MOOR JOURNAL OF AGRICULTURAL RESEARCH
Journal homepage: https://iart.gov.ng/moorjournal/index.php/mjar/

Residual Effects of Cassava Peel and Tithonia Compost on Growth, Yield and Nutrient Uptake of Lima Bean Varieties

***Adebayo, A. K. and Anjorin, F. B.**

Institute of Agricultural Research and Training, Obafemi Awolowo University, PMB 5029 Moor Plantation, Ibadan, Nigeria.

Article Info

Article history:
Received: May 1, 2025
Revised: May 22, 2026
Accepted: May 25, 2026

Keywords:
Lima bean
Compost
Yield
Varieties
Nutrient uptake

Abstract

The application of compost in agricultural systems is widely acknowledged for its ability to enhance crop yields and improve soil nutrient status over time. This study examines the comparative performance of two Lima bean varieties (B17 and LB 52) under immediate and residual applications of composts made from cassava peel and *Tithonia diversifolia,* each mixed with Poultry manure in ratio 3:1 on a dry basis. Composts (Cassava Peel Compost (CPC) and *Tithonia divesifolia* compost (TdC) were applied at rates of 5 t ha^{-1} and 10 t ha^{-1}, alongside a control (no compost) in a randomised complete block design (r = 4). Immediately after harvesting, residual trial was conducted to assess the residual impact of compost on lima yield. Data on Dry Matter (DM, g), Chlorophyll Content (CC, µg/gfw), post-soil nutrient and plant tissue analyses were collected and analysed using descriptive statistics and analysis of variance at α=0.05. The results showed that compost application significantly increased CC, DM, and Soil Nitrogen (SN, %) and Soil Potassium (SP, mg kg^{-1}), with the highest responses observed in the LB 52 variety treated with TdC at 10 t ha^{-1}. The CC and DM increased from 2.89 µg/gfw and 508.58 g to 2.96 µg/gfw and 557.58 g, respectively, across both trials. Similarly, SN and SP contents increased from 3.35% and 1.94 mg kg^{-1} to 3.47% and 2.13 mg kg^{-1} under 10 t ha^{-1} TdC. Overall, LB 52 produced higher yields than B17. Notably, the residual trial demonstrated improved crop performance and soil nutrient status, highlighting the sustained benefits of compost application over time.

Introduction

The use of organic amendments, particularly compost, is increasingly recognized as a sustainable approach to enhancing soil fertility, crop yield, and most notably, its residual benefits (Ranjan *et al.,* 2023). Compost provides a slow-release source of nutrients, ensuring that its effects extend beyond the immediate cropping cycle (Abd El Lateef *et al.,* 2023). This residual benefit makes compost an efficient and sustainable soil amendment, as it continues to improve soil fertility, structure, and productivity over time, reducing the need for subsequent fertilizer applications (Taaime *et al.,* 2024). In successive planting cycles, the slow mineralization of organic matter releases nutrients in accordance with crop demand, which is responsible for residual compost effects (Jesmin *et al.,* 2023). This slow-release characteristic promotes long-term soil health and production by improving soil nutrient retention and reducing nutrient leaching (Baijukya *et al.,* 2023). According to research, for example, the residual benefits of compost greatly increase crop yields in the second and third cropping seasons, especially for leguminous crops with complementary nitrogen-fixing capabilities like Lima beans (lsalam *et al.,* 2021; Oluwatoyin *et al.,* 2023). Furthermore, compost has lingering advantages for the biological and physical characteristics of soil. Compost's organic content improves soil structure by lowering soil erosion and boosting water infiltration and aggregate stability

Corresponding author: +2348060276282
Email address: adebayokehinde0410@gmail.com, (A.K. Adebayo)

1595 – 4153 Copyright © 2026 MJAR

(Temiz *et al.*, 2020). These improvements persi st for several cropping cycles, supporting root development and crop resilience to abiotic stresses such as drought or waterlogging (Ojewole *et al.,* 2023).

Additionally, compost stimulates soil microbial activity, enriching the microbial community responsible for nutrient cycling and pathogen suppression. The sustained activity of these microbes further contributes to the prolonged benefits of compost applications (Nemet, *et al.,* 2021). The long-term benefits of compost are likewise consistent with environmental benefits. By consistently enhancing soil quality, compost lessens reliance on chemical fertilizers, which are frequently linked to environmental problems like soil acidification and river eutrophication (Musa *et al.,* 2022). Long-term composting improves soil fertility and helps sequester carbon in soils, which helps mitigate climate change (Aina *et al.,* 2023). Research continues to highlight the importance of compost application rates and types in maximizing residual benefits. High-quality composts, such as those derived from nutrient-rich biomass like *Tithonia diversifolia*, have shown superior residual effects compared to less nutrient-dense organic materials (Setyowati *et al.,* 2022). Similarly, strategic application rates, optimized to soil and crop requirements, can amplify the prolonged benefits, ensuring sustainable crop production systems. The use of organic amendments, particularly compost, is increasingly recognized as a sustainable approach to enhancing soil fertility, crop yield, and environmental health (Omokaro *et al.,* 2024).

Leguminous crops like lima beans (*Phaseolus lunatus*) have special needs for nutrients because of their capacity to fix nitrogen, which improves soil health (Martins da Costa *et al.,* 2017). However, using compost as an organic amendment could have major agronomic and ecological advantages for long-term optimization of Lima bean yield and soil quality (Wright *et al.,* 2022). Compost serves as a source of macro- and micronutrients essential for plant growth (Ayilara *et al.,* 2020**)**. While Lima beans, as legumes, fix atmospheric nitrogen, they still require balanced nutrient availability for optimal growth (Haile *et al.,* 2022). Compost supplies nitrogen in a slow-release form, along with phosphorus, potassium, and trace elements, providing a balanced nutrient profile for the crop's lifecycle (Martínez-Blanco *et al.,* 2013). Lima beans thrive in well-drained, aerated soils. Compost improves soil structure by increasing organic matter content, which enhances water retention and aeration (Louzada Rodrigues *et al.,* 2021). This is particularly beneficial in regions prone to drought or erratic rainfall, as compost-amended soils maintain moisture, supporting Lima bean growth during dry periods (Larkin, 2020). Studies have shown that organic amendments like compost can significantly increase crop yield and improve crop quality (Amadi *et al.,* 2024). The slow-release nature of compost nutrients helps in maintaining a steady nutrient supply throughout the Lima bean growth period, supporting flowering and pod formation, ultimately leading to higher yields and quality (Eboibi *et al.,* 2018). Hence, this study aims to evaluate the efficacy of compost on the growth, yield, and soil enhancement properties of Lima bean production.

Materials and Methods

Compost preparation

Compost was produced from different organic materials of plant and animal origin using *Tithonia diversifolia* (Mexican sunflower), cassava peel, and poultry manure, mixed in a 3:1 ratio by weight. After sorting and chopping, the materials were combined using Partially Aerated Composting Technique (PACT-2) in a 3:1 plant material to poultry manure (dry weight basis) ratio as described by Adediran *et al.* (2003). Using a garden fork, constant turning and watering was done every two weeks till maturity to hasten the breakdown process. The physical and biological properties of composting were monitored at two weeks interval till maturity until compost maturity (AAFRD, 2005).

Prior to the initiation of the first experiment, surface soil samples (0-15 cm depth) were randomly collected from the experimental site and combined into a composite sample. This was achieved by pooling 20 core samples in a plastic bucket. A similar sampling procedure was before the commencement of the residual trial. The collected soil samples were air-dried, crushed, and sieved through a 2 mm mesh, followed by

routine laboratory analyses to determine their physical and chemical properties.

Soil physical and chemical properties were analysed using standard procedure. Particle size distribution was determined by the hydrometer method (Bouyoucos, 1962). Organic matter content was assessed using the Walkley-Black dichromate wet oxidation method (Nelson and Sommers, 1982). Total nitrogen was analysed by Micro-Kjeldahl digestion (Bremmer, 1965). Available phosphorus was extracted using Bray P-1 and quantified by molybdenum blue colorimetry (Bray and Kurtz, 1945), with absorbance measured at 882 nm using a Spectronic 20 spectrophotometer. Exchangeable potassium, calcium, and magnesium were extracted and quantified by EDTA titration (Jackson, 1962). Soil pH was measured in a 1:2 soil-to-water suspension using a digital electronic pH meter.

Chlorophyll determination

A 15 ml of 96% (v/v) ethanol and 1.0 g of fresh leaf material were added to 25 ml glass test tubes. The plant material was incubated in a water bath at 79.8°C for about 4 hours or until it was fully discoloured. After that, the absorbance of chlorophyll (a and b) was measured at 649 and 665 nm, respectively.

Total chlorophyll was determined using the following equations which are consistent with Wintermans and Mots (1965):

$$\text{Chl (a+b)} = \frac{(6.10 \times A665 \times 20.04 \times A649) \times 15}{1000/\text{F. W (mg/g F.W)}}$$

Experimental site

A field experiment was conducted during the early seasons of 2021 and 2022 at the Institute of Agricultural Research and Training farm in Ibadan (latitude 07°22'N, longitude 03°50'E) within the derived savannah/transition agro-ecology of Southwest Nigeria. The site sits at an altitude of 122 meters above sea level, with an average annual rainfall of 1220 mm and a mean temperature of 26°C

Experimental design and treatments

The land preparation involved mechanical ploughing, followed by harrowing two weeks later. The experimental layout followed a Randomized Complete Block Design (RCBD) (r=4). The field was demarcated into plots at a size of 5 m x 4m (20 m^2) and separated by an alley of 1m using wooden pegs. Two weeks before the planting date, compost types were applied according to treatments to facilitate decomposition and nutrient availability during the crop-growing season. Two seeds (lima) were sown per hole at a spacing of 1m × 1m, missing hills were replanted to achieve the target plant population per unit area. The two accessions used were obtained from the International Institute of Tropical Agriculture (IITA), Ibadan, Oyo State, Nigeria. Staking was carried out four weeks after field establishment to prevent lodging (falling over) and support the plants, ensuring they grow upright.

Treatments include, two compost types (tithonia compost, cassava compost), two lima accessions (LB 52 and B17)

1. 5 t ha^{-1} CPC +B17
2. 5 t ha^{-1} CPC + LB52
3. 5 t ha^{-1} TC +B17
4. 5 t ha^{-1}TC + LB 52
5. 10 t ha^{-1} CPC + B17
6. 10 t ha^{-1} CPC + LB 52
7. TC at 10 t ha^{-1} +B17
8. TC at 10 t ha^{-1}+ LB 52
9. B17 lima accession (No fertilizer application)
10. LB 52 Lima accession (No fertilizer application)

Data collection

Data collection involved five randomly selected tagged plants in two rows per plot. Yield parameters recorded were; pod length (cm). Number of seed/pod, number of pod/plant, 100 seed weight (g), total seed weight/plot (g) and total dry weight (g); chlorophyll content, soil and plant tissue analysis (which were carried out after harvesting).

Data analysis

Data were subjected to statistical analysis of variance (ANOVA) using SAS (2003) package. The treatments means were separated using Duncan Multiple Range Test (DMRT) at 5% level of probability (Duncan, 1955).

Results and Discussion

Soil analysis

Table 1 compares the nutrient composition and pH of two types of compost: (cassava peel compost and tithonia compost). Cassava peel compost: pH 6.67

(slightly acidic to neutral) whi le TC **is** slightly alkaline with pH 7.64. TC contains higher nitrogen, phosphorus, potassium and calcium content (2.13%,0.37, 2.07 and 2.15%) than cassava peel compost (1.17, 0.13, 1.25 and 1.94%), respectively.

Table 1: Chemical properties of composting materials.

Parameters	Cassava peel compost	Tithonia compost
Ph	6.67	7.64
Nitrogen (%)	1.17	2.13
Phosphorus (%)	0.13	0.37
Potassium (%)	1.25	2.09
Calcium (%)	1.94	2.15
Magnesium (%)	0.62	1.05
Zinc (%)	307.54	284.26

Treatments effect on chlorophyll content of Lima bean varieties

In both experiments, the application of 10 t ha^{-1} of TC to B17 produced the maximum chlorophyll content (2.89 and 2.94 µg/gfw, respectively) which was noticeably higher than that of any other treatment (Fig 1). This was significantly followed by cassava peel compost at 10 t ha^{-1} applied to LB 52. All treatments showed a significant increase in chlorophyll content at the second trial, with the exception of the controls plant, which was planted with LB 52 and B17 without any compost amendment (Fig 1).

Yield components response of lima bean to initial and residual application of compost type

Number of seed/pod

In terms of seed number, there was a significant difference among the treatments; TC exceeded cassava peel compost, especially at the higher application rate of 10 t ha^{-1}. Higher numbers of seeds per pod were typically produced when the compost application rate was increased from 5 to 10 t ha^{-1}. Interestingly, all treatments, regardless of the composting material used, demonstrated an increase in the number of seeds per pod during the second trial, with LB 52 consistently producing more seeds per pod than B17. TC at 10 t ha^{-1} with LB 52 had the greatest residual value (5.52), which related to the largest seed number noted. In contrast, in the absence of compost, seed numbers were significantly lower, with B17 producing 2.37 seeds per pod and LB 52 producing 2.77 seeds per pod (Table 2).

Number of pod/plant

Tithonia compost at 10 t ha^{-1} with LB 52 yields the highest number of pods/plant, indicating its superior effectiveness compared to cassava peel compost and lower application rates. Compost application significantly improves pod production compared to untreated plants, with LB 52 demonstrating a consistently higher performance than B17. An increased in number of pod/plant was observed in all treatments at the second trials compared to the first trial. The no of pod/plant at the second trials was significantly higher than the first trial trials in all treatments applied. The residual trial confirms the trend, highlighting potential variability and scope for improvement, particularly with the use of TC and higher application rates.

Pod length (cm)

Tithonia compost, at a higher rate of 10 t ha^{-1} with LB 52 lima bean accessions, consistently and significantly produced the longest pod length in comparison to cassava peel, the lower rate, and when no fertilizer was applied (regardless of the accessions planted). This is similar to what was observed for the number of seeds/pod and number of seeds/plant. At the second trial (residual), an increased in all treatments were observed except where no compost amendment was applied.

100 seed weight (g)

Tithonia compost amended at 10 t ha^{-1} to the LB 52 lima accessions produced the greatest results in both trials, with an increase from 84.70 in the first trial to 88.95 in residual trial. The values obtained were significantly higher ($p=0.5$) in both trials compared to all treatments. Also, Cassava Peel Compost, which ranked second in both trials, performed well at 10t ha^{-1} with LB 52 lima accessions. The lima seed weight increased irrespective of compost types and the rate of application at the second trial compared to the initial trial.

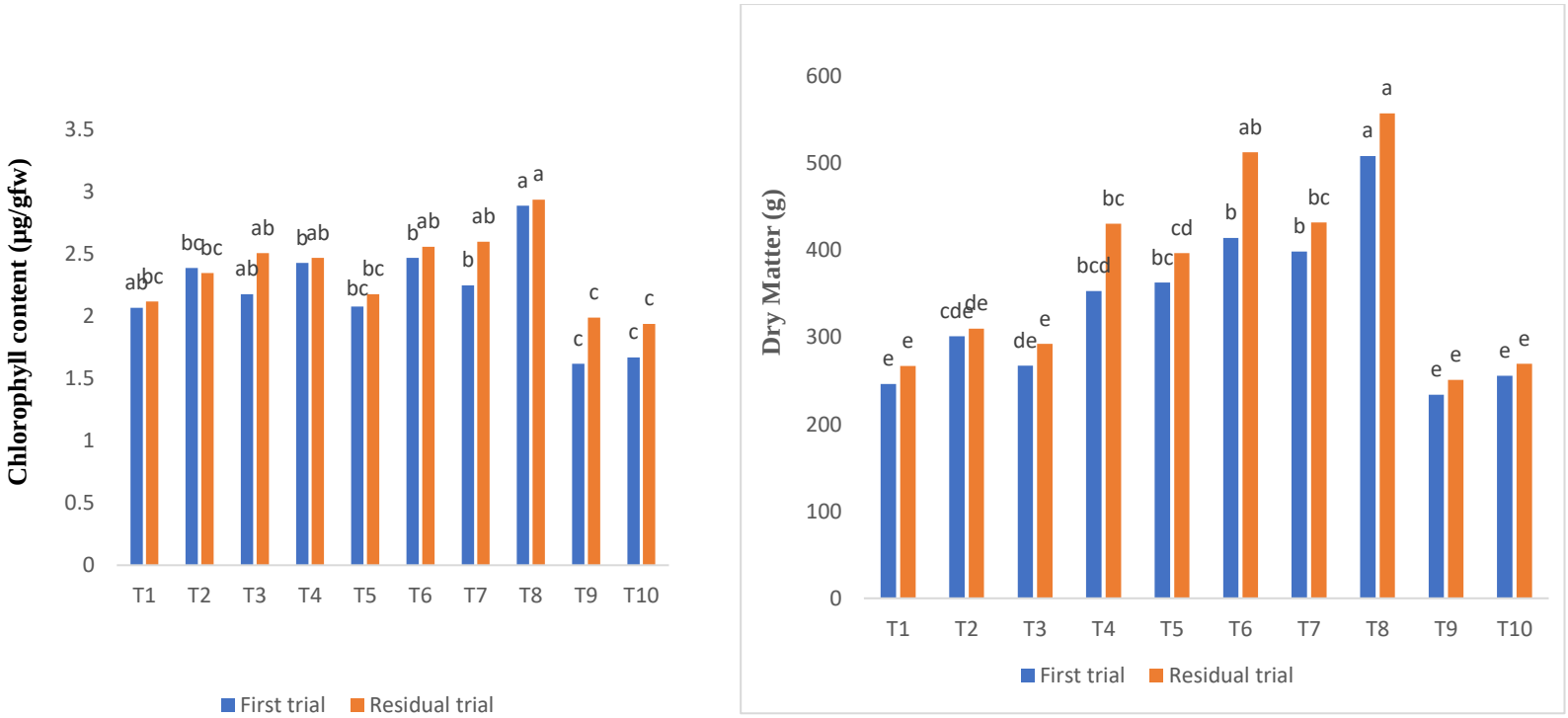


Fig 1: Immediate and Residual Effects of Cassava Peel and TC on chlorophyll content and total dry weight of Lima Bean Varieties. T1: Cassava peel compost at 5 t ha^{-1}+ B17, T2: Cassava peel compost at 5 t ha^{-1}+ LB 52, T3: TC at 5 t ha^{-1} +B17, T4: TC at 5 t ha^{-1}+ LB 52, T5: Cassava peel compost at 10 t ha^{-1}+ B17, T6: Cassava peel compost at 10 t ha^{-1}+ LB 52. T7: TC at 10 t ha^{-1} +B17, T8: TC at 10 t ha^{-1}+ LB 52, T9: B17 lima accession (No fertilizer application, T10: T9: LB 52 lima accession.

Table 2: Immediate and residual application of Lima bean yield to application of different compost types

	No of seed/pod		No of pod/plant		Pod length (cm)		100 seed weight (g)		Total Seed weight/plot (g)	
	First trial	Residual	First trial	Residual	First trial	Residual	First trial	Residual	First trial	Residual
5 t ha^{-1} CPC x B17	2.75^{de}	3.37^{bc}	262.83^{d}	246.35^{d}	7.12d^{ef}	7.55^{bc}	56.67^{e}	60.62^{de}	1898.10^{de}	1994.90^{de}
5 t ha^{-1} CPC x LB 52	3.75^{abc}	4.05^{b}	321.45^{c}	299.83^{c}	8.35^{cd}	8.70^{c}	59.20^{de}	58.52^{e}	1903.40^{de}	2037.20^{cd}
5 t ha^{-1} TC x B17	3.15^{cd}	3.47^{bc}	265.15^{d}	246.58^{d}	7.70^{de}	8.12^{bc}	59.67^{de}	63.35^{cde}	1917.40^{de}	2129.00^{bc}
5 t ha^{-1} TC x LB 52	3.52^{bc}	3.92^{bc}	350.13^{bc}	336.18^{bc}	9.85^{bc}	10.75^{b}	64.77^{cd}	73.40^{b}	2557.60^{abc}	2778.90^{ab}
10 t ha-1 CPC x B 17	3.15^{cd}	3.47^{bc}	348.78^{bc}	330.20^{bc}	700d^{ef}	7.47^{cd}	60.17^{de}	66.82^{bcd}	2207.60^{cd}	2346.50^{bc}
10 t ha-1 CPC x LB 52	3.87^{ab}	3.75^{bc}	378.30^{b}	361.58^{b}	10.72^{b}	11.75^{b}	74.82^{b}	82.20^{a}	2667.20^{ab}	2896.70^{ab}
10 t ha^{-1} TC x B17	3.42^{bc}	4.05^{b}	363.28^{bc}	345.38^{bc}	10.60^{b}	11.42^{b}	70.6^{7bc}	70.25^{bc}	2264.00^{bcd}	2401.80^{bc}
10 t ha^{-1} TC x LB 52	4.10^{a}	5.52^{a}	430.43^{a}	409.80^{a}	12.90^{a}	13.60^{a}	84.70^{a}	88.95^{a}	2871.70^{a}	3067.30^{a}
B17 Accession	2.37^{e}	2.47^{d}	210.10^{e}	200.65^{de}	05.67^{f}	6.77^{d}	37.5^{7f}	38.95^{g}	1485.30^{e}	126.40^{c}
LB 52 Accession	2.77^{de}	3.00^{cd}	205.90^{e}	188.58^{e}	6.12^{ef}	7.67^{cd}	43.15^{f}	49.32^{f}	1568.20^{e}	1430.20^{c}
S. E±	0.10	0.11	11.8	11.9	0.38	0.39	1.46	2.34	105.7	98.02

Mean followed by the same letter within the column are not significantly different according to DMRT at P=0.05. T1: Cassava peel compost at 5 t ha^{-1}+ B17, T2: Cassava peel compost at 5 t ha^{-1}+ LB 52, T3: TC at 5 t ha^{-1} +B17, T4: TC at 5 t ha^{-1}+ LB 52, T5: Cassava peel compost at 10 t ha^{-1}+ B17, T6: Cassava peel compost at 10 t ha^{-1}+ LB 52. T7: TC at 10 t ha^{-1} +B17, T8: TC at 10 t ha^{-1}+ LB 52, T9: B17 lima accession (No fertilizer application, T10: T9: LB 52 lima accession.

Total seed weight/plot (g)

The application of a higher rate (10 t ha^{-1}) of TC consistently resulted in significantly higher seed weight per plot in both trials. However, no significant difference was observed in the residual trial when cassava peel compost (CPC) at the same rate was applied to LB 52. The lowest total seed weight was observed in plots where no fertilizer was applied (Table 2).

Dry matter (g)

The application of TC at 10 t ha^{-1} with LB 52 (508.58 g) produced the highest Dry Weight and was substantially different (p=0.05) from all other treatments used in both trials. B17 without compost had the lowest dry weight (234 g in the first and 251 g in the residual).

Effect of initial application of different compost types on plant tissue analysis of Lima bean varieties

Plant tissue analysis for immediate and residual trial showed a significant increase (p=0.05) with the application of all treatments. All compost treatments resulted in higher plant nitrogen content compared to the control (B17 and LB 52), which had the lowest values (1.59–1.62% in the first trial and 1.50–1.54% in the residual trial). Lima bean LB 52 treated with 10t ha^{-1} TC had significantly higher nitrogen content (3.35% and 3.47%) in both trials. It was also observed that, regardless of the accessions planted, application of TC consistently led to higher plant nitrogen content than cassava peel compost at both application rates (5 and 10 t ha^{-1}) in both trials (Table 3).

The higher phosphorus content (PC) was observed in LB 52 amended with higher rate of TC and it has significant effect compared to other treatments applied while the least PC was observed in the control lima plant tissue. The trend was the same for Phosphorus content with LB 52 amended with higher rate of TC being significantly different from all treatments at the first trial, However, in the second trial, no significant difference in plant PC was observed with the application of a higher rate of TC and CPC to LB 52. Similar trend was observed in potassium content in both trial as the plant potassium content was significantly higher in LB 52 accession with the application of higher rate of TC. The magnesium content in plants was significantly higher in accession LB 52 when amended with higher application rates (10 t ha^{-1}) of TC compared to all other treatments, including the controls. Notably, the LB 52 accession exhibited a higher magnesium content than the B17 accession (Table 3). However, in the residual trial, no significant differences were observed among the treatments. The sodium content in the plant tissue of LB 52 and B17 accessions amended with TC at 10 t ha^{-1} did not differ significantly from each other. However, both exhibited significantly higher sodium content compared to all other treatments in both trials (Table 3).

Effect of initial application of different compost types on post cropping soil nutrient analysis of lima bean varieties

Soil analysis after harvesting showed a significant increase ($p<0.05$) in nutrient content of the soil treated with soil amendments. LB 52 and B17 lima accessions amended with TC at 10 t ha^{-1} exhibited significant higher residual nitrogen content, with values of 1.29-1.31%, respectively. interestingly, B17 and LB 52 accessions without compost application had the lowest Nitrogen content, with values of 0.17–0.21% in the first trial and slightly lower in the residual trial (0.17–0.18 %). The highest soil phosphorus content in the first trial was observed in soil amended with TC at 10 t ha^{-1} on LB 52 accession (20.18 mg/kg) and B17 accession (20.02 mg/kg). In contrast, the lowest phosphorus content was recorded in the control treatments, with B17 Accession at 13.15 mg/kg and LB 52 Accession at 13.52 mg/kg. Phosphorus content increased across all organic amendments, with the highest residual phosphorus content (27.87 mg/kg) observed in soil amended with TC at 10 t ha^{-1} on LB 52 accession. The highest soil potassium content was recorded in soil amended with TC at 10 t ha^{-1} on LB 52 accession (1.21%), followed by TC at 5 t ha^{-1} on B17 accession (1.10%) and TC at 10 t ha^{-1} on B17 accession (1.08%). These treatments were not significant differences from one another. Same trend was observed in the residual trial, also, there was a significant increase in the soil

Table 3: Immediate and residual effect of application of compost types on plant tissue analysis of Lima bean accessions.

	N (%)		P mg kg^{-1}		K Cmol kg^{-1}		Mg (cmol kg^{-1})		Na (cmol kg^{-1})		Ca (Cmol kg^{-1})	
Treatments	First trial	Residual	First trial	Residual	First trial	Residual	First trial	Residual	First trial	Residual	First trial	Residual
5 t ha^{-1} CPC x B17	2.61^{f}	2.66^{d}	1.31^{f}	1.39^{e}	3.78^{g}	3.82^{e}	1.24^{f}	1.30^{a}	1.42^{f}	1.47^{cd}	1.58^{a}	1.48^{d}
5 t ha^{-1} CPC x LB 52	2.73^{e}	2.77^{d}	1.51^{e}	1.57^{d}	4.26^{e}	4.33^{d}	1.48^{d}	1.50^{a}	1.76^{c}	1.52^{bc}	1.89^{e}	1.74^{c}
5 t ha^{-1} TC x B17	2.59^{f}	2.66^{d}	1.47^{e}	1.55^{d}	4.01^{f}	4.17^{d}	1.36^{e}	1.40^{a}	1.66^{d}	1.83^{abc}	1.80^{f}	1.89^{c}
5 t ha^{-1} TC x LB 52	2.99^{c}	3.10^{c}	1.79^{bc}	1.83^{c}	5.28^{c}	5.37^{bc}	1.79^{bc}	1.90^{a}	1.90^{b}	1.86^{abc}	2.37^{c}	2.42^{b}
10 t ha^{-1} CPC x B 17	2.87^{d}	2.98^{c}	1.67^{d}	1.76^{c}	5.19^{d}	5.30^{c}	1.70^{c}	1.80^{a}	1.55^{e}	1.99^{a}	1.80^{f}	1.67^{cd}
10 t ha^{-1} CPC x LB 52	3.17^{b}	3.24^{b}	1.76^{c}	1.82^{c}	5.57^{b}	5.64^{ab}	1.89^{b}	2.00^{a}	1.99^{b}	1.90^{ab}	2.66^{b}	2.51^{b}
10 t ha^{-1} TC x B17	3.12^{b}	3.26^{b}	1.84^{b}	1.93^{b}	5.28^{c}	5.37^{bc}	1.86^{b}	1.82^{a}	2.23^{a}	1.99^{a}	2.03^{d}	2.28^{b}
10 t ha^{-1} TC x LB 52	3.35^{a}	3.47^{a}	1.94^{a}	2.13^{a}	5.78^{a}	5.86^{a}	2.05^{a}	2.22^{a}	2.31^{a}	2.00^{a}	2.73^{a}	2.83^{a}
B17 Accession	1.59^{g}	1.50^{e}	1.11^{g}	0.98^{f}	3.34^{h}	2.46^{f}	0.85^{h}	0.90^{a}	1.22^{h}	1.02^{e}	1.70^{g}	1.25^{e}
LB 52 Accession	1.62^{g}	1.54^{e}	1.11^{g}	1.00^{f}	2.68^{i}	2.46^{f}	1.00^{g}	0.90^{a}	1.23^{g}	1.10^{e}	1.09^{i}	1.09^{e}
S. E±	0.07	0.1	0.04	0.05	0.01	0.19	0.07	0.08	0.02	0.06	0.02	0.09

Mean followed by the same letter within the column are not significantly different according to DMRT at P=0.05. T1: Cassava peel compost at 5 t ha^{-1}+ B17, T2: Cassava peel compost at 5 t ha^{-1}+ LB 52, T3: TC at 5 t ha^{-1} +B17, T4: TC at 5 t ha^{-1}+ LB 52, T5: Cassava peel compost at 10 t ha^{-1}+ B17, T6: Cassava peel compost at 10 t ha^{-1}+ LB 52. T7: TC at 10 t ha^{-1} +B17, T8: TC at 10 t ha^{-1}+ LB 52, T9: B17 lima accession (No fertilizer application, T10: T9: LB 52 lima accession.

potassium content in all treatments except in control plot (Table 4).

The results of this study highlight the residual benefits of compost treatment on crop yield, particularly regarding lima bean performance. Organic amendments such as cassava peel compost (CPC) and *Tithonia diversifolia* compost (TdC) not only supply essential nutrients but also contribute to improved soil physical and biological properties, ultimately enhancing crop performance (e.g., increased chlorophyll content and dry matter) compared to unfertilised controls. The increased soil nutrient content recorded in this study further supports the premise that compost enhances soil structure and improves soil fertility, which directly promotes sustainable crop production (Ogunwole, *et al.*, 2010; Sara *et al.*, 2024). These findings also corroborate broader research showing that compost enriches soil organic matter, improves nutrient availability, and enhances plant growth parameters in diverse cropping systems (e.g., maize, legumes) by releasing nutrients gradually over time (Mulugeta and Getahun, 2020; Omokaro *et al.*, 2024; Adebayo *et al.*, 2025). The observed improvements in lima bean yield under residual compost conditions suggest that organic amendments provide a sustained nutrient release, which benefits subsequent cropping cycles (Diacono and Montemurro, 2010; Zerga and Tsegaye, 2019). Notably, the higher residual effect observed at the 15 t ha^{-1} application rate highlights the long- term contribution of compost to soil nutrient dynamics. This supports the findings of Sayara *et al.*, (2020). who reported that compost application at higher rates extends its effectiveness beyond the initial season by enhancing soil nutrient retention.

The observed superior performance of the LB 52 variety under higher rates of Tithonia compost suggests that both the nutrient content of the compost and the rate of application are critical determinants of crop response (Fatubarin and Olojugba, 2014). *Tithonia diversifolia* is widely recognised for its relatively high nutrient content and rapid decomposition, which can make nutrients more readily available to plants (Okonji *et al*., 2023; Adebayo *et al*., 2025). This is consistent with the greater increases in soil nitrogen, potassium, and potassium observed in plots receiving 10 t ha^{-1} of TdC compared to lower application rates or CPC. In contrast, cassava peel-based compost, while contributing to soil organic matter and microbial activity, typically has a higher C:N ratio and slower nutrient release (as indicated in comparative analyses of compost nutrient properties), which may partly explain the relatively lower yield responses (Adebayo *et al*., 2025).

The residual effects observed in this study underscore the importance of compost in sustainable nutrient management. The improved crop performance and enhanced soil nutrient status in the residual trial reflect the capacity of organic amendments to provide a sustained release of nutrients beyond the initial cropping season, reducing the need for frequent fertilizer application (Mulugeta and Getahun, 2020). This is a critical advantage in low-input systems, especially in smallholder contexts where access to synthetic fertilisers may be limited or expensive. Similar trends have been reported in maize and other crops, where compost-treated plots exhibited enhanced yield parameters in subsequent seasons compared to inorganic fertilisers alone (Adebayo *et al.*, 2025).

Despite these benefits, some variations in residual compost effects were observed in compost types, likely due to differences in decomposition rates and nutrient mineralization processes. Tithonia compost exhibits a more robust residual effect compared to cassava peel compost. This advantage is primarily due to its rapid decomposition, high nutrient content, and stimulation of beneficial soil biological processes (Blouin *et al.*, 2019). Tithonia compost demonstrated a significantly higher residual impact on both plant growth and soil chemical properties in post-cropping seasons. This observation is consistent with findings by Mutabazi *et al.*, (2021), who reported that Tithonia biomass, due to its low C:N ratio and high nutrient concentrations particularly in nitrogen (N), phosphorus (P), and potassium (K) mineralizes rapidly and contributes to sustained nutrient availability in the soil. The nutrient-rich residues of Tithonia not only support the immediate crop cycle but also enhance the nutrient pool for subsequent crops through continued decomposition and microbial activity. In contrast, cassava peel compost, though a valuable organic input, exhibited a comparatively lower residual benefit. Its relatively

higher lignin and cellulose content, coupled with a higher C:N ratio, results in slower decomposition and delayed nutrient release (Adekiya *et al.*, 2020).

Conclusion

The findings of this study demonstrate that compost application significantly enhances the growth performance, yield, and soil nutrient status of lima bean, with effects persisting beyond the initial cropping cycle. Both cassava peel compost and *Tithonia diversifolia* compost, when enriched with poultry manure, improved chlorophyll content, dry matter accumulation, and soil nutrient status compared with the control, confirming the agronomic value of organic amendments in legume-based systems. Among the compost types, *Tithonia diversifolia* compost applied at 10 t ha^{-1} consistently produced superior results, particularly in the LB 52 variety, indicating a strong interaction between compost quality, application rate, and varietal response. These results support the integration of compost-based soil amendments, particularly *Tithonia diversifolia* compost at higher application rates, as a sustainable approach for improving lima bean production

References

AAFRD. (2005). Composting manual. Livestock Engineering Unit and Environmental Practice Unit, Technical Services Division, Alberta Agriculture, Food and Rural Development, 1–21.

Abd El Lateef, E. M., Selim, M. M., Asal, M., Wali, A. S., and Abd El-Salam, M. S. (2023). Cumulative and residual effects of compost in different crop rotations under sandy soil conditions. *Journal of Global Innovations in Agricultural Sciences*, *11*(2), 113–125.

Adebayo, A. K., Olanipekun, S. O., Anjorin. F. B. and Ogedengbe, T. E. (2025). Comparative evaluation of the biological, chemical properties, and nutrient content of *Tithonia diversifolia* and cassava peel composts as sustainable soil amendments. *Egyptian Journal of Agricultural Research, 10*(1), 102-111.

Adebayo, A. K., Adejumo, S. A., Anjorin, F. B. and Olanipekun, S. O. (2025). Comparative Effects of cassava peel compost, *Tithonia Diversifolia* compost, and NPK Fertilizer on maize performance in Ibadan. *Journal of Applied Life Sciences and Environment*, *58*(1), 71-84.

Adediran, J. A., De Baets, N., Mnkeni, P. N. S., Kiekens, L., Muyima, N. Y. O. and Thys, A. (2003). Organic waste materials for soil fertility improvement in the border region of the Eastern Cape, South Africa. *Biological Agriculture & Horticulture*, *20*(4), 283-300

Adekiya, A. O., Olayanju, A., and Ewulo, B. S. (2020). Comparative effects of cassava peel compost and poultry manure on soil properties, growth and yield of maize. *Journal of Soil Science and Plant Nutrition*, *20*(2), 543–552.

Aina, B. M., Saliu, A. O. and Adewole, M. B. (2023). Soil properties and carbon sequestration using biochar and compost on an Alfisol in Southwest Nigeria. Digital Economy, Energy and Sustainability. pp 141-155.

Amadi, N., Yabrade, M. and Okubor, P. C. (2024). Impact of cassava peel on soil nutrient and microbial restoration of crude oil contaminated soil in Rivers State, Nigeria. *Scientia Africana*, *23*(4), 141-156.

Ayilara, M., Olanrewaju, O., Babalola, O. and Odeyemi O. (2020). Waste management through composting: challenges and potentials. *Sustainability*, *12*(11), 4456.

Baijukya, F. P., Njeru, R. W. and Vanlauwe, B. (2023). Leveraging organic resources for sustainable intensification in sub-Saharan Africa: The role of *Tithonia diversifolia*. *Agriculture, Ecosystems and Environment, 349*, 108434. https://doi.org/10.1016/j.agee.2023.108434.

Blouin, M., Barrere, J., Meyer, N. and Lartigue, S. (2019). Vermicompost significantly affects plant growth. A meta-analysis. *Agronomy for Sustainable Development*, *39*(4).

Bray, R. H. and Kurtz, L. T. (1945). Determination of total organic and available forms of phosphorus in soils. *Soil Science*, *59*, 39-45.

Bremner, J. M. (1965). Total nitrogen. In C. A. Black (Ed.), Methods of Soil Analysis: Part 2. Chemical and Microbiological Properties (Agronomy Monograph No. 9, Part 2, pp. 1149–1178). American Society of Agronomy, Wisconsin.

Bouyoucos, G. J. (1936). Directions for making mechanical analysis of soils by the hydrometer method. *Soil Science, 42*(3), page?

Diacono, M. and Montemurro, F. (2010). Long-term effects of organic amendments on soil fertility. *Review of Agronomy Sustainable Development*, *30*, 401–422.

Duncan, D. B. (1955). Multiple range and multiple F-test. *Biometrics 11,* 1–42.

Eboibi, O., Akpokodje, O. I. and Uguru, H. (2018). Growth performance of five bean (*Phaseolus* spp) varieties as influenced by organic amendment. *Journal of Applied Science and Environmental Management*, 22(5), 759–763.

Fatubarin, A. and Olojugba, M. R. (2014). Effect of rainfall season on the chemical properties of the soil of a Southern Guinea Savanna ecosystem in Nigeria. *Journal of Ecology and Natural Environment*, *6*(4), 182-189.

Haile, M. A., Karanja, N. N., Nyawade, S. O., Gitari, H. I., Cheruto, G., Nyawira, L., Raza, M. A. and Kamau, S. (2022). Lupin and Lima Beans diminish potatoes' N and P uptake, Uptake Efficiency and Use Efficiency. *European Potato Journal*, 67(1), 37-53.

Jackson, M. L. (1962). Soil chemical analysis. Prentice Hall, New York. pp. 263-268.

Jesmin, T., Mulvaney, R. L. and Boutton, T. W. (2023). Residue- and nitrogen-induced carbon mineralization varies with soil fertility status. *Soil Science Society of America Journal*, *87*(3), 541-554.

Larkin, P. (2020). Effects of selected soil amendments and mulch type on soil properties and productivity in organic vegetable production. *Agronomy*, *10*(6), 795-800.

Louzada Rodrigues, T., Martins da Costa, E., de Almeida Ribeiro, P.R., de Carvalho, F., Rufini, M.; Oliveira Silva, A., dos Santos Teixeira, A.F., de Assis Pereira, T., Reis Sales, F., and de Souza Moreira, F.M. (2021). Diversity and biotechnological potential of rhizobia isolated from lima bean nodules collected at a semiarid region. *Soil Science Society of America Journal*, *85*, 1663–1678.

lsalam, H. E. A., El-Sharnouby, M. E., Mohamed, A. E., Raafat, B. M., and El-Gamal, E. H. (2021). Effect of sewage sludge compost usage on corn and faba bean growth, carbon and nitrogen forms in plants and soil. *Agronomy 11*, 1–20.

Martínez-Blanco, J., Lazcano, C., Christensen, T.H., Muñoz, P., Rieradevall, J., Møller, J., Antón, A. and Boldrin, A. (2013). Compost benefits for agriculture evaluated by life cycle assessment. A review. *Agronomy for Sustainable Development*, *33*, 721–732.

Martins da Costa, E., de Almeida Ribeiro, P.R., de Lima, W., Palhares Farias, T., de Souza Moreira, F.M. (2017). Lima bean nodulates efficiently with Bradyrhizobium strains isolated from diverse legume species. *Symbiosis*, *73*, 125–133.

Mulugeta, A. and Getahun, B. (2020). Effects of Organic Amendments on Soil Fertility and Environmental Quality: A Review. *Journal of Plant Sciences*, *8*(5): 112-119.

Musa, A., Zanna, F. M., Wakil, N. A. and Gujja, A. A. (2022). Perception of the environmental impact of chemical fertilizer application by vegetable farmers along river Ngadda of Maiduguri, Borno State, Nigeria. *Applied Science and Environmental Management*, *26* (1), 105-108.

Mutabazi, S., Nhamo, N. and Mafongoya, P. L. (2021). Residual effects of integrated nutrient management using Tithonia diversifolia on maize yield and soil fertility. *Nutrient Cycling in Agroecosystems*, *120*, 253–265.

Nelson, D. W. and Sommer, L. E. (1982). Total carbon, organic carbon and organic matter. methods of soil analysis, Part 2. Chemical and Microbiological Properties, 2nd Edition. ASA-SSSA, Madison, 595-579.

Nemet, F., Perić, K. and Lončarić, Z. (2021). Microbiological activities in the composting process–A review. *COLUMELLA–Journal of Agricultural and Environmental Sciences*, *8*(2), 41-53

Nweke, I. A. (2018). Residual effect of organic waste amendment on soil productivity and crop yield: A Review. *Greener Journal of Agricultural Science*, *8*(9), 209-216.

Ogunwole, J., Iwuaf or, E. O., Eche, N., and Jels, J. (2010). Effect of organic and inorganic soil amendments on soil physical and chemical properties in a West African savanna agroecosystem. *Tropical and Subtropical Agroecosystems*, *12*, 247–255.

Ojewole, G. O., Pam, H. D., Joseph, E., Idrisu, M., Liadi, M. T. and Oyerinde, A. A. (2023). Evaluation of *Tithonia diversifolia* and cattle dung on the growth of maize at University of Abuja Teaching and Research Farm. *Journal for Undergraduate Research, 1*(2),1-5.

Okonji, C. J., Adewale, D., Obisesan, O. I., Osundare, O. I. and Ahaneku, C. G. (2023). Impact of *Tithonia diversifolia* as *Green Manure Amendment on Yield and Yield Attributes OF Maize* (*Zea mays*.). *Badeggi Journal of Agricultural Research and Environment, 5*(1), 01-14.

Oluwatoyin, A. B., Lawal, O. A. and Yusuf, M. T. (2023). Organic soil amendments and their influence on nutrient uptake and yield of legumes. *African Journal of Agricultural Research, 18*(3), 287–295.

Omokaro, G.O., Osarhiemen, I.O., Idama, V. and Airueghian, E. (2024). The role of organic amendments and their impact on soil restoration: A review. *Asian Journal of Environment and Ecology, 23*(11), 45-52.

Ranjan, S., Kumar, S., Dutta, S. K., Sow, S., Kumar, S. and Sushant. (2023). Long-term organic amendment application improves soil fertilty status, nutrient accumulation and crop productivity under rice-wheat cropping system. *Communication in Soil Science and Plant Analysis, 54*, 18-23.

Sara, S. S., Shuaibu, Y. M. and Garba, A. A. (2024). Influence of organic manure sources and urea deep placement on the production of maize (*Zea mays*) in Bauchi state, Nigeria. *Nigerian Journal of Agriculture and Agricultural Technology*, *4*(2), 811-1893.

Sayara, T., Basheer-Salimia, R., Hawamde, R. and Sánchez, A. (2020). Recycling of organic wastes through composting: Process performance and compost application in agriculture. *Agronomy, 10*(11), 1838.

Setyowati, N., Hutapea, J. V. and Muktamar, Z. (2022). Mexican sunflower (*Tithonia diversifolia*) compost as substitution of synthetic fertilizers for sweet corn in Ultisols. October 2024

Taaime, N., El Mejahed, K., Oukarroum, A., Choukr-Allah, R., Pittelkow,C., Bouabid, R. and El Gharous, M. (2024). Residual effects of compost and manure fertilizers on quinoa production and nutrient uptake. *Journal of Soil Science and Plant Nutrition*, *24*, 4338–4348.

Temiz, C., Akca, M. O., Cayci, G.,and Baran, A. (2020). Assessment of the effect of different compost materials on aggregation and mechanical properties in an Entisol. *Communication in Soil Science and Plant Analysis*, *52*, 871-885.

Wintermans, J.F. and Mots, A. (1965). Spectrophotometric characteristics of chlorophylls a and b and their pheophytins in ethanol. *Biochemical, Biophysic. Acta*; *109*, 448-453.

Wright, J., Kenner, S. and Lingwall, B. (2022). Utilization of compost as a soil amendment to increase soil health and to improve crop yields. *Journal of Soil Science*, *12*(6), 216-224.

Zerga, K. and Tsegaye, B. (2019). Effect of different rates of compost application on growth performance and yield components of carrot (*Daucus carrota L.). International Journal of African and Asian Studies, 54*, 27-36.