

Growth and soil responses of *Zea mays* to coconut husk-based compost amended with chicken manure

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ABSTRACT

Coconut husk (*Cocos nucifera*) is often discarded as waste, resulting in pollution and the loss of natural resources. This study evaluated the effectiveness of compost made from coconut husk, chicken manure, and molasses on the growth performance and chlorophyll status of *Zea mays* (maize), as well as selected soil chemical properties. A completely randomized design (CRD) was used to test six treatments: one control (chicken manure) and five compost rates (20 g to 100 g per plant), each replicated four times. Plant height, stem diameter, number of leaves, chlorophyll content, and biomass were measured as key growth parameters. Standard analytical procedures were used to analyze soil pH, EC, TOC, OM, and exchangeable acidity (Al and H). The results showed that higher compost application significantly improved plant height, stem diameter, chlorophyll content, and above-ground biomass at the 80 g and 100 g rates. Soil pH shifted towards neutrality, and nutrient availability increased, particularly for nitrogen, phosphorus, and potassium. However, higher application rates also increased EC, indicating potential salt accumulation. Root biomass responded most at 60 g, suggesting this rate maximized benefits. The study recommends coconut husk compost as a suitable on-farm organic fertilizer due to its benefits for sustainable agriculture and waste recycling. A rate of 60–80 g per plant is suggested to maximize plant performance while minimizing negative impacts on soil health.

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1. INTRODUCTION

Concerns about the environmental and health impacts of synthetic fertilizers have increased global interest in sustainable agriculture. This shift reflects growing recognition of the need to balance food production with environmental stewardship. Although chemical fertilizers can quickly boost crop yields, their long-term use leads to environmental problems such as soil nutrient depletion, water pollution, loss of biodiversity, and greenhouse gas emissions (Gomiero et al., 2011; Menegat, 2022). In response, researchers and farmers are exploring new approaches that use organic waste materials more sustainably. The use of organic compost can improve soil quality, reduce dependence on chemical inputs, and maintain crop yields (Alvarenga et al., 2017).

Coconut husks, a byproduct of the coconut industry, are a significant source of organic compost. When combined with composted chicken manure and molasses, they provide a cost-effective means to improve soil structure, increase water-holding capacity, create air spaces, and supply

essential nutrients for global food production. This synergistic mixture promotes microbial diversity in the soil and helps address agricultural waste disposal issues (Chang et al., 2020), supporting climate change mitigation and end-use objectives. However, in many major coconut-producing countries, including Malaysia, coconut husks are often mismanaged and end up incinerated or discarded. This leads to environmental problems such as air pollution and greenhouse gas emissions (Ferronato & Torretta, 2019).

Raw coconut husk is primarily a lignocellulosic material and is not naturally high in nitrogen and phosphorus (Torillo et al., 2012; Swarnam et al., 2016). The fibrous nature of these products facilitates water retention and aeration by providing an ideal environment for plant roots and beneficial soil microbes. Well-composted coconut husks can supply fertility and reduce dependence on chemical fertilizers. Therefore, they are a valuable resource for the development of organic and sustainable agriculture.

Maize (*Zea mays*) is the world's third most important cereal crop after wheat and rice, contributing significantly to the human diet, animal feed, and industrial applications

(Kazerooni et al., 2014). Given the global importance of maize, improving its productivity through sustainable practices is essential. However, conventional maize cultivation within a chemical-dependent agricultural model undermines long-term sustainability through soil erosion, water contamination, and biodiversity loss (Ahmad et al., 2020). Furthermore, climate change, with unpredictable weather patterns, prolonged droughts, and increased pest infestations, places additional pressure on maize farming systems. To address these urgent challenges, it is necessary to develop eco-friendly technologies that support maize growth and protect the environment.

Coconut husk composting, such as using cocopeat-based organic manure, can be another option. It provides essential nutrients, stimulates microbial activity, and increases soil aggregation. In this process, molasses, a byproduct of palm sugar, is used as a carbon source to enhance microbial activity and accelerate composting. Molasses also helps balance pH and assists in nutrient cycling (Duffy, 2004; Ch'ng et al., 2013). Another important factor is chicken manure, which supplies nitrogen and other essential nutrients while increasing the soil's microbial diversity (Minkina et al., 2023).

This study addresses a clear gap in the current evidence on the use of coconut husk-based compost for maize production. Although coconut husk compost is widely promoted as an organic amendment, information on rate-response remains limited, particularly for compost amended with chicken manure and directly compared with a chicken manure control under the same pot conditions. Most studies report general treatment differences, but fewer quantify how increasing application rates affect crop performance and soil quality, or whether higher rates introduce trade-offs such as increased soil electrical conductivity (EC). Therefore, this study evaluates different application rates of coconut husk-based compost (amended with chicken manure), compared with a chicken manure control, to determine effects on maize growth, leaf chlorophyll (SPAD), and soil quality indicators including pH, nutrient availability, and organic matter. We hypothesized that (H1) coconut husk-based compost treatments would improve maize growth and chlorophyll status compared with chicken manure alone, (H2) increasing compost application rate would increase soil pH and improve soil nutrient status and organic matter indicators, and (H3) higher compost rates would increase soil EC, indicating a potential soluble-salt risk at excessive application rates.

2. MATERIAL AND METHODS

2.1 Compost preparation

The compost used in this study was prepared from a blend of coconut husk, chicken manure, and molasses. These materials were purchased in Kota Samarahan, Sarawak. The

coconut husks were carefully selected to be free from chemical contamination and non-organic particles, such as plastics and stones, to ensure the compost feedstock was safe and suitable for use. The chicken manure was collected from a local poultry farm in Kota Samarahan and was stored and handled under hygienic conditions to prevent pathogen contamination.

Molasses, a food-grade byproduct purchased from a local shop in Kota Samarahan, was used as an additional carbon source. It plays an important role in promoting microbial activity and supplementing the compost with nutrients (Kassa et al., 2024). To raise the temperature of the coconut husk and reduce unwanted losses during composting, the fresh extraction was completely dried by spreading it on a mat for 3–5 days under direct sunlight until no moisture remained. This process also destroyed pathogens. During drying, the husks were cut into smaller pieces to increase surface area, thereby facilitating microorganism-mediated decomposition of organic material (Xie et al., 2023).

The two components were mixed at a 2:1 weight ratio, specifically 1.6 kg of coconut husks and 0.8 kg of chicken manure. Simultaneously, a solution of 1 kg molasses in 10 litres of water was prepared. The 10 L molasses solution was gradually added to the compost mixture while turning to ensure even distribution throughout the pile. After mixing, the material was formed into a heap and placed in a compost bin with a minimum volume of 1 m³ to retain sufficient heat. The moisture content was maintained at 45%–55%, and the compost heap was turned 1–2 times per week for adequate aeration (Peng et al., 2023). Composting proceeded through three sequential phases: first, the mesophilic phase (25–40°C), during which simple compounds were degraded; second, the thermophilic phase (40–65°C), with partial decomposition of more resistant substances such as lignin; and finally, a maturation phase to produce humus-like materials. Compost matured in 8–12 weeks, resulting in a dark, crumbly material with an earthy smell.

2.2 Pot experiment

2.2.1 Site and plot preparation

The pot experiment was carried out in the open field of the Faculty of Resource Science and Technology, Universiti Malaysia Sarawak (UNIMAS), under direct natural sunlight. Plants were watered once daily with 300 mL per pot using the nearby water supply. During the experimental period, the site experienced a mean daily air temperature of 26°C to 31°C and total rainfall of 449 mm, based on records from the nearest meteorological station. The experimental area was cleared of vegetation, stones, and debris to ensure uniform ground conditions before pot placement. A weed mat was

installed to minimise weed growth and secured with garden staples.

2.2.2 Soil and planting

The growth medium was commercial topsoil. In each 30 cm × 30 cm pot, three maize seeds were sown directly into the soil to ensure successful establishment. After seedling emergence and early growth, the plants were thinned to one uniform seedling per pot by removing the extra seedlings, so that each pot contained the same plant density for the remainder of the experiment. The same amount of topsoil was used in every pot to maintain consistency across treatments.

2.2.3 Treatments and experimental design

Six treatment groups were established to evaluate the effects of different compost application rates on maize growth. The control group (T0) received chicken manure, as chicken manure is one of the components of the coconut husk-based compost formulation used in this study (coconut husk, chicken manure, and molasses), and it is a commonly used organic amendment in local practice. The remaining five experimental groups (T1–T5) received increasing amounts of coconut husk-based compost to assess whether the compost blend offers additional benefits beyond chicken manure alone and to identify the most suitable application range under pot conditions. The treatment details were as follows:

T0: Control (60 g chicken manure)

T1: 20 g compost

T2: 40 g compost

T3: 60 g compost

T4: 80 g compost

T5: 100 g compost

Each treatment was replicated four times, resulting in a total of 24 experimental units. The experiment was arranged in a completely randomized design (CRD) to minimize experimental bias and ensure reliable comparisons among treatments. The experiment was conducted for three months after planting, and plants were harvested at the end of this period. Compost was applied as a top dressing every two weeks during the three-month experimental period (six applications in total), following the assigned treatment rate. All pots were watered consistently with 300 mL per pot per day (manual watering) to maintain comparable moisture conditions across treatments.

2.3 Plant growth and chlorophyll content

Growth performance was assessed at the end of the experimental period. Plant height (distance from the soil surface to the tip of the longest leaf) was measured using a ruler (Ogunlade-Anibasa et al., 2024). Stem diameter was

measured at the plant base with a manual caliper (Almeida et al., 2016). The total number of leaves per plant was manually counted. Leaf chlorophyll status was determined using a SPAD-502 Plus chlorophyll meter (Konica Minolta, Japan). For each plant, SPAD readings were taken from the top, fully expanded leaves (three leaves per plant). Measurements were conducted at a consistent time of day (09:00–11:00) to minimize diurnal variation. For each selected leaf, the reading was taken at the middle portion of the lamina, avoiding the midrib. The three readings per plant were averaged to obtain one representative SPAD value per plant, which was used for statistical analysis. Plant biomass was measured as both fresh and dry weights of leaves, stems, and roots. After harvest, plant parts were washed, blotted to remove surface moisture, and weighed to record fresh mass. Samples were then oven-dried at 60°C for 72 hours, and dry weight was measured.

2.4 Soil sampling

The pot soil samples were collected after harvesting the crop to a depth of 10 cm using a hand auger. The samples were air-dried at room temperature, milled with a mortar and pestle, and sieved through a 2 mm sieve to obtain a homogeneous powder. The samples were placed in plastic bags, labelled, and then air-dried for physicochemical studies.

2.4.1 Soil nutrient content

The concentrations of major nutrients (N, P, and K) were assessed using a portable soil test kit/analyser (HI3896; Hanna Instruments Co., Woonsocket, USA). This method provides semi-quantitative estimates and was chosen to generate a rapid, practical indication of relative nutrient status among treatments under pot conditions, enabling consistent handling of multiple samples within a short time frame. To aid interpretation of the portable test kit results, nutrient status was also reported using the rating classes from the manufacturer's interpretation chart (HI3896; Hanna Instruments). In this scale, N and P are categorized into ordinal classes representing relative fertility levels, from deficient to excessive. For N, N0 = absent, N1 = deficient, N2 = low, N3 = sufficient, and N4 = surplus. For P, P0 = depleted, P1 = low, P2 = moderate, and P3 = sufficient. For K nitrogen, N0 = absent, N1 = deficient, N2 = Adequate, N3 = sufficient, and N4 = surplus. These classes were used to describe nutrient status trends across treatments, in addition to the measured values. These macronutrients are essential for many physiological and developmental functions in plants, including photosynthesis, energy exchange, root growth, and shoot development. Nutrient detection in the test kit was performed using colorimetric methods, and all steps were carried out according to the manufacturer's instructions to ensure reliable and accurate results.

2.4.2 Soil pH and electrical conductivity (EC)

Soil pH was measured as described by Al-Busaidi et al. (2005). Ten grams of air-dried soil subsamples were mixed with 25 mL of distilled water (soil-to-water ratio 1:2.5), shaken for 30 minutes, and left to stand for 24 hours. The pH of the supernatant was determined using a calibrated digital pH meter (model SevenCompact S210, Mettler-Toledo, Switzerland). Electrical conductivity (EC) was measured in the same soil-water suspension with a portable EC meter (model HI993310, Hanna Instruments, USA) to determine the concentration of soluble salts in the soil.

2.4.3 Organic matter (OM) and total organic carbon (TOC)

Organic matter (OM) and total organic carbon (TOC) contents were estimated by loss on ignition (LOI) at 550°C, following Hoogsteen et al. (2018). Approximately 5 g of air-dried, sieved soil (<2 mm) was placed in a pre-weighed crucible and dried in an oven at 300°C (Ohaus N7/15CD) for two hours to remove moisture and volatile matter. The sample was then incinerated in a muffle furnace (Carbolite, Model CWF 1100, UK) at 550°C for four hours. The weight loss from combustion was used to determine OM%, and TOC was estimated by assuming that organic matter contains approximately 58% carbon.

2.4.4 Exchangeable aluminium (Al) and hydrogen (H)

Exchangeable aluminium (Al^{3+}) and hydrogen (H^+) ions were extracted using the titration method described by Abreu et al. (2003). The soil samples were air-dried, and extraction was performed with 1 M potassium chloride (KCl) at a 1:10 sample-to-solution ratio. A few drops of phenolphthalein were added to the extracts as an indicator, and the mixture was titrated with 0.02 M NaOH solution to determine the combined concentration of exchangeable Al and H. An automatic digital burette and a conventional titration apparatus were used to ensure precise control of the applied volume. The quantities of exchangeable Al and H obtained in this process provide an index of soil acidity.

2.5 Statistical analysis

Data were analyzed using SAS software version 9.4 (SAS Institute Inc., Cary, NC, USA). One-way analysis of variance (ANOVA) was used to assess the effects of different compost application rates (20–100 g per pot) and the chicken manure control on maize growth parameters, SPAD values, and soil chemical properties. Before ANOVA, model assumptions were evaluated using residual diagnostics, including normality (Shapiro–Wilk test) and homogeneity of

variances (Levene's test). Where necessary, data transformation was applied to meet these assumptions. Duncan's Multiple Range Test (DMRT) was used when significant differences were detected ($p < 0.05$). Results are presented as F-values, p-values, and group means based on 24 pots (6 treatments $\times$ 4 replicates = 24). Effect sizes for treatment effects (η^2) are also reported to indicate the magnitude of differences among treatments. A p-value < 0.05 was considered statistically significant at the 5% probability level.

3. RESULTS

3.1 Plant growth and chlorophyll content

3.1.1 Plant height and stem diameter

The analysis of variance (ANOVA) revealed a highly significant effect of compost application on plant height ($F = 46.56$, $p < 0.0001$) (Table 1). Average plant height increased with higher compost application. The lowest height was recorded in the control group at 71.5 cm, which was almost equal to T1 (20 g compost) at 72.5 cm. Moderate increases were observed in T2 (76.13 cm) and T3 (78.57 cm), while the greatest increases were seen in T4 (86.0 cm) and T5 (90.4 cm). Means were further categorized using Duncan's Multiple Range Test, which showed that T5 was significantly taller than all other treatments. Compost treatment also had a significant effect on stem diameter ($F = 1671.68$, $p < 0.0001$). The lowest mean stem diameter was observed in the control group T0 (3.85 cm), while the highest mean was found in T5 (4.875 cm). T1 to T4 showed intermediate values, with higher compost doses resulting in a linear increase in diameter.

Table 1: One-way ANOVA and Duncan's Multiple Range Test Results of plant height and stem diameter for different treatment rates of coconut husk compost.

Treatment	Height	Stem diameter
Control	71.500 $\pm$ 0.399 ^A	3.850 $\pm$ 0.096 ^A
T1 (20 g)	72.500 $\pm$ 1.240 ^A	4.600 $\pm$ 0.122 ^B
T2 (40 g)	76.133 $\pm$ 1.308 ^B	4.650 $\pm$ 0.096 ^B
T3 (60 g)	78.567 $\pm$ 1.276 ^B	4.550 $\pm$ 0.087 ^C
T4 (80 g)	86.000 $\pm$ 1.110 ^C	4.850 $\pm$ 0.096 ^D
T5 (100 g)	90.400 $\pm$ 1.051 ^D	4.875 $\pm$ 0.075 ^D

3.1.2 Number of leaves and chlorophyll content

The differences in leaf number among treatments are shown in Figure 1. The leaf number was seven for the control, T1, and T2 treatments, while eight leaves were observed in T4 and T5. This slight but consistent increase in leaf production at higher compost rates reflects greater nutrient availability and stronger vegetative growth. Chlorophyll content-related SPAD values increased with compost treatments (Figure 1). The highest chlorophyll content was detected in T5 (100 g), demonstrating a positive correlation between compost application and photosynthetic characteristics. At T2 (40 g), a

small reduction in SPAD value was recorded; however, the overall trend for chlorophyll content increased consistently from the control to T5.

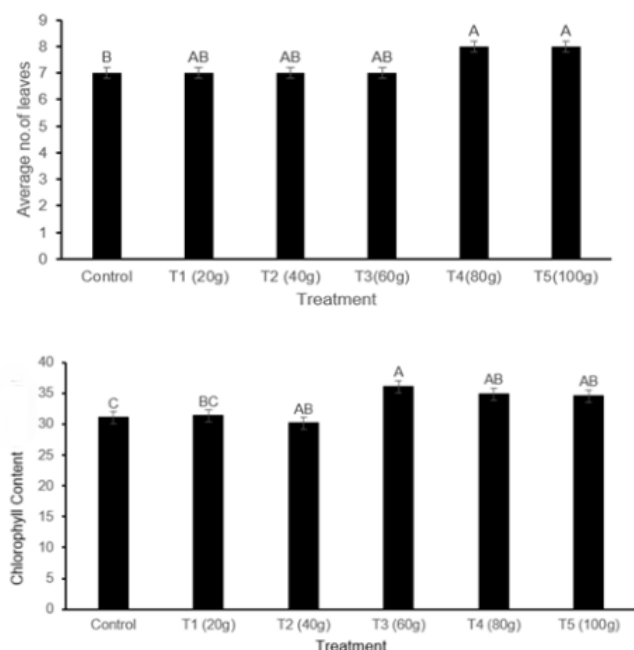


Figure 1: Number of leaves and SPAD (chlorophyll) values of maize under different treatments. Values are means $\pm$ SE ($n = 4$). Different letters indicate significant differences among treatments at $p < 0.05$ (DMRT).

3.1.3 Fresh and dry biomass

The measurements of fresh and dry weights of leaves, stems, and roots are presented in Table 2. T5 produced the highest fresh weight (41.53 g) and dry weight

(13.19 g) of leaves, followed closely by T4 and T3. Leaf biomass increased significantly from T3, indicating improved foliar development with a higher compost proportion. A similar trend was observed in stems; T5 plants had the highest fresh weight (62.38 g) and dry weight (10.07 g), followed by T4 with 52.99 g fresh weight and 8.34 g dry weight. This suggests that more nutrients were absorbed and utilized at higher compost rates. The maximum fresh root weight (60 g) was recorded at T3, resulting in a dry weight of 7.98 g, while all other treatments, including T4 and T5, showed relatively lower values. Dry root weight showed no significant difference among the treatments ($F = 0.672$).

3.2 Soil chemical properties

3.2.1 Nutrient content (N, P, K), pH and electrical conductivity (EC)

From Table 3, nitrogen remained very deficient (N1) throughout T2 (40 g), but increased from N3 to sufficient at T3 and T4, then became excessive (N4) at T5. Phosphorus levels were generally adequate (P3) but declined significantly to a low range (P0) at T2, likely due to interaction and/or transient fixation in the soil. Potassium levels were nearly sufficient, except for an excess at T5. Table 4 shows large changes in soil pH and EC across treatments. Soil pH increased from the control (6.78) to T5 (7.01), approaching neutrality, which benefits most crops. EC increased substantially with compost application, ranging from 660 to 1086 $\mu\text{S}/\text{cm}$ in T5.

Table 2: Fresh and dry weights of leaves, stems, and roots for different treatment rate of coconut husk compost. The mean $\pm$ SD values with the same upper-case letters are not significantly different by Duncan's Multiple Test.

Treatment	Mean (Fresh weight)	F value	p-value	Mean (Dry weight)	F value	p-value
Leaves						
Control	27.933±1.325 ^B	6.630	0.006	9.367±0.250 ^C	5.510	0.011
T1 (20 g)	28.823±1.309 ^B			10.103±0.198 ^{BC}		
T2 (40 g)	27.523±1.422 ^B			9.767±0.587 ^{BC}		
T3 (60 g)	39.930±3.857 ^A			13.267±1.634 ^A		
T4 (80 g)	34.907±2.114 ^{AB}			12.190±0.987 ^{AB}		
T5 (100 g)	41.533±3.788 ^A			13.193±1.702 ^A		
Stems						
Control	35.120±0.549 ^C	5.370	0.012	5.443±0.278 ^B	3.530	0.042
T1 (20 g)	35.290±0.506 ^C			6.383±0.260 ^B		
T2 (40 g)	36.473±2.524 ^C			6.357±0.642 ^B		
T3 (60 g)	45.000±4.795 ^{BC}			7.160±0.842 ^{AB}		
T4 (80 g)	52.997±3.807 ^{AB}			8.340±0.812 ^{AB}		
T5 (100 g)	62.377±9.002 ^A			10.073±1.598 ^A		
Roots						
Control	5.557±0.405 ^C	3.450	0.045	1.803±0.258 ^A	0.640	0.672
T1 (20 g)	5.780±0.332 ^{BC}			1.963±0.101 ^A		
T2 (40 g)	5.667±0.410 ^{BC}			1.773±0.150 ^A		
T3 (60 g)	7.977±1.039 ^A			2.117±0.453 ^A		
T4 (80 g)	7.497±0.460 ^{AB}			2.537±0.542 ^A		
T5 (100 g)	6.867±0.316 ^{ABC}			2.093±0.112 ^A		

Table 3: Soil nutrient content for different treatment rate of coconut husk compost (For N, N0 = absent, N1 = deficient, N2 = low, N3 = sufficient, and N4 = surplus. For P, P0 = depleted, P1 = low, P2 = moderate, and P3 = sufficient, For K nitrogen, N0 = absent, N1 = deficient, N2 = Adequate, N3 = sufficient, and N4 = surplus.)

Nutrient Content	Control	T1 (20 g)	T2 (40 g)	T3 (60 g)	T4 (80 g)	T5 (100 g)
N	N1- Deficient	N1 - Deficient	N1 - Deficient	N3 - Sufficient	N3 - Sufficient	N4 - Surplus
P	P3 - Sufficient	P3 - Sufficient	P0 - Depleted	P3 - Sufficient	P3 - Sufficient	P3 - Sufficient
K	K2 - Adequate	K4 - Surplus	K2 - Adequate	K2 - Adequate	K2 - Adequate	K2 - Adequate

3.2.2 Organic matter (OM) and total organic carbon (TOC)

For TOC, the control treatment recorded the highest mean value (9.775%), followed by T1 (20 g) at 9.717% and T5 (100 g) at 9.697% (Table 5). The lowest TOC value was observed in T3 (60 g), with a mean of 9.583%. One-way ANOVA showed that TOC differed significantly among treatments ($F = 243.92$; $p < 0.001$). For OM, the control also had the highest mean value (16.85%), followed by T1 (20 g) at 16.75% and T5 (100 g) at 16.72%, while the lowest OM value was again observed in T3 (60 g) (16.52%). Consistent with the TOC results, ANOVA indicated a significant treatment effect on OM ($F = 247.32$; $p < 0.001$).

Table 4: One-way ANOVA and Duncan's Multiple Range Test Results of pH and EC for different treatment. Mean $\pm$ SD values with the same upper-case letters are not significantly different by Duncan's Multiple Test.

Treatment	Mean	F-value	p-value
pH			
Control	6.780±1.35 ^C	16.27	<0.0001
T1 (20 g)	6.940±0.77 ^B		
T2 (40 g)	6.923±0.83 ^B		
T3 (60 g)	6.957±0.68 ^{AB}		
T4 (80 g)	6.973±0.91 ^{AB}		
T5 (100 g)	7.010±0.43 ^A		
EC (μS/cm)			
Control	660.33±34.45 ^C	15.47	<0.0001
T1 (20 g)	651.00±28.84 ^C		
T2 (40 g)	751.00±27.36 ^{BC}		
T3 (60 g)	853.00±41.68 ^B		
T4 (80 g)	845.33±46.51 ^B		
T5 (100 g)	1086.00±58.79 ^A		

Table 5: One-way ANOVA and Duncan's Multiple Range Test of TOC and OM for different treatments. The Mean $\pm$ SD values with the same upper-case letters are not significantly different by Duncan's Multiple Test.

Treatment	Mean	F-value	Pr > F
TOC (%)			
Control	9.775±0.43 ^A	243.92	<0.001
T1 (20 g)	9.717±0.44 ^A		
T2 (40 g)	9.687±0.36 ^{AB}		
T3 (60 g)	9.583±0.35 ^B		
T4 (80 g)	9.666±0.34 ^{AB}		
T5 (100 g)	9.697±0.44 ^A		
OM (%)			
Control	16.85±2.35 ^A	247.32	<0.001
T1 (20 g)	16.75±1.64 ^A		
T2 (40 g)	16.70±2.35 ^{AB}		
T3 (60 g)	16.52±2.16 ^B		
T4 (80 g)	16.64±2.34 ^{AB}		
T5 (100 g)	16.72±3.28 ^A		

4. DISCUSSIONS

4.1 Influence of coconut husk compost on maize growth

The results clearly show that *Zea mays* growth was positively affected by coconut husk compost. Plant height increased significantly with higher compost applications, with the tallest plants observed in the T5 group (100 g compost). This indicates that the organic amendment provided a consistent release of nutrients required for sustained vegetative growth. Similar results were reported by Ameya et al. (2025), who found that coconut husk compost improved root and shoot development due to its balanced nutrient composition and water-retaining properties.

The increase in stem diameter further indicates that compost has enhanced the vigor of these plants. Thicker stems are typically associated with more efficient nutrient and water uptake, as well as greater resistance to lodging. The greater stem diameter observed in treatments T4 and T5 suggests that higher compost doses promoted stronger architectural development, which is crucial for supporting reproductive growth in cereal species. A similar trend was observed for the number of leaves, which showed a small but consistent increase with higher compost doses. Although this effect was slightly less pronounced than those for height and stem diameter, the trend still indicates that compost improved overall vegetative growth. The number of leaves is directly linked to the plant's photosynthetic capacity and overall health, underscoring the importance of compost in promoting strong growth.

4.2 Influence of coconut husk compost on chlorophyll content

One of the most notable aspects of these components was the increase in chlorophyll content, as indicated by higher SPAD values. Chlorophyll is the most direct indicator of a plant's photosynthetic capacity, and its content is closely related to nitrogen supply. The compost, especially in the T5 group, could provide sufficient nitrogen and other nutrients essential for chlorophyll synthesis, such as magnesium and iron (Wang et al., 2021).

These findings are consistent with those of Alsherif et al. (2022), who showed that organic amendments enhance

chlorophyll content and photosynthetic activity in maize. The increase in SPAD values recorded in this study indicates that, under compost treatments, the light-harvesting ability of maize leaves is improved, supporting higher photosynthetic rates and biomass accumulation. This result aligns with the studies of Cheng et al. (2026), who observed that photosynthetic pigment content is significantly associated with nutrient availability and compost use in cereal grains.

4.3 Influence of coconut husk compost on biomass accumulation

Compost treatments had a highly significant effect on the fresh and dry weights of both leaf and stalk, with the effect most pronounced in the T5 group. Greater biomass indicates increased nutrient uptake and photosynthate allocation, both enhanced by organic amendments. Photosynthesis depends on leaf biomass, while structural integrity and nutrient transport are facilitated by stem biomass. The superior performance in T5 also suggests that an appropriate compost rate is required to maximize nutrient availability and plant physiological activity.

It is noteworthy that the fresh weight of roots was highest in treatment T3 (60 g); however, the dry weight of roots did not differ significantly among treatments. This suggests that the higher root fresh weight in T3 may be due to differences in root water content rather than a clear increase in root biomass, and root growth cannot be considered 'optimal' without root morphological measurements.

These findings are consistent with the study by Iqbal et al. (2019), who found that biomass accumulation in maize is strongly influenced by nitrogen and phosphorus availability, both of which are present in coconut husk compost. The opposite response of roots may also indicate a complex relationship among compost amount, soil structure, and microbial activity, which should be investigated in long-term experiments.

4.4 Influence of coconut husk compost on soil nutrients and chemical properties

The nutrient content, including N, P, and K, in the soil was significantly affected by compost. At the beginning of the growth period, nitrogen was not sufficiently available, but it reached an optimal level at T3 and a supra-optimal level at T5. Most TPSO/P ratios consistently maintained sufficient P levels after the first week, except for T2, which may have resulted from temporary fixation or competing nutrient uptake. Potassium levels increased across treatments and tended to be highest at T5. These results are similar to those obtained here, indicating that cocopeat compost has high nutritional quality and, when applied at appropriate rates, can supply all

or slightly more than what plants require.

However, the highest nutrient supply (e.g., as indicated by N and K in T5) may increase the risk of nutrient leaching or toxicity, especially under field conditions. As Scotti et al. (2016) explained, careful application of compost is necessary to avoid over-fertilisation and other possible environmental effects. This study proposes that moderate amounts of N (60–80 g per plant) can help maintain a balance between plant growth promotion and nutrient equilibrium. The compost also has a beneficial effect on soil pH, increasing acidity towards neutrality, particularly at higher treatment levels. Neutral pH in the rhizosphere increases the bioavailability of many immobile nutrients and supports microbial populations (Zhang et al. 2023). The buffering capacity of the compost likely helped moderate soil acidity, which is particularly important when dealing with tropical soils that are mostly naturally acidic. These findings support those of Narambuye and Haynes (2006), who explained that applying composted organic materials reduces soil acidity and improves nutrient exchange kinetics.

The increase in EC under all treatments, especially T5, indicates a higher concentration of soluble salts in the soil. Even though *Zea mays* has moderate salt tolerance, long-term application of high compost rates can increase salinity and may lead to soil salinization problems as reported by Tamai et al. (2023). Soils in the Western Great Plains and Great Basin have also shown increased salinity problems with high compost applications (Blumenthal et al, 2017). Therefore, future research should monitor soil EC and help identify compost application rates that keep EC within safe levels for maize growth.

4.5 Influence of coconut husk compost on soil organic matter and soil carbon content

TOC and OM differed significantly among treatments, but the absolute differences were small, with TOC ranging from 9.583% to 9.775% and OM from 16.52% to 16.85%. This limited separation is likely due to the short duration of the experiment (3 months), as changes in soil organic carbon pools and stable organic matter fractions typically require longer periods for decomposition, humification, and incorporation into the soil matrix. Although statistical significance was detected, the magnitude of change indicates only minor short-term shifts in soil organic matter dynamics under the tested rates. Therefore, these results are presented for completeness, while a longer-term experiment would be more appropriate to assess meaningful and sustained changes in TOC and OM following repeated compost application (Agegnehu et al., 2016).

4.6 Influence of coconut husk compost on soil exchangeable acidity components (Al and H)

The effects of the compost treatments on exchangeable aluminium (Al) and hydrogen (H) were minimal in the short term, with no statistically significant differences between treatments. However, general observations revealed a clear pattern: as soil acidification intensified, Al content decreased markedly, while H content increased. This negative association is consistent with Vieira et al. (2008), who reported that organic matter can complex Al ions, thereby lowering their solubility and potential toxicity. The increase in exchangeable H is likely linked to the release of organic acids during compost decomposition, which can contribute to buffering reactions in the soil system (Gurmessa, 2021). In acidic soils, elevated Al^{3+} activity is widely recognized to restrict root development and reduce water and nutrient uptake. Although H^+ is less directly toxic to roots than Al^{3+} , higher H^+ (soil acidity) can still reduce maize growth by lowering nutrient availability and increasing Al^{3+} solubility. In humid or high-rainfall conditions, leaching and acidification processes are stronger, so shifts in acidity and Al^{3+} availability may occur more easily and should be considered when interpreting maize growth responses.

4.7 Implications of coconut husk compost for sustainable agriculture

The implications of these findings for sustainable agriculture are discussed. The application of coconut husk-based compost is an economical alternative for enhancing soil fertility, increasing crop productivity, and recycling agricultural waste. The improvement in plant growth and soil condition justifies the use of coconut husk compost as a replacement for chemical fertilizer. Furthermore, it addresses the broader issue of agricultural waste disposal. Coconut husks, which are often discarded or burned, can now be converted into nutrient-rich compost through a zero-waste process. This study supports the previous report by Ayilara et al. (2020), which emphasized the importance of composting for reducing waste volume and promoting environmentally sound soil management. However, the results also indicate that risks from excessive nutrients and salinity may increase with higher application rates (as seen in T5). Therefore, an intermediate rate (60–80 g per plant) appears most favorable for the crack and hole treatment without causing adverse effects. This highlights the need to tailor compost application to specific crop and soil conditions.

4.8 Limitation of the study

A limitation of this study is that detailed characterization of the coconut husk-based compost (e.g. pH, EC, C:N ratio, moisture content, and nutrient composition) was

not conducted. Future work should include full compost characterization to better link compost properties with plant and soil responses. Another limitation is that soil N, P, and K were measured using a portable soil test kit (HI3896), which provides semi-quantitative, indicative estimates and may have lower analytical precision and sensitivity than standard laboratory methods (e.g. Kjeldahl for total N, Bray/Olsen for available P, and ammonium acetate extraction with ICP/AAS for exchangeable K). Therefore, the reported nutrient values should be interpreted primarily as comparative trends between treatments rather than absolute concentrations, and future studies should validate these measurements using accredited laboratory analyses to strengthen methodological rigour and improve comparability. This experiment was also conducted under pot-based conditions for a relatively short duration (three months), which may not fully represent field-scale processes or longer-term changes in soil organic matter dynamics and nutrient cycling. In addition, the study focused on early vegetative growth responses and did not include grain yield measurements, which limits direct agronomic conclusions on productivity at harvest. Microbial parameters were also not assessed; therefore, the potential effects of the compost treatments on soil microbial biomass, community structure, and nutrient mineralization pathways could not be evaluated. Finally, the statistical analysis was based on one-way ANOVA for comparisons among discrete treatment rates, and dose-response regression modelling (e.g. linear or quadratic fits) was not performed. Future studies should include longer-term field trials, grain yield assessment, and microbial analyses, and apply regression-based dose-response approaches with more rate levels to better characterize response shapes and estimate optimum compost rates more robustly.

5. CONCLUSION

The results showed that coconut husk-based compost amended with chicken manure improved maize performance compared to the chicken manure control, with higher values recorded for key vegetative indicators such as leaf number and SPAD (chlorophyll). Across treatments, the overall response pattern indicated that moderate to high compost rates produced the most consistent improvements, while the highest rate did not provide clear additional benefit across all parameters. Therefore, based on the combined trends in plant growth, SPAD, and soil pH over the three-month pot trial, 60–80 g per plant is suggested as a practical application range for this study. However, soil EC increased with compost addition and was highest at the maximum rate, indicating that 100 g per plant should be applied with caution due to potential soluble salt or salinity risk under repeated application. Further studies should confirm the optimum rate

under longer-term and field conditions, including grain yield measurement and routine EC monitoring to balance crop response with salinity risk.

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