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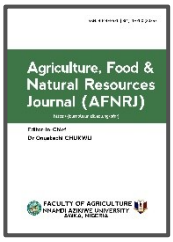

Original Article

Growth response of *Cola lepidota* K. Schum. seedlings to organic soil amendments under nursery conditions

OPEN ACCESS

Chisom Leticia UMEH[1,2]*, Benson NWAJIOBI[2] & Micheal Chukwugoba DIKE[2]

[1]*Department of Forestry and Wildlife, Nnamdi Azikiwe University, Awka, Nigeria*
[2]*Department of Forestry and Environmental Management, Michael Okpara University of Agriculture, Umudike, Nigeria.*

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ABSTRACT

Regeneration of tropical forest species depends largely on successful seedling establishment, which is influenced by soil fertility and nutrient management. Nursery propagation of indigenous tropical tree species is often limited by poor soil fertility and inadequate nutrient availability. This study investigated the growth response of Cola lepidota seedlings to selected organic soil amendments under controlled nursery conditions. The experiment was conducted at the Forestry Nursery of Nnamdi Azikiwe University, Awka, Nigeria, using a Completely Randomized Design (CRD) with four treatments; topsoil (control), topsoil amended with cow dung, poultry manure, and pig manure. Each treatment was replicated sixty (60) times. Growth variables measured include collar diameter (CD), seedling height (HT), and leaf chlorophyll content (LC_{trans}). Results showed that pig manure significantly enhanced seedling growth, recording the highest mean collar diameter (5.7 mm), height (17.1 cm), and chlorophyll content (3.39). Poultry manure also performed well (CD = 5.4 mm; HT = 16.8 cm), while cow dung recorded the lowest values (CD = 4.7 mm; HT = 12.7 cm). ANOVA revealed significant differences ($p < 0.05$) for collar diameter ($F = 6.36$) and height ($F = 6.37$), but no significant difference for chlorophyll content ($F = 1.24$; $p > 0.05$). The findings demonstrate that organic amendments, particularly pig and poultry manure, significantly improve early seedling growth through enhanced nutrient availability and soil conditioning. The study recommends the use of pig manure for optimal nursery performance of Cola lepidota species.

KEYWORDS: *Cola lepidota, Nursery management, Organic manure, Seedling growth, Tropical tree species*

INTRODUCTION

Tropical forest ecosystems provide indispensable ecological services, including carbon sequestration, biodiversity conservation, and climate regulation, yet they are experiencing rapid degradation due to anthropogenic disturbances (Pan *et al.,* 2011; Curtis *et al.,* 2018). In Nigeria, ongoing deforestation has heightened the urgency for effective reforestation strategies that incorporate indigenous species. The success of such initiatives is strongly dependent on soil fertility and seedling quality, as early growth performance determines field establishment, resilience, and long-term productivity (Grossnickle & MacDonald, 2018; Haase *et al.,* 2021).

Soil fertility and organic amendment remain key determinants of seedling growth, and organic amendments have emerged as sustainable alternatives to inorganic fertilizers due to their capacity to enhance nutrient cycling, soil structure, and microbial activity (Agbede *et al.,* 2020). However, variations in nutrient composition and decomposition rates among organic manures influence their effectiveness (Adekiya *et al.,* 2019). Some economical indigenous tree species slowly response to

*Corresponding author: cl.umeh@unizik.edu.ng

growth and as a result of that are being neglected but soil organic amendments can help to improve their growth rate.

Cola lepidota K. Schum., a multipurpose indigenous tree species of significant socio-economic value, has received limited attention in plantation forestry due to insufficient knowledge of its propagation requirements (Onyekwelu *et al.,* 2015). Despite the ecological and economic value of *Cola lepidota*, there is limited information on the appropriate soil amendments required to enhance its nursery growth performance. Understanding the species' response to organic soil amendments is therefore essential for improving nursery practices and promoting its domestication. This study therefore investigates the growth response of *Cola lepidota* seedlings to selected organic soil amendments under nursery conditions to inform sustainable nursery management practices and regeneration of indigenous tropical tree species.

MATERIALS AND METHODS

Study Area

The study was conducted at the Forestry Nursery, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. Nnamdi Azikiwe University (UNIZIK). It is located from latitude 6.245° N to 6.283° N and longitude 7.115° E to 7.121° E. in the suburban landscapes of Awka metropolis of Anambra State, Southern Nigeria. The campus spans about 4.99 km^2 (equivalent to 499 hectares). Climate is a tropical type, with mean rainfall and temperature of 1828 mm and 26.3°C, respectively, at the altitude below 300 m above sea level in a valley on the plain of the Mamu River (Chukwu and Emebo, 2020). The weather feels very dry and uncomfortable from February to May, while from June to September it is much cooler and more pleasant (Enete *et al.,* 2014).

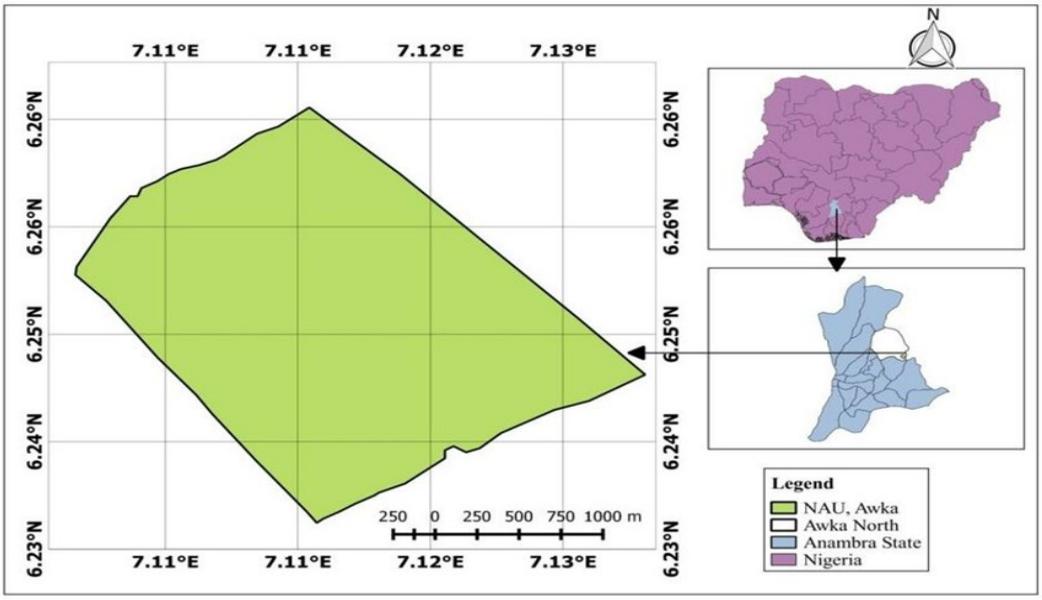

Figure 1: Map of Nnamdi Azikiwe University, Awka, Nigeria
Source: Chukwu *et al.* (2020)

Materials

Materials used were viable seeds of *Cola lepidota*, germination boxes (25 × 25 × 10 cm), topsoil, cow dung, poultry manure, pig manure, polythene bags, watering cans, digital caliper, chlorophyll meter, and weighing balance. Organic manures were selected due to their nutrient content and soil conditioning properties (Ayeni *et al.,* 2012).

Fruit Collection and Processing

Mature fruits of *Cola lepidota* were collected from healthy trees. Seeds were extracted manually, washed, and air-dried under shade to maintain viability. Non-viable seeds were removed using floatation methods. The fruits were placed in labeled polythene bags and transported to the Forestry and Wildlife Nursery, Nnamdi Azikiwe University, Awka. In the nursery, damaged or infested fruits were removed, and the pulp was manually removed before the seeds were washed with clean water. The procedures followed standard seed handling protocols described by Nwoboshi (1982), after which the processed seeds were temporarily stored under shade prior to sowing.

Experimental Procedure

The experiment was conducted in a screen-house and laid in a completely randomized design (CRD) comprised of four treatments (T1= Topsoil, T2 = Topsoil and Cowdung, T3 =Topsoil and Poultry Manure, and T4 = Topsoil and Pig Manure), replicated sixty (60) times, adopting Bello *et al.* (2022). Seeds were sown at a depth of 4 cm and watered regularly.

Data Analysis

Data collected on collar diameter, height, and chlorophyll content were subjected to Analysis of Variance (ANOVA). Significant means were separated using Duncan Multiple Range Test (DMRT) at 5% probability level.

RESULTS AND DISCUSSION

Effect of treatments on the growth of *Cola lepidota* seedlings

The results presented in Table 1 (ANOVA) indicate that the application of different organic soil amendments had significant effects on collar diameter and seedling height, but no significant effect on leaf chlorophyll content of *Cola lepidota* seedlings.

For collar diameter, the ANOVA results in Table 1 showed a significant treatment effect ($F_{3,235} = 6.36$; $p < 0.05$), indicating that soil amendment significantly influenced stem girth development. This suggests that organic amendments enhanced nutrient availability necessary for cambial activity and radial growth. Organic manures, particularly those rich in nitrogen and phosphorus, are known to stimulate stem thickening by promoting cell division and tissue differentiation (Agbede *et al.,* 2020). The observed variation among treatments further reflects differences in nutrient composition and mineralization rates of the amendments.

Similarly, seedling height was significantly affected by treatments, as shown in Table 1 ($F_{3,235} = 6.37$; $p < 0.05$). This indicates that the amendments influenced vertical growth and biomass accumulation. Height growth is largely dependent on nitrogen availability, which supports cell elongation and vegetative development (Tripathi *et al.,* 2020). The significant F-value confirms that the observed differences in height are attributable to treatment effects rather than random variation.

In contrast, leaf chlorophyll content showed no significant difference among treatments, as indicated in Table 1 ($F_{3,231} = 1.24$; $p > 0.05$). This suggests that while organic amendments influenced structural growth variables, they did not significantly affect physiological traits related to chlorophyll concentration. Chlorophyll synthesis is closely tied to nitrogen availability; however, once a sufficient threshold is reached, additional nutrient supply may not lead to further increases (Richardson *et al.,* 2002). This explains the lack of statistical significance despite slight numerical differences among treatments.

The results demonstrate that organic soil amendments play a crucial role in enhancing the early growth performance of *Cola lepidota* seedlings, particularly in terms of structural development. These findings are consistent with previous studies highlighting the importance of nutrient availability and soil fertility in seedling growth (Haase *et al.,* 2021).

Table 1: ANOVA Result for Growth Variables

Variables	Source	SS	Df	MS	F-value	p-value
Collar Diameter	Between	34.436	3	11.479	6.358	0.000*
	Within	424.257	235	1.805		
Height	Between	785.040	3	261.680	6.367	0.000*
	Within	9659.108	235	41.103		
Chlorophyll	Between	5.127	3	1.709	1.242	0.295ns

** Means Significant, ns means Not significant*

Comparison of Different Soil Amendments on *Cola lepidota* Seedling Growth

The comparative performance of the treatments, as presented in Table 2 (Duncan Multiple Range Test), provides further insight into the effectiveness of each soil amendment.

For collar diameter, Table 2 shows that pig manure (T4) recorded the highest mean value (5.7 mm) and was significantly different from cow dung (T2), which had the lowest value (4.7 mm). Poultry manure (T3) and topsoil (T1) showed intermediate performance. This indicates that pig manure is the most effective amendment for enhancing stem growth, likely due to its high nutrient content and rapid mineralization rate. Poultry manure also performed well, which aligns with its known richness in readily available nitrogen (Ayeni *et al.,* 2012). The inferior performance of cow dung may be attributed to its slower decomposition rate, which delays nutrient release (Adediran *et al.,* 2003).

For seedlings height, Table 2 indicates that pig manure (17.1 cm), poultry manure (16.8 cm), and topsoil (16.8 cm) formed a statistically similar group, all significantly higher than cow dung (12.7 cm). This suggests that while pig manure produced the highest mean value, its effect was comparable to poultry manure and the control. The similarity between treatments implies that the base soil had moderate fertility, but nutrient-rich amendments further enhanced growth. The significantly lower performance of cow dung reinforces its limited effectiveness during early growth stages.

In terms of leaf chlorophyll content, Table 2 shows that all treatments belong to the same statistical group, confirming the ANOVA result that there is no significant difference among treatments. Although pig manure recorded the highest mean value (3.39), the differences were not statistically significant. This indicates that chlorophyll content is less responsive to variations in organic amendments under nursery conditions, likely due to sufficient baseline nutrient levels.

The comparative analysis reveals a consistent trend: Pig manure > Poultry manure > Top soil > Cow dung in terms of growth performance. This trend highlights the importance of nutrient availability and mineralization rate in determining the effectiveness of organic amendments. Pig and poultry manure,

being fast-decomposing and nutrient-rich, provide immediate nutrient supply, thereby promoting rapid seedling growth. In contrast, cow dung releases nutrients more slowly, making it less effective during the early growth phase. These findings align with previous studies reporting superior performance of poultry and pig manure over cow dung in improving seedling growth (Adekiya *et al.,* 2019; Agbede *et al.,* 2020).

Table 2: Duncan Multiple Range Test

Treatment	CD (mm)	HT (cm)	LC_{trans}
T1	4.968 ab	16.808 b	3.269 a
T2	4.697 a	12.717 a	2.995a
T3	5.429 bc	16.753 b	3.125a
T4	5.668 c	17.098 b	3.387a

Means of the same alphabets are not significantly different, CD=collar diameter (mm), HT= height (cm), LCtrans = leaf chlorophyll content. T1=Topsoil, T2= Cow dung, T3= Poultry manure and T4= Pig manure

CONCLUSION AND RECOMMENDATION

Organic soil amendments significantly influence the growth of *Cola lepidota* seedlings under nursery conditions. Pig manure was the most effective amendment, followed by poultry manure, while cow dung showed limited effectiveness during early growth stages. Growth improvements were more pronounced in structural parameters (height and collar diameter) than physiological parameters (chlorophyll content). It is therefore, recommended that pig manure should be adopted for raising *Cola lepidota* seedlings in nurseries, poultry manure can serve as an effective alternative, cow dung should be composted or combined with other amendments before use, and further studies should investigate long-term field performance and combined fertilizer applications.

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Authors' Contributions

CLU managed the conceptualization, data curation, formal analysis, funding, methodology, project administration, validation, visualization and writing original draft. BN & MCD engaged in supervision, validation, visualization and writing original draft. All authors approved the final manuscript.

Ethical Statement

Not applicable.

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