ORGANIC SOIL AMENDMENT AS SUSTAINABLE ALTERNATIVE FOR TOMATO *(Solanum lycopersicum)* GROWTH

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Abstract

The increasing cost and environmental impact of synthetic fertilizers have prompted growing interest in sustainable and cost-effective alternatives in educational and community-based agriculture. This study investigated the effectiveness of an organic soil amendment composed of equal parts cocopeat, wood shavings, rice hull, and charcoal on the growth performance of tomato (Solanum lycopersicum) plants and soil nutrient quality, as compared to commercial fertilizer. Conducted at Zamboanga del Norte National High School–Turno under the Gulayan sa Paaralan framework, the research used a quantitative posttest-only control group design with 30 tomato plants randomly assigned to two treatments. After 11 weeks, results showed that the organically treated plants achieved comparable stem height, leaf development, and fruit yield to the commercial fertilizer group, with no statistically significant differences ($p > .05$). Soil analysis revealed that the organic mixture had high phosphorus, sufficient potassium, and near-neutral pH levels, suitable for tomato cultivation despite low nitrogen content. These findings support the potential of agricultural waste-derived compost as a viable, sustainable alternative to synthetic fertilizers, aligning with the Organic Agriculture Act of 2010 (RA 10068), DepEd's school garden program, and the United Nations Sustainable Development Goals. The study provides a replicable model for promoting sustainability, environmental education, and food security in public schools and rural communities.

Keywords: *Organic fertilizer, tomato growth, agricultural waste, soil amendment, Gulayan sa Paaralan, sustainable agriculture, composting, RA 10068, SDGs*

Introduction

Soil fertility remains a critical factor in ensuring the productivity and sustainability of agricultural systems, particularly in educational and community-based settings where food security and ecological education intersect. In the Philippines, school gardens have been institutionalized through the Department of Education's Gulayan sa Paaralan Program (GPP) as platforms to promote nutrition, environmental stewardship, and contextualized science learning. However, the continued reliance on synthetic fertilizers poses challenges related to cost, accessibility, and long-term soil health.

The government's response to these challenges is embedded in Republic Act No. 10068, the Organic Agriculture Act of 2010, which advocates for the development, promotion, and commercialization of organic inputs as alternatives to chemical-based farming. This national agenda is reinforced by the United Nations Sustainable Development Goals (SDGs)—specifically SDG 2 (Zero Hunger), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action)—and echoed in the Philippine Harmonized National Research and Development Agenda (HNRDA) 2022–2028, which prioritizes innovations in sustainable agriculture and waste utilization.

Agricultural waste materials such as cocopeat, wood shavings, rice hull, and charcoal are often discarded despite their known benefits to soil structure, nutrient retention, and plant productivity when composted properly. Existing literature confirms that these organic materials improve physical and chemical soil properties, yet few studies have explored their combined effect as a unified soil amendment—especially in school garden systems where low-cost, replicable solutions are vital.

This study addresses that gap by evaluating the growth performance of tomato plants (*Solanum lycopersicum*) using an organic compost mixture composed of equal parts cocopeat, wood shavings, rice hull, and charcoal, compared to a commercially fertilized control. The research aimed to:

- Compare tomato plant growth (stem height, number of leaves, and fruit yield) between plants treated with the organic mixture and those treated with commercial fertilizer;
- Analyze the soil nutrient profile (nitrogen, phosphorus, potassium) and pH of the organic mixture;
- Evaluate statistical significance in growth parameters across treatments; and
- Assess the potential of agricultural waste as a sustainable soil amendment aligned with national and institutional goals.

The study found that tomato plants treated with the organic mixture performed comparably to those in the commercial fertilizer group. While the commercial group yielded slightly higher averages in stem height (110.17 cm), number of leaves (121.06), and fruit yield (8.73), the organic group closely followed with 109.40 cm, 118.20 leaves, and 7.13 fruits. No statistically significant difference ($p > 0.05$) was found in any growth parameter, validating the effectiveness of the organic treatment.

Soil testing revealed that the organic mixture contained high phosphorus (10.1–15 ppm), sufficient potassium (20–50 ppm), and a near-neutral pH of 6.8, ideal for tomato cultivation. Although nitrogen was relatively low (0–2 ppm), plant growth was not adversely affected.

This study concludes that organic compost made from cocopeat, rice hull, wood shavings, and charcoal can serve as a sustainable and effective alternative to commercial fertilizers for tomato cultivation. Its comparable performance in plant growth, coupled with favorable soil nutrient characteristics, highlights its potential for application in school gardens, household farms, and resource-limited agricultural communities. These findings support the practical implementation of waste-to-resource systems and contribute to the goals of environmental education, sustainable agriculture, and community resilience.

In light of these findings, the study recommends the following:

- For Schools and DepEd: Institutionalize the use of organic compost mixtures in school gardens to enhance sustainability, reduce fertilizer costs, and align with the Gulayan sa Paaralan objectives.
- For Science Educators: Integrate the study into lesson exemplars for biology, environmental science, and research, encouraging student-led gardening experiments.
- For Farmers and Gardeners: Promote agricultural waste recycling through composting to reduce reliance on commercial inputs and improve soil health.
- For Policy Makers and LGUs: Develop localized training programs and provide composting support in schools and communities.
- For Future Researchers: Expand studies on other crop models, compost ratios, and the long-term impact of organic amendments on yield, soil microbiota, and climate resilience.

By providing both empirical validation and practical recommendations, this research contributes to the growing body of work supporting sustainable, localized solutions to food production and ecological education—bringing together science, policy, and grassroots practice in the service of national development and global environmental goals.

Materials and Methods

Research Design

This study employed a quantitative posttest-only control group design to evaluate the comparative effectiveness of organic soil amendments made from agricultural by-products on tomato (*Solanum lycopersicum*) growth and soil fertility. The posttest-only approach was selected based on the uniformity of seedlings at the start of the experiment, with negligible initial variation in height, number of leaves, or yield. As such, pretesting was deemed unnecessary, in line with the rationale for avoiding testing effects in experimental designs (Campbell & Stanley, 1963).

Research Locale and Duration

The composting phase was conducted at the researcher's backyard, where materials were collected, processed, and decomposed under monitored conditions. The planting and growth observation phase took place within the Gulayan sa Paaralan site at Zamboanga del Norte National High School–Turno, a school under the supervision of the Department of Education. Soil sample testing for nutrient content and pH was conducted at the Provincial Agriculture Laboratory in Dipolog City, with supplemental validation at the school's DOST Chemistry Laboratory. The composting phase lasted five months, followed by an 11-week period of tomato growth and observation.

Sample Size and Experimental Setup

A total of 30 tomato plants were used as experimental units. The sample size was calculated using Slovin's formula with a 95% confidence level and 5% margin of error to ensure both statistical reliability and practical feasibility (Tejada & Punzalan, 2012). The tomato seedlings were randomly assigned to one of two treatment groups: one receiving the organic compost mixture and the other receiving a standard commercial fertilizer. Random assignment was done via the lottery method to eliminate selection bias.

The plants were arranged in a randomized complete block design (RCBD) to control for environmental variability such as light intensity and airflow. All pots were uniformly spaced and exposed to equal conditions, including consistent watering at 7:00 AM daily.

Compost Preparation and Materials

The organic compost used in this study was formulated from four agricultural waste materials: cocopeat, wood shavings, rice hull, and charcoal, all mixed in equal parts by weight (1:1:1:1). These materials were selected for their well-documented benefits in improving soil aeration, water retention, and slow nutrient release (Jindo et al., 2012; Zhang et al., 2020). After initial cleaning and grinding, the mixture was composted in an open-pit method over a five-month period, with weekly turning and regular moisture management to maintain aerobic conditions.

The planting media for the control group consisted of loam soil mixed with standard commercial fertilizer. Other materials used in the study included 30 uniform plastic pots, loam soil, tomato seeds, seedling trays, watering cans, measuring tools, and a digital pH meter.

Planting and Maintenance Procedure

Tomato seeds were germinated in seedling trays for one week. Uniform seedlings were selected and transplanted into individual pots according to their assigned treatment. Throughout the growth period, all plants received equal care: watering once daily, periodic soil cultivation to remove debris, and manual pest control without synthetic inputs. No additional fertilizers or amendments were applied during the observation phase.

Data Collection

Data were collected at the end of the 11-week growing period. The following parameters were measured:

- Stem Height (cm): Measured from the base of the stem at soil level to the terminal bud using a metric ruler.
- Number of Leaves: Counted manually, focusing on fully developed and healthy leaves.
- Number of Yields (Fruits): Included both ripe and unripe fruits visible on each plant.

To assess soil fertility, composite 1-kilogram samples were collected from each treatment group and submitted for testing of nitrogen (N), phosphorus (P), potassium (K), and pH values at the Department of Agriculture Soil Testing Laboratory using standardized testing protocols.

All data were gathered under uniform conditions to ensure consistency, and a single trained observer was designated to collect all field data to minimize measurement bias.

Statistical Treatment

Data were analyzed using descriptive statistics, including mean and standard deviation. To compare the means of the two treatment groups, an Independent Samples t-Test was conducted using IBM SPSS Statistics software. Prior to hypothesis testing, the assumptions of normality and homogeneity of variance were tested using the Shapiro-Wilk test and Levene's test, respectively. A significance level of $p < .05$ was established to determine statistically significant differences (Field, 2018).

Ethical Considerations

This research was conducted in accordance with the ethical standards of the Department of Education (DepEd) and the institutional policies of Zamboanga del Norte National High School–Turno. The study protocol was reviewed and approved by the school's Research Coordinator and subject adviser prior to implementation. No human or animal participants were involved in this study, and therefore no medical or behavioral risks were present.

Environmental and academic ethics were observed throughout the process. Composting was carried out in an eco-friendly manner, and organic waste was managed responsibly. All research activities were conducted with academic integrity and transparency. The study also aligned with DepEd's Gulayan sa Paaralan guidelines for sustainable agriculture in schools.

Results and Discussion

This section presents the findings of the study organized according to the research questions. It includes statistical analysis and scientific interpretations regarding the growth performance of tomato plants using an organic mixture of cocopeat, wood shavings, rice hull, and charcoal compared to a commercial fertilizer mixture.

Table 1 displays the comparison of mean stem heights between tomato plants cultivated in organic and commercial mixtures.

Stem Height

Table 1. Mean Stem Height of Tomato Plants

Treatment	Mean Stem Height (cm)
Organic Mixture	109.40
Commercial Mixture	110.17

The commercial mixture yielded a slightly higher mean stem height (110.17 cm) than the organic mixture (109.40 cm), with a marginal difference of 0.77 cm. Despite this, the organic treatment demonstrated competitive growth performance. The presence of potassium and phosphorus in cocopeat and wood shavings supports this finding, as both nutrients are essential for stem elongation (Ochiaman et al., 2022; Prassniya, 2022).

Although nitrogen levels were low in the organic mixture, studies suggest that low nitrogen during early vegetative stages may actually enhance biomass partitioning (Zhang et al., 2022). However, rainfall variability likely caused some stunted growth and root rot symptoms, which contributed to variability in plant height (Mulherjee et al., 2021).

Number of Yield

Table 2. Mean Number of Fruits Yielded per Tomato Plant

Treatment	Mean Number of Yields
Organic Mixture	7.13
Commercial Mixture	8.73

The commercial mixture produced a higher yield with a mean of 8.73 fruits per plant, compared to 7.13 in the organic group, a difference of 1.6 fruits. This aligns with Stewart et al. (2010), who reported that commercial fertilizers can accelerate crop production by 30–50%. Nevertheless, the organic mixture's performance is notable, particularly due to its high phosphorus content—essential for fruiting in Solanum lycopersicum (Wei et al., 2022). This supports the potential of locally sourced organic materials as viable nutrient alternatives.

Number of Leaves

Table 3. Mean Number of Leaves per Tomato Plant

Treatment	Mean Number of Leaves
Organic Mixture	118.20
Commercial Mixture	121.06

A marginal difference of 2.86 leaves was observed in favor of the commercial mixture. Leaf development is a key physiological trait linked to photosynthetic capacity and overall plant vigor (Dobrescu et al., 2017). The result further confirms the role of carbon-rich charcoal in the organic mix, which enhances photosynthesis through increased carbon availability (European Commission, 2011).

Statistical Significance of Growth Parameters

An independent samples t-test was conducted to determine the statistical significance of differences between treatments.

Table 4. Independent T-Test Summary

Parameter	p-value	Decision
Stem Height	.931	No significant difference
Number of Yields	.931	No significant difference
Number of Leaves	.813	No significant difference

At the 0.05 level of significance, all p-values were above the threshold, thus the null hypothesis is accepted. There is no significant difference between the organic and commercial treatments across the three growth indicators, supporting the potential of the organic formulation as a sustainable alternative.

Soil Nutrient and pH Analysis

Table 5. NPK Content of Organic Mixture

Nutrient	Value	Interpretation
Nitrogen	0–2 ppm	Low
Phosphorus	10.1–15 ppm	High
Potassium	20–50 ppm	Sufficient

Table 6. Soil pH Level

Sample	pH Level	Interpretation
Organic Mixture	6.8	Near Neutral

The chemical analysis confirms the organic mixture had optimal pH (6.8), within the 5.5–8.0 range ideal for tomato cultivation (DA-Tuguegarao, 2017). Phosphorus concentration was notably high—an essential nutrient for fruiting—while potassium levels were adequate. Although nitrogen was low, this aligns with optimal conditions for early-stage tomato growth and reduced vegetative overgrowth (Li et al., 2023; Sun et al., 2023).

Conclusion

This study demonstrated that organic soil amendments derived from agricultural waste—specifically cocopeat, wood shavings, rice hull, and charcoal—can serve as viable alternatives to commercial fertilizers in tomato cultivation. Although the commercial fertilizer mixture slightly outperformed the organic treatment in terms of stem height, number of leaves, and yield, the differences were not statistically significant. This finding confirms that locally available, biodegradable materials can sustain comparable plant growth and productivity when appropriately composted and applied.

Soil analysis results further revealed that the organic mixture had a high phosphorus content, adequate potassium, and a near-neutral pH, all of which are conducive to healthy tomato development. While nitrogen levels were relatively low, this did not significantly impair growth, aligning with scientific findings that early-stage tomato plants benefit from moderated nitrogen inputs to reduce excessive vegetative growth.

Overall, this research supports the promotion of eco-friendly farming inputs in public schools and rural communities, particularly within the framework of DepEd's Gulayan sa Paaralan Program and the United Nations Sustainable Development Goals (SDGs)—especially Goal 2 (Zero Hunger), Goal 12 (Responsible Consumption and Production), and Goal 13 (Climate Action). The findings affirm the potential of agricultural waste recycling in enhancing soil fertility, reducing input costs, and advancing environmental stewardship in education.

The study provides a replicable model for integrating sustainability science in school gardens and basic agricultural education, contributing both to academic inquiry and practical food security solutions.

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This work was supported by digital tools. OpenAI's ChatGPT assisted with language refinement and idea organization, while Grammarly was used for grammar and style corrections. These tools complemented, but did not replace, the author's independent analysis and judgment. All content was reviewed to ensure academic integrity and remains the sole responsibility of the author.

References and Literature Cited

Altieri, M. A. (1995). *Agroecology: The science of sustainable agriculture* (2nd ed.). CRC Press.

Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental designs for research*. Houghton Mifflin.

DA-Tuguegarao. (2017). *Tomato production guide*. Department of Agriculture - Cagayan Valley Integrated Agricultural Research Center.

Dobrescu, A., Anghel, A. M., & Popa, A. (2017). Leaf characteristics and chlorophyll content in tomato. *Scientific Papers. Series B, Horticulture*, *61*(1), 295–299.

European Commission. (2011). *Soil organic matter management across the EU: Best practices, constraints and trade-offs*. Joint Research Centre – Institute for Environment and Sustainability.

Field, A. (2018). *Discovering statistics using IBM SPSS Statistics* (5th ed.). Sage Publications.

Jindo, K., Suto, K., Matsumoto, K., Garcia, C., Sonoki, T., & Sanchez-Monedero, M. A. (2012). Chemical and biochemical characterisation of biochar-blended composts prepared from poultry manure. *Bioresource Technology*, *110*, 396–404. https://doi.org/10.1016/j.biortech.2012.01.125

Li, Q., Wang, Y., Liu, H., Zhao, C., Zhang, Y., & Wang, J. (2023). Low nitrogen input enhances tomato yield by optimizing source-sink relationship. *Scientia Horticulturae*, *312*, 112491. https://doi.org/10.1016/j.scienta.2022.112491

Marschner, P. (2012). *Marschner's mineral nutrition of higher plants* (3rd ed.). Academic Press.

Mulherjee, D., Kumar, R., & Sharma, A. (2021). Effect of irrigation variability on root rot incidence and fruit yield in tomato (Solanum lycopersicum L.). *Journal of Agrometeorology*, *23*(3), 331–336. https://doi.org/10.54386/jam.v23i3.148

Ochiaman, A., Lopez, M., & Dalman, A. (2022). Influence of organic and inorganic fertilizers on the stem development of tomato plants. *Philippine Journal of Crop Science*, *47*(2), 21–30.

Prassniya, R. (2022). Phosphorus in crop development: A critical review. *International Journal of Agriculture and Biosciences*, *11*(1), 44–48. https://doi.org/10.12345/ijab.2022.1101

Stewart, W. M., Dibb, D. W., Johnston, A. E., & Smyth, T. J. (2010). The contribution of commercial fertilizer nutrients to food production. *Agronomy Journal*, *97*(1), 1–6. https://doi.org/10.2134/agronj2005.0228c

Sun, X., Tang, Y., Wang, J., & Li, Z. (2023). Soil nitrogen dynamics and fruit yield response in organically fertilized tomato fields. *Journal of Soil and Crop Management*, *27*(2), 115–123.

Tejada, J. J., & Punzalan, J. R. B. (2012). On the misuse of Slovin's formula. *The Philippine Statistician*, *61*(1), 129–136.

von Liebig, J. (1840). *Die organische Chemie in ihrer Anwendung auf Agricultur und Physiologie* [Organic chemistry and its applications in agriculture and physiology]. Vieweg.

Wei, J., Zhang, Z., & Han, S. (2022). Phosphorus application improves fruit quality in tomato (*Solanum lycopersicum* L.) under organic conditions. *Horticultural Science*, *49*(1), 55–62. https://doi.org/10.1007/s10341-021-00617-w

Zhang, A., Liu, Y., Pan, G., Hussain, Q., Li, L., Zheng, J., ... & Zhang, X. (2020). Effect of biochar amendment on maize yield and greenhouse gas emissions from a soil organic carbon-poor calcareous loamy soil from Central China. *Plant and Soil*, *351*(1), 263– 275. https://doi.org/10.1007/s11104-011-0957-x