initial soil analysis. The soil was placed in a container. Each container was filled with approximately 10 kilograms of soil.

2.5. Plant By-Products Collection and Process

The corn stover, sugarcane bagasse, rice straw, and pineapple crown were gathered from nearby farms or agricultural locations. Clean sacks were used to carry each sample of various plant by-products to the experimental area. Eight (8) kilograms of each plant by-product were collected, with a total of forty (32) kilograms. The samples were ensured to be representative of the respective plant materials. Each plant by-product was carefully sorted to remove any debris. All plant by-products were air-dried before starting the experiment. The corn stover, sugarcane bagasse, rice straw, and pineapple crown plant by-products were shredded separately using a shredder machine to ensure uniformity of sizes. After shredding, the corn stover, sugarcane bagasse, rice straw, and pineapple crown plant by-product were placed under the nursery shed before being buried in the soil.

Before placement, each weight was measured in kilo, which was considered the "initial weight. Approximately one (1) kilogram in each treatment was buried 2 inches below the surface of the soil. This was monitored throughout the experiment.

2.6. Nursery Shed and Field Layout

All containers were placed under the nursery located at Manapla, Negros Occidental. The nursery was installed using net, wood and galvanized steel. An area of 40 square meters, including alleyways, was utilized. The area was divided into 32 experimental units; each will have a dimension of 1x1 meter. The height of the shed was six (6) foot from the ground level.

2.7. Moisture Level

All samples were maintained at a level of 45% to 60 % moisture based on the optimal moisture content for composting (J. Willis et al., 2022). Random testing was done daily to determine the samples' moisture level. Moisture level was determined using a moisture meter. Watering was done if the moisture level is below 40%.

Water was added to the samples based on the basic principles of composting formula:

$$Water\ needed\ kg = Total\ weight \times \frac{(Target\ moisture\ content - Current\ moisture\ content)}{100 - Current\ moisture\ content}$$

2.8. Data Collection and Analysis

2.8.1. Soil and Collection Analysis

A soil sample of about 1 kilogram was collected before placement in each container to analyze soil pH, total N, total P, total K, and organic matter, which was considered the "initial soil analysis."

All Factor A was collected after 30 days with 16 samples and Factor B after 60 days with 16 samples. The ten (10) kilograms of soil filled with one (1) kilogram substrates in each treatment was removed from the container and sieved through a 2mm sieve screen wire to separate the soil from substrates for analysis. The soil was air-dried, and samples with approximately 1 kilogram were placed in separate labeled plastic ziplock bags. The soil samples were transported to the testing laboratory to analyze soil pH, N, P, K, and organic matter.

2.8.2. Decomposition Rate Determination

The computation of the decomposition rate was based on the kilogram of plant by-product samples buried in each treatment. At 30 and 60 days of collection, the undecomposed plant by-product samples from each treatment separated from the soil were weighed using a weighing scale, considering weight changes to get the final weight. "The "weight loss" was calculated in percent by first deducting the "final weight" from the "initial weight" and then dividing that number by the "initial weight" multiplied by 100 (L. Berg et al., 2022). The decomposition rate was calculated in percentage (%) using the following formula:

$$Decomposition\ rate\ (\%) := [(Initial\ weight - Final\ weight)\ /\ Initial\ weight] \times 100$$

2.9. Statistical Analysis

The Analysis of Variance (ANOVA) was used to determine if there are significant differences among treatments. Post-hoc tests were conducted to identify specific group differences.

3. Results and Discussion

Table 1 presents the decomposition rate of different plant by-products at 30 and 60 days. As a whole, the treatments exhibited varying decomposition rates at both observation periods, indicating differences in the breakdown of organic materials over time. At 30 days, the analysis revealed a statistically significant difference among treatments, p=0.000]. Rice straw recorded the highest mean decomposition rate (M=98.8), indicating a high level of decomposition and was significantly higher than all other treatments. Corn stover (M=85.8) and pineapple crown (M=90.2) showed comparable decomposition rates and did not differ significantly from each other, as indicated by their shared letter grouping. Sugarcane bagasse obtained the lowest mean decomposition rate (M=6.7), reflecting a very low rate of decomposition and was significantly lower than all other treatments. This is consistent with the study of Sotnikov, B. A., et.al. 2021, where residue decomposition rates are influenced by residue chemical composition, especially carbon to nitrogen ratio, lignin content, and other biochemical factors affecting microbial decomposition over time. The coefficient of variation at 30 days was low (CV=4.0%), indicating minimal experimental error and high precision of the measurements.

At 60 days, a statistically significant difference among treatments was likewise observed [p=0.000]. Rice straw (M=92.0), pineapple crown (M=95.7), and corn stover (M=86.4) did not differ significantly from one another, as reflected by their shared superscript letter, indicating comparable decomposition rates at this stage. In contrast, sugarcane bagasse continued to exhibit the lowest decomposition rate (M=6.2), which was significantly lower than those of the other treatments. The coefficient of variation remained low at 60 days (CV=6.4%), suggesting consistent experimental precision across the two observation periods. Overall, the results indicate that while decomposition rates among most residues tended to converge over time, sugarcane bagasse consistently decomposed at a substantially slower rate compared with the other organic residues.

Table 1 Decomposition Rate of Different Plant By-Products at 30 and 60 Days of Incubation

Treatment	30 days	60 days
	M	**M**
Corn Stover	85.8b	86.4a
Sugarcane Bagasse	6.7c	6.2b
Rice Straw	98.8a	92.0a
Pineapple Crown	90.2b	95.7a
p-value	0.000	0.000
cv (%)	4.0	6.4
Means that share a letter are not significantly different		

Table 2 presents the soil pH values under different plant by-products treatments at 30 and 60 days, with the initial soil pH recorded at 5.71. As a whole, soil pH increased across all treatments at 30 days relative to the initial condition, indicating a general shift toward less acidic soil during the early stage of decomposition. However, no statistically significant difference among treatments was observed at 30 days [p=0.149]. At this time point, soil pH values ranged from 6.1 to 6.6, suggesting a relatively uniform increase in soil pH regardless of residue type. The coefficient of variation was low (CV=4.4%), indicating high precision of the measurements.

At 60 days, a statistically significant difference in soil pH among treatments was observed [p=0.004]. Rice straw (M=6.6) and corn stover (M=6.4) recorded significantly higher soil pH values, reflecting a more pronounced increase from the initial soil pH. Pineapple crown (M=6.2) exhibited an intermediate pH level and did not differ significantly from either the higher or lower groups. In contrast, sugarcane bagasse resulted in the lowest soil pH at 60 days (M=5.3), which was significantly lower than those of corn stover and rice straw, indicating a tendency toward increased soil acidity over time. Abbas et al. (2024) studied organic amendments like biochar and compost in maize cropping systems and reported variable effects on soil pH—some amendments caused acidification attributed to organic acid release during decomposition, while others increased pH due to mineral content, matching with the observations of residue-dependent pH changes. The coefficient of variation remained low at 60 days (CV=6.7%), suggesting consistent experimental precision. Overall, the results indicate that while all treatments initially increased soil pH, differences among organic residues became more pronounced over time, with sugarcane bagasse showing a contrasting acidifying effect relative to the other treatments.

Table 2 Changes in Soil pH as Affected by Different Plant By-Products Treatments at 30 and 60 Days of Decomposition

Treatment	30 days	60 days
	M	**M**
Corn Stover	6.3	6.4b
Sugarcane Bagasse	6.1	5.3a
Rice Straw	6.4	6.6b
Pineapple Crown	6.6	6.2ab
p-value	0.149	0.004
cv (%)	4.4	6.7
Means that share a letter are not significantly different		

Table 3 presents the nitrogen content of different agricultural residues at 30 and 60 days of decomposition, with the initial nitrogen content recorded at 0.112. As a whole, nitrogen levels at 30 days were uniform across all treatments, with corn stover, sugarcane bagasse, rice straw, and pineapple crown each registering a mean nitrogen content of 0.10. This indicates minimal change in nitrogen content during the early stage of decomposition regardless of residue type.

No statistically significant difference among treatments was observed at 30 days, [p=0.156]. The coefficient of variation was relatively high (CV=22.5%), suggesting moderate variability in nitrogen measurements at this time point.

At 60 days, nitrogen content remained at 0.10 for corn stover, sugarcane bagasse, and pineapple crown, while rice straw showed a higher mean nitrogen content of 0.20, indicating a numerical increase over time. However, the analysis of variance revealed that this difference was not statistically significant, [p=0.349]. Sukitprapanon et al. (2020) conducted a research study and examined nutrient composition, finding uniform, stable N levels with no significant early differences, explaining minimal N changes, much like the result of this analysis. The coefficient of variation decreased to 15.5%, reflecting improved consistency of nitrogen measurements at the later stage of decomposition. Overall, the results indicate that nitrogen content did not differ significantly among agricultural residues at both observation periods, suggesting comparable nitrogen dynamics across treatments throughout the decomposition process.

Table 3 Mean Nitrogen Content of Agricultural Residues at 30 and 60 Days of Decomposition

Treatment	30 days	60 days
	M	M
Corn Stover	0.1	0.1
Sugarcane Bagasse	0.1	0.1
Rice Straw	0.1	0.2
Pineapple Crown	0.1	0.1
p-value	0.156	0.349
cv (%)	22.5	15.5
Means that share a letter are not significantly different		

Table 4 presents the phosphorus content of different plant by-products at 30 and 60 days of decomposition, with the initial phosphorus content recorded at 1.194. At 30 days, a statistically significant difference in phosphorus content among treatments was observed, [p=0.042]. Corn stover (M=0.8) exhibited a significantly higher phosphorus content compared to sugarcane bagasse (M=0.7), rice straw (M=0.7), and pineapple crown (M=0.7), which did not differ significantly from one another as indicated by the shared letter notation. Phosphorus values at this stage ranged from 0.7 to 0.8. The coefficient of variation was low (CV=3.2%), indicating high precision of the measurements.

At 60 days, phosphorus content ranged from 0.7 to 0.9 across treatments. Rice straw (M=0.9) recorded the highest mean phosphorus content, followed by corn stover (M=0.8) and pineapple crown (M=0.8), while sugarcane bagasse showed the lowest value (M=0.7). However, the differences among treatments were not statistically significant, [p=0.443]. The coefficient of variation increased to 14.5%, suggesting greater variability in phosphorus content at the later stage of decomposition. Coulibaly et al. (2020) analyzed phosphorus dynamics during burial/decomposition of crop residues (corn stalk, rice straw, millet straw, sorghum stalk) in pots, showing P content with significant early increases and stabilization later, aligning with the sig. diff. at 30 days, corn stover high at 0.8% and non-sig. at 60 days. Overall, the findings indicate that treatment-related differences in phosphorus content were evident at 30 days but were no longer apparent at 60 days, suggesting that phosphorus dynamics among residues became more similar as decomposition progressed.

Table 4 Phosphorus Content of Plant-By Products at 30 and 60 Days of Decomposition

Treatment	30 days	60 days
	M	M
Corn Stover	0.8a	0.8
Sugarcane Bagasse	0.7b	0.7
Rice Straw	0.7b	0.9
Pineapple Crown	0.7b	0.8

p-value	0.042	0.443
cv (%)	3.2	14.5
Means that share a letter are not significantly different		

Table 5 presents the potassium content of different plant by-products at 30 and 60 days of decomposition, with the initial potassium content recorded at 2.107. At 30 days, a statistically significant difference in potassium content among treatments was observed, [p=0.000]. Sugarcane bagasse (M=1.3), rice straw (M=1.3), and pineapple crown (M=1.3) did not differ significantly from one another, as indicated by the shared letter notation, but all three differed significantly from corn stover (M=1.4). Although the numerical difference among treatments was small, the low coefficient of variation (CV=1.6%) indicates high precision of the measurements and supports the statistical significance observed at this stage.

At 60 days, potassium content ranged from 1.3 to 1.4 across treatments, with corn stover (M=1.4) and pineapple crown (M=1.4) recording slightly higher values than sugarcane bagasse (M=1.3) and rice straw (M=1.3). However, the differences among treatments were not statistically significant, [p=0.244]. The coefficient of variation increased to 4.7%, suggesting greater variability in potassium measurements at the later stage of decomposition. Sharma et al. (2023) provided a relevant recent study on potassium dynamics in crop residue decomposition under tillage and residue management in rice-wheat systems, examining K release from above-ground crop residues over decomposition periods, finding significant early treatment differences due to tillage/residue interactions, which converged later as K leached rapidly in ionic form. Overall, the results indicate that treatment-related differences in potassium content were evident at 30 days but diminished by 60 days, implying convergence of potassium levels among plant by-products as decomposition progressed.

Table 5 Potassium Content of Plant By-Products at 30 and 60 Days of Decomposition

Treatment	**30 days**	**60 days**
	M	**M**
Corn Stover	1.4b	1.4
Sugarcane Bagasse	1.3a	1.3
Rice Straw	1.3a	1.3
Pineapple Crown	1.3a	1.4
p-value	0.000	0.244
cv (%)	1.6	4.7
Means that share a letter are not significantly different		

Table 6 presents the organic matter content of different plant by-products at 30 and 60 days of decomposition, with the initial organic matter content recorded at 5.08. At 30 days, organic matter values ranged from 5.1 to 5.7 across treatments. Corn stover (M=5.7) and rice straw (M=5.7) recorded the highest mean organic matter content, followed by sugarcane bagasse (M=5.3), while pineapple crown (M=5.1) showed the lowest value. However, the analysis of variance revealed no statistically significant difference among treatments at 30 days, [p=0.121]. The coefficient of variation was 7.3%, indicating acceptable variability and consistent measurements.

At 60 days, organic matter content ranged from 4.9 to 5.7. Rice straw (M=5.7) maintained the highest organic matter level, followed by corn stover (M=5.4) and sugarcane bagasse (M=5.3), while pineapple crown (M=4.9) exhibited the lowest mean value. Despite these numerical differences, no statistically significant difference among treatments was observed, [p=0.385]. The coefficient of variation increased to 11.4%, suggesting greater variability in organic matter content at the later stage of decomposition. Uwamahoro et al. (2023) analyzed organic matter decomposition from vegetable crop residues (squash, southern pea) in sandy soils over 30 days, finding no significant differences in soil organic carbon (SOC) dynamics across treatments despite numerical variations, with decomposition rates varying by residue quality but stabilizing overall. Overall, the findings indicate that organic matter content did not differ significantly among agricultural residues at both 30 and 60 days, implying similar patterns of organic matter decomposition across treatments over time.

Table 6 Organic Matter Content of Plant By-Products at 30 and 60 Days of Decomposition

Treatment	30 days	60 days
	M	M
Corn Stover	5.7	5.4
Sugarcane Bagasse	5.3	5.3
Rice Straw	5.7	5.7
Pineapple Crown	5.1	4.9
p-value	0.121	0.385
cv (%)	7.3	11.4
Means that share a letter are not significantly different		

4. Conclusion and Recommendation

This study successfully evaluated the decomposition rates and nutrient dynamics of four agricultural plant by-products, corn stover, sugarcane bagasse, rice straw, and pineapple crown, as potential organic soil amendments in a nursery setting over 30 and 60 days. Findings showed that the distinct decomposition patterns of rice straw exhibited the highest decomposition rate (98.8% at 30 days, 92.0% at 60 days), followed closely by pineapple crown and corn stover, while sugarcane bagasse decomposed markedly slower (6.7% at 30 days, 6.2% at 60 days). The differences aligned with the biochemical factors like C/N ratios and lignin content, as noted in prior research by Sotnikov et al., 2021. Soil nutrient responses varied by treatment and time. All amendments initially raised soil pH from 5.71, but by 60 days, rice straw and corn stover sustained higher pH levels (6.6 and 6.4), whereas sugarcane bagasse acidified soil to 5.3. The content of nitrogen remained stable, and non-significant across treatments (around 0.1–0.2%), which indicating consistent but limited release. The phosphorus showed an early, significant elevation with the corn stover (0.8 at 30 days), and later converged. The potassium displayed initial differences favoring non-corn treatments, which was equalized at 60 days. The organic matter (OM) levels hovered around 5 - 5.7% without significant differences, suggesting balanced contributions to soil structure.

Overall result showed that the rice straw and pineapple crown appear to be superior short-term amendments due to their rapid decomposition and positive effects on pH and nutrient levels, and synthetic fertilizer alternative. These results support and encourage agricultural sustainability by lowering environmental risks, promoting waste recycling, and improving soil health. Future research studies could include field trials across diverse soils and crop yield integration to validate long-term efficacy.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

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