



## Evaluation of poultry manure rates on growth and yield attributes of Kapok seedlings in Southeastern Nigeria

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### ABSTRACT

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A pot experiment examined the effect of poultry manure rates on Kapok seedlings' growth by evaluating above- and below-ground biomass production at the Teaching and Research Farms of the Department of Crop Science, University of Nigeria, Nsukka. The experiment was laid out in a completely randomized design (CRD) with five replications. Poultry manure (PM) was applied at five treatment rates (0, 10, 20, 30, and 40 t ha<sup>-1</sup>) to Kapok seedlings, and parameters for growth and yield were measured at different time periods. Data collected were subjected to statistical analysis of variance (ANOVA). Results indicate that seedlings treated with 40 t ha<sup>-1</sup> of PM showed consistent growth in plant height. Poultry manure rates had a significant effect ( $p < 0.05$ ) on stem girth across the months, except at 2 MAT, with the application of 40 t ha<sup>-1</sup> of PM consistently leading to greater stem girth measurements. A significant influence ( $p < 0.05$ ) of PM rates was detected on the dry weight of shoot and whole seedling biomass, and the application of 40 t ha<sup>-1</sup> of PM recorded higher yield values compared to other treatments. The application of poultry manure at 40 t ha<sup>-1</sup> consequently favored increases in above- and below-ground biomass accumulation of Kapok seedlings, indicating its potential for organic production of Kapok seedlings.

**Contribution/Originality:** This study contributes to the existing literature by exploring the effect of poultry manure application on kapok seedlings. It offers new insights into poultry manure use for kapok seedlings grown in Nigeria and enhances understanding of biomass accumulation in tree plant seedlings for sustainable agroforestry.

## 1. INTRODUCTION

The Kapok tree, *Ceiba pentandra* (L.) Gaertn. belongs to the family Malvaceae (Pezzini et al., 2021). It is a large, hermaphroditic tree native to Central and South America, the Caribbean, and North West Africa. The tree is also known as the cotton silk tree (Sahid & Zeven, 2003).

In Nigeria, it is called Rimi (Hausa), Araba (Yoruba) and Akpu-ogwu (Igbo) (Chaiarekij, Apirakchaiskul, Suvarnakich, & Kiatkamjornwong, 2011). Gibbs and Semir (2002) stated that most *Ceiba* species flowering occurs when trees have no leaves and they produce digitate leaves. Anthesis of the flowers opens during sunset or at night. The flowers have five petals with corolla colors ranging from white, cream, pink, to red (Gómez-Maqueo & Gamboa-deBuen, 2022). Bats, bees, butterflies, and moths are pollinators of *Ceiba* species. The kapok tree is especially valued

for its fiber, but also supplies food, medicines, and many commodities. According to Fern (2025), the tree has become naturalized in many areas throughout the tropics for medicines and fibre.

Soil amendment using organic fertilizers (poultry manure) has proven to boost soil productivity, enhance soil organic carbon content, soil micro-organisms, improve soil structure, the nutrient status of the soil, and increase crop yield (FAO, 2000; Udoh, Abubakar, & Okorie, 2005). According to Stiles (2017), poultry manure as a by-product of poultry production is nutrient-rich, providing a major source of nitrogen, phosphorus, potassium and trace elements for plant growth. Using poultry manure as a fertilizer for crops or trees can meet some or all plant nutrient needs. The high demand for sustainable agriculture has driven the search for natural resources to enhance crop production, improve soil fertility, and promote environmental health (Ahmadi & Arien, 2022). The continuous use of synthetic fertilizers in intensive cropping systems leads to increased soil acidity and nutrient imbalance, which adversely affects soil health because of their susceptibility to losses through gaseous form and by leaching (Amoah, Miyagawa, & Kawakubo, 2012). Dos Passos, De Rezende, Carvalho, and Aker (2014) stated that poultry manure can help in soil when used to improve water holding capacity, soil aeration and soil structure that results to high yield of plants. Hence, this study aims to evaluate poultry manure effects on growth and biomass accumulation of Kapok seedlings in Southeastern Nigeria.

## 2. MATERIALS AND METHODS

Kapok seed (Sourced from Kabba, Kogi state), rice husk (Sourced from Adani, Nsukka), cement bags, soil, poultry manure, weighing scale, 30L bucket, white thread and measuring tape.

### 2.1. Methods

The ground nursery was established in a 1m x 2m raised bed beneath a Kapok tree shed at the Kapok tree plantation. Soil amendment involved supplementing the soil with rice husk at a volume ratio of 7:3 (70% soil to 30% rice husk) to improve water retention in the growing medium. The mixture was filled into 25 cement bags, each weighing 24kg, using a scale. These bags were placed in an open field with a planting distance of 50cm x 50cm. The mixture in the bags was left to decompose for two weeks, with daily watering to facilitate proper breakdown. Transplanting occurred eight weeks after planting. Five rates of poultry manure 0, 10, 20, 30, and 40 tons per hectare were applied in split doses. The initial 50% of each manure treatment was applied two weeks after transplanting at rates of 0, 5, 10, 15, and 20 tons per hectare. The remaining 50% was applied six weeks after transplanting. Cultural practices included weed control through hoeing and hand-pulling, along with watering four times weekly to minimize nutrient loss through drainage. These practices aimed to optimize plant growth and soil health, ensuring proper nutrient availability and water management throughout the nursery development process.

### 2.2. Experimental Design and Field Layout

The field experiment was laid out as CRD, a completely randomized design made up of 25 experimental units with five PM rates, replicated five times (0, 10, 20, 30 and 40 t ha<sup>-1</sup>).

### 2.3. Data Collection

Data collection started two months after transplanting. Data was taken on the Plant height (Height of each plant was measured in cm from the ground to the apex with the use of measuring tape and the average taken), number of leaves (The leaves of each plant was counted and the average recorded), stem girth (The stem of each plant was measured round at 5 cm above ground level using white thread and measuring tape and the average recorded) and number of branches (The branches of each plant was counted and the average taken). All the data was taken at 2, 3, 4, 5, 6 and 7 months after transplanting (MAT).

The destructive sampling of three sampled plants for each treatment rate was done at 7 months of data collection for biomass assessment. Data taken were root length (Length of each plant root was measured in cm from the region between the shoot base to the root cap with the use of measuring tape and the average taken). The fresh shoots and roots were dried in an oven until a constant dry weight (g) was obtained to estimate the dry matter yield. Dry weights (g) of shoots and roots, shoots/roots (S/R) ratio, percentage dry matter shoots and roots (%DMS and %DMR) were determined.

#### 2.4. Statistical Analysis

All collected data were analyzed using analysis of variance (ANOVA) with (Genstat, 2013) software, following the CRD procedure. Means separation to assess poultry manure effects was performed using the least significant difference (LSD) at a 5% probability level.

### 3. RESULTS

#### 3.1. Plant Height (cm)

The application of poultry manure (PM) did not exhibit a significant ( $p > 0.05$ ) impact on the height of Kapok seedlings at 2, 3 and 7 months after transplanting (MAT). However, there were notable differences observed at 4, 5, and 6 MAT (Table 1). Seedlings treated with 40 t ha<sup>-1</sup> of PM showed consistent growth in plant height, measuring 81.5, 109.5 and 127.30 cm at 4, 5, and 6 MAT, respectively. Conversely, plants in the control plots, where no PM was applied, demonstrated the shortest height, measuring 50.2, 80.2 and 90.1 cm, respectively.

**Table 1.** Effect of poultry manure rates on plant height(cm) of Kapok seedlings in months after transplanting.

PM Rates (t/ha)	MONTHS AFTER TRANSPLANTING (MAT)					
	2	3	4	5	6	7
Control	8.6	18.7	50.2	80.2	90.1	114.9
10 t/ha	9.42	27.1	61.2	89.9	107.9	135.9
20 t/ha	8.92	37.9	72.3	98.7	114.0	141.0
30 t/ha	9.08	24.4	65.2	88.8	107.5	137.8
40 t/ha	9.14	32.7	81.5	109.5	127.3	161.3
<b>LSD</b> (0.05)	<b>NS</b>	<b>NS</b>	<b>19.9</b>	<b>18.24</b>	<b>22.91</b>	<b>NS</b>

**Note:** Ha= hectare; t= Ton; PM= Poultry Manure, NS= Non-significant; MAP= Months after planting.

#### 3.2. Stem Girth (cm)

According to the results presented in Table 2, the application rates of poultry manure had a significant effect ( $p < 0.05$ ) on stem girth across the months, except at 2 MAT. Specifically, at 2 and 3 MAT, the use of 20 t ha<sup>-1</sup> of PM resulted in producing the highest stem girth of 0.5 and 2.34 cm, respectively, compared to other treatments. However, starting from 4 MAT and continuing through 7 MAT, the application of 40 t ha<sup>-1</sup> of PM consistently led to greater stem girth measurements (6.66, 8.3, 10.22 and 11.34 cm, respectively).

**Table 2.** Effect of poultry manure rates on stem girth(cm) of Kapok seedlings in months after planting.

PM Rates (t/ha)	MONTHS AFTER TRANSPLANTING (MAT)					
	2	3	4	5	6	7
Control	0.36	0.97	3.88	6.08	7.28	8.30
10 t/ha	0.37	1.46	5.02	6.88	8.28	9.92
20 t/ha	0.50	2.34	5.62	7.20	8.34	9.78
30 t/ha	0.39	1.48	5.30	7.02	8.62	9.50
40 t/ha	0.45	1.64	6.66	8.30	10.22	11.34
<b>LSD</b> (0.05)	<b>NS</b>	<b>0.596</b>	<b>1.649</b>	<b>1.31</b>	<b>1.457</b>	<b>1.769</b>

**Note:** Ha= hectare; t= Ton; PM= Poultry Manure, NS= Non-significant; MAP= Months after planting.

### 3.3. Number of Leaves

The analysis of variance (ANOVA) results presented in Table 3 indicated that poultry manure application rates had a significant effect ( $p < 0.05$ ) on the number of leaves at 3, 4, 6, and 7 except at 2 and 5 MAT. Plants treated with 20 t ha<sup>-1</sup> of PM had the highest number of leaves (18.6) at 3 MAT and showed a tendency to produce more leaves (5.8) at 2 MAT. Conversely, applying 40 t ha<sup>-1</sup> of PM increased leaf numbers to 30.2, 63.4, and 104.4 at 4, 6, and 7 MAT, respectively. It also tended to yield more leaves (49.8) at 5 MAT, indicating a dose-dependent response in leaf production over time.

**Table 3.** Effect of poultry manure rates on number of leaves of Kapok seedlings in months after transplanting.

PM Rates (t/ha)	Months After Transplanting (MAT)					
	2	3	4	5	6	7
Control	4.8	10.2	20.4	36.4	38.4	57.2
10 t/ha	4.4	12.2	28.0	45.0	61.0	84.0
20 t/ha	5.8	18.6	30.0	40.0	59.8	90.8
30 t/ha	3.6	10.4	26.4	41.0	49.4	78.0
40 t/ha	4.0	13.4	30.2	49.8	63.4	104.4
<b>LSD</b> <sub>(0.05)</sub>	<b>NS</b>	<b>4.912</b>	<b>6.485</b>	<b>NS</b>	<b>15.16</b>	<b>23.19</b>

**Note:** Ha= hectare; t= Ton; PM= Poultry Manure, NS= Non-significant; MAP= Months after planting.

### 3.4. Number of Branches

Table 4 indicates that the application rates of poultry manure in months 4, 5, 6, and 7 did not result in significant variations ( $p > 0.05$ ) in the number of branches, except at 3 MAT. No branch yield was recorded at 2 MAT. Notably, the use of 20 t ha<sup>-1</sup> of PM as an amendment led to a greater number of branches at 3 MAT (3.4), while 30 t ha<sup>-1</sup> of PM resulted in no branch yield. The lowest number of branches was observed in plants grown without soil amendment from 4 to 7 MAT (2.2, 2.8, 2.8, and 4, respectively). Interestingly, at 7 MAT, plants treated with 10 t ha<sup>-1</sup> of PM produced more branches (6.6).

**Table 4.** Effect of poultry manure rates on number of branches of Kapok seedlings in months after transplanting.

PM Rates (t/ha)	Months After Transplanting (MAT)				
	3	4	5	6	7
Control	0.2	2.2	2.8	2.8	4.0
10 t/ha	1.4	3.6	4.6	4.4	6.6
20 t/ha	3.4	4.6	4.6	3.6	5.0
30 t/ha	0.0	2.6	3.6	3.6	4.4
40 t/ha	1.6	2.6	5.0	5.6	6.0
<b>LSD</b> <sub>(0.05)</sub>	<b>1.679</b>	<b>NS</b>	<b>NS</b>	<b>NS</b>	<b>NS</b>

**Note:** Ha= hectare; t= Ton; PM= Poultry Manure, NS= Non-significant; MAP= Months after planting.

### 3.5. Dry Matter Attributes at 7 Months after Transplanting

Table 5 revealed that there were no significant variations ( $p > 0.05$ ) observed in the length of the longest root. However, significant influence ( $p < 0.05$ ) of PM rates was detected on the dry weight of shoot and the whole seedling. Moreover, poultry manure rates did not significantly influence the dry matter allocation of roots ( $p > 0.05$ ).

Regarding the length of the longest root, there was a trend indicating that 20 t ha<sup>-1</sup> of PM had the longest root (53.5 cm), followed by 30 t ha<sup>-1</sup> (49.3 cm), and then 40 t ha<sup>-1</sup> (48.7 cm). Plots treated with 40 t ha<sup>-1</sup> of PM showed a tendency to have heaviest dry weight of root (132.2 g), while the control plots exhibited lesser root dry matter attributes (66.2 g). Moreover, the application of 40 t ha<sup>-1</sup> of PM resulted in more shoot and whole seedling dry matter attributes (225.8 and 358 g, respectively), while the control plots yielded less (87.2 and 153 g, respectively).

**Table 5.** Effect of poultry manure rates on the dry matter attributes of Kapok seedlings at 7 months after transplanting.

PM rates (t/ha)	Lt. longest root(cm)	Dry wt. root (g)	Dry wt. shoot (g)	Total d.wt. (g)	S/R	% DMR	% DMS
Control	45.7	66.2	87.2	153.0	1.310	43.3	56.7
10 t/ha	43.0	76.8	112.3	189.0	1.570	39.8	60.2
20 t/ha	53.5	95.9	210.7	307.0	2.217	31.2	68.8
30 t/ha	49.3	82.9	173.8	257.0	2.090	32.3	67.7
40 t/ha	48.7	132.2	225.8	358.0	1.807	36.3	63.7
<b>LSD</b> <sub>(0.05)</sub>	<b>NS</b>	<b>NS</b>	<b>69.46</b>	<b>117.3</b>	<b>0.6017</b>	<b>7.95</b>	<b>7.95</b>

**Note:** Ha= hectare; t= Ton; PM= Poultry Manure, NS= Non-significant; MAP= Months after planting; Lt.LR = Length of Longest root; Dry wt. root = Dry weight of roots; Dry wt. shoot= Dry weight of shoot; Total d.wt. = Total dry weight of shoot and root; S/R= shoot to root ratio; % DMR= percentage dry matter of root; % DMS= percentage dry matter of shoot.

#### 4. DISCUSSION

The study indicates that poultry manure can enhance kapok yield, aligning with findings by Olajide (2024) and research on amaranthus by Okoli and Nweke (2015). Poultry manure did not significantly influence seedling height at 2, 3, and 7 months post-transplanting, implying other factors affected growth during these periods. However, applying poultry manure, especially at 40 t/ha, notably promoted seedling growth during the middle to later stages, resulting in taller plants compared to untreated seedlings. This underscores poultry manure's role as a valuable supplement for improving kapok seedling development, particularly during key growth phases (Olajide, 2024). These findings are consistent with studies by Direkvandi, Ansari, and Dehcordie (2008) and Ayeni, Omole, Adeleye, and Ojeniyi (2010) on tomatoes, which also showed that applying poultry manure increased plant height. Additionally, regardless of the treatments applied, plant height, indicating growth rate, increased as the plants aged, aligning with observations from Ansa and Woke (2018) on Cayenne Pepper (*Capsicum frutescens L.*).

Also, the findings suggest that the optimal PM application rate for leaf production varies across different stages of plant growth. While lower application rates may satisfy demands initially, higher rates become more effective in promoting leaf production as the plants mature. This deepens the importance of tailoring PM application rates to specific growth stages to maximize leaf yield and overall plant health (Shanmugavel, Rusyn, Solorza-Feria, & Kamaraj, 2023). This finding is similar to the findings of Alim, Muhammad, and Isah (2022), who reported increased plant height and number of leaves of maize resulting from the application of a higher rate of poultry manure. Fagimi and Odebode (2007) also reported increased plant height and number of leaves of pepper resulting from the application of a higher rate of poultry manure. It is also similar to the report of Enujeke (2013) on the increased plant height and number of leaves of maize resulting from application of a higher rate of poultry manure. The findings of Olajide, Ndubuaku, and Baiyeri (2023) regarding *Saba senegalensis* indicate that poultry manure application exceeding 20 t ha<sup>-1</sup> can reduce leaf number and vine length. The absence of significant effects at specific months highlights the importance of careful interpretation and considering multiple factors that influence plant growth dynamics. Accurate analysis is essential for effective agricultural management and research conclusions.

The effects of poultry manure (PM) application rates on the number of branches across various months showed the dynamics of plant branching in response to different treatments. Remarkably, plants grown without soil amendment exhibited the lowest number of branches across the subsequent months (4 to 7 MAT), emphasizing the importance of soil enrichment for promoting branch development. Different report had supported this finding (Agba, 2019; Alim et al., 2022; Baiyeri & Mbah, 2006). On that note, as reported by Nsukka soils are known for their acidity, which hinders the amount of nutrients available to plants (Baiyeri & Mbah, 2006). Hence, the application of organic manure becomes necessary in order to boost crop yield. An observation arises at 7 MAT, where plants treated with 10 t ha<sup>-1</sup> of PM surprisingly produced more branches (6.6) compared to other application rates.

It was noted that the dry matter distribution pattern favored the above-ground portion of the plant and this result agreed with findings from Ugese (2010) on growth of tamarind (*Tamarindus indica L.*) seedlings. This finding aligns with Boateng, Zickermann, and Kornahrens (2006), who reported that maize yield was highest on plots treated

with poultry manure. The study found that higher application rates (4, 6, and 8 t/ha) resulted in more biomass than lower rates (2 t/ha). No significant differences were observed in the length of the longest root across different poultry manure (PM) application rates. However, a trend suggests that 20 t/ha of PM may promote the longest root length, followed by 30 t/ha and then 40 t/ha. This indicates a potential dose-dependent response, where lower PM rates might initially encourage longer root growth, but higher rates do not necessarily produce further increases. Overall, the results suggest that optimal poultry manure application enhances biomass and may influence root development in maize crops. Plots treated with 40 t ha<sup>-1</sup> of PM showed a tendency to have higher root dry matter (132.2 g), whereas control plots had lower root dry matter (66.2 g). The data suggest a positive effect of the treatment on root biomass. This indicates the positive impact of PM application on root biomass accumulation, particularly at higher application rates like Biratu, Elias, Ntawuruhunga, and Nhamo (2018) study on cassava biomass and root yield. Additionally, the application of 40 t ha<sup>-1</sup> of PM resulted in significantly higher shoot and whole seedling dry matter attributes compared to control plots. This underlines the importance of PM as a nutrient source for promoting above-ground biomass production and overall seedling growth (Siddiqui et al., 2021).

## 5. CONCLUSION

This study emphasizes the significance of poultry manure (PM) application, showing that 40 t ha<sup>-1</sup> of PM enhances both above- and below-ground biomass in Kapok seedlings. To promote sustainable agroforestry, further research should explore soil fertility, microbial activity, and organic matter changes over extended PM use. Such studies will deepen understanding of PM's role in *Ceiba pentandra* cultivation, supporting improved management practices.

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