



Comparative Evaluation of the Influence of Organic and Inorganic Fertilizers on Growth Performance of *Tetrapleura tetraptera*

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Authors' contributions

This work was carried out in collaboration between both authors. Author ULE designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author EEE managed the analyses of the study and the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

The continuous destruction of our rainforest has threatened the existence of many useful and multipurpose plant species such as *Tetrapleura tetraptera*. To revert this situation, efforts must be made towards its sustainable use by encouraging reforestation which entails raising of seedlings for mass propagation of this crop. This study was aimed at comparing the effects of organic (chicken litter) and inorganic (NPK 15:15:15) fertilizers on seedling growth in four accessions of *Tetrapleura tetraptera* and hence determining fertilizer preference for this forest species. The Complete Randomized Design (CRD) was used in a factorial arrangement with four accessions and three fertilizer types in eight replicates. One month after transplanting, the fertilizers (organic and inorganic) were uniformly applied at the rate of 45 kg/hectare according to the experimental design. Data were collected monthly for a period of three months on plant height, stem diameter, leaf area, leaf length, number of branches, number of leaves, primary and secondary internode

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length per plant. Data on seedling emergence were also taken. Data collected were subjected to a two-way analysis of variance. Least significant difference (LSD) was used to separate significant means at $p = 0.05$. Result obtained revealed that the soil was rich in calcium, phosphorus and organic matter but low in nitrogen and potassium which were adequately complemented in mean days to seedling emergence in four accessions studied. Our findings also revealed that the organic (chicken litter) fertilizer did better ($P < 0.05$) in all accessions than inorganic (NPK 15:15:15) fertilizer for all morphological traits studied. The performance of Cross River accession was outstanding as illustrated by the significant interaction obtained in most parameters. With chicken, litter fertilizer, Cross River accession produced the tallest plant (27.38 cm), largest leaf area (1.99 cm²), highest number of branches (20.13), highest number of leaves (66.75), longest stem diameter (0.93 cm), longest leaf length (1.94 cm), lowest primary (0.80) and lowest secondary (0.83) internode length. The use of organic fertilizers is therefore recommended for improved seedling growth of *Tetrapleura tetraptera*.

Keywords: Fertilizer; organic manure; inorganic manure; *Tetrapleura tetraptera*.

1. INTRODUCTION

Since long ago, man has utilized plant and plant materials for food, medicine and other economic goals. The use of plants for these purposes is a popular practice in Africa [1] and Asia [2]. This practice is facilitated by cultural beliefs, poverty and high cost of conventional healthcare [3]. The use of plants such as *Tamarindus indica*, *Garcinia buchananii*, *Canarium schweinfurthii*, *Tetrapleura tetraptera* [4,5,6] as well as *Gonogromema lotifolium* and *Osimum gratificum* have been reported to be useful for food and medicine, especially in communities with limited health facilities.

Tetrapleura tetraptera, have received less attention in socioeconomic research compared to other indigenous fruit tree species despite its medicinal and nutritional potential [3]. Most studies on *T. tetraptera* have focused on the chemical and pharmacological properties of the fruit of *T. tetraptera* [7,8] while its conservation and propagation have been given less attention. Methods have been developed for the rapid propagation of plants especially tree crops such as plant tissue culture and the use of fertilizers [9].

Fertilizer application has been the oldest used method, and many reports have been documented comparing the efficiency, efficacy and advantages of organic and inorganic fertilizers. Although the use of inorganic fertilizers is preferred due to the rapid results obtainable, however, there remains the concern of bioaccumulation of the inorganic fertilizer component which could cause harm to human and animal consumers [10]. Organic manure, on the other hand, contributes to the

fertility of the soil by adding organic matter and nutrients such as nitrogen, phosphorus and potassium amongst others, that are utilized by bacteria, fungi and other organisms in the soil [11].

Higher organisms then feed on the fungi and bacteria in a chain of life that makes up the soil's food web. During this process the products obtained after decomposition of this organic matter, are used for the replenishment of the soil with an essential element that add humus to the soil [11], thereby reducing the risk of bioaccumulation of chemicals. The above notwithstanding, the effect of these two groups of fertilizers ought to improve the morphology and reproductive characteristics of the plants they are applied to. The present study thus seeks to compare the effect of organic and inorganic fertilizers on the morphology (vegetative properties) of *Tetrapleura tetraptera*.

2. MATERIALS AND METHODS

2.1 Experimental Site and Collection of Experimental Materials

The experiment was conducted at the experimental field of the Faculty of Biological Sciences, University of Calabar, Nigeria. Five matured fruits of *T. tetraptera* were collected from each of the following states; Cross River, Akwa Ibom, Imo and Abia during 2018. Twenty (20) kg of organic (chicken litter) fertilizer was obtained from Unical poultry farm in the University of Calabar and 5 kg of inorganic (NPK at 15:15:15) fertilizer was purchased from Watt Market, Calabar.

2.2 Determination of Soil Nutrients

Humus soil samples collected at different sites of the fallowed land behind the Faculty of Biological Sciences Block, University of Calabar, were thoroughly mixed together and dried using standard procedures. Soil pH was determined in a 2:5 (w/v) soil water suspension; organic carbon by chronic acid digestion and spectrum ether analysis [12]. Total nitrogen was determined from wet acid digest [13], exchangeable cations (calcium, magnesium and potassium) were extracted using the Mehlich's procedure [14] and determined by atomic absorption spectrophotometry. Available phosphorus was extracted following the Bray's procedure and analyzed using the *Molybdaic* blue procedure described by Murphy and Riley [15].

2.3 Extraction and Germination

Mature seeds of *T. tetraptera* were extracted from fruits using surgical blades. A pilot experiment was conducted to determine the best method of germination. The following methods were tried: Soaking seeds in hot water for one minute, in tap water at room temperature for six hours and in H₂SO₄ for 3 minutes. The second method gave the best result and was adopted in this study. A total of 40 seeds per accession (4 accessions) were germinated in pots filled with soil.

2.4 Experimental Design

The Complete Randomize Design (CRD) was used in a factorial arrangement with four accessions and three fertilizer types (4x3) in eight replicates. The four accessions were obtained from four states designated as Cross River (A), Akwa Ibom (B), Imo (C) and Abia (accession D). The 3 fertilizer application were; control, organic and inorganic.

2.5 Transplanting

Two weeks after germination, at the two-leaf stage a total of 96 seedlings with no visible signs of infection and of equal heights were picked out from the germination pots and transplanted in polythene bags filled with 10 kg of the thoroughly mixed topsoil whose nutrients were determined as given in Table 1.

2.6 Fertilizer Application

One month after transplanting, the fertilizers (organic and inorganic) were applied at the rate

of 45 kg/hectare according to the experimental design. The ring method of fertilizer application was adopted to avoid direct contact of the fertilizer with the roots of the seedlings.

2.7 Data Collection

Data were collected monthly for a period of three months (12 weeks) on plant height, stem diameter, leaf area, leaf length, number of leaves, primary internode length, secondary internode length and number of branches per plant. Data on days to 50% seedling emergence was also taken.

2.8 Data Analysis

Data collected were subjected to a two-way analysis of variance. Least Significant Difference (LSD) test was used to separate significant means at P < 0.05.

3. RESULTS

3.1 Soil Analysis

The results of soil analysis showed that the soil was rich in Calcium, phosphorus and organic matter but low in nitrogen and potassium minerals (Table 1).

Table 1. Physico-chemical properties of experimental soil

Parameters	Values
pH	5.52
C (mol/kg)	2.76
Mg (meq/100 g)	0.91
Potassium (meq/100 g)	0.08
Phosphorus (ppm)	3.2
Organic components	8.5
Nitrogen (%)	0.06

3.2 Days to 50% Seedling Emergence

The mean days to 50% seedling emergence in *T. tetraptera* accessions evaluated, ranged from 5.70 to 6.29. There was, however, no significant (P > 0.05) difference (Fig. 1).

3.3 Leaf Area

The result obtained showed that leaf area was affected significantly (P < 0.05) at all stages of growth (4, 8 and 12 weeks after planting) investigated. The largest leaf area in all cases was that of Cross River State accession (A)

treated with organic fertilizer. It had means of 1.00 cm², 1.91 cm² and 1.99 cm² at 4, 8 and 12 weeks after planting (WAP), respectively. The smallest leaf area in all cases was from Abia State (accession D) with no fertilizer treatment. It had means of 0.45 cm², 0.70 cm² and 0.76 cm² at 4, 8 and 12 weeks after planting, respectively (Tables 2, 3 and 4). Leaf area ranged from 0.45 cm² to 1.99 cm².

3.4 Stem Diameter

The smallest stem diameter at 4, 8 and 12 weeks after planting were those from Imo (C) and Abia (D) accessions which were significantly different (P<0.05) from all the others. The biggest was Cross River accession (A) treated with inorganic fertilizer (at 4 weeks after planting) and organic fertilizer (8 and 12 weeks after planting) as shown in Tables 2, 3 and 4. Stem diameter ranged from 0.26 cm to 0.93 cm.

3.5 Secondary Internode Length

The least secondary internode length was obtained in Cross River treated with organic fertilizer at all stages of growth examined (4, 8, 12 WAP). However, at 4 weeks after planting the value (0.65 cm) did not differ from those of Akwa Ibom and Imo State accessions. The highest value was obtained from Abia State accession (D) with no fertilizer treatment (control).

Secondary internode length ranged from 0.65 cm to 1.50 cm (Tables 2, 3 and 4).

3.6 Number of Branches per Plant

At 4 weeks after planting, accessions from Imo and Abia State with treatment as well as those without fertilizer treatment had the least of branches which differed significantly (P<0.05) from all other groups. The highest numbers of branches were from Cross River treated with organic fertilizer. At 8 to 12 weeks after planting, accessions with no fertilizer application had the least number of branches while Cross River accessions treated with organic fertilizer had the highest (Tables 2, 3 and 4). Number of branches ranged from 8 to 20.

3.7 Primary Internode Length

Accession from Imo and Abia which had no fertilizer treatment produced largest internodes while Cross River accession treated with organic manure had the least in all the stages of growth. Primary internode length ranged from 0.08 cm to 1.75 cm (Tables 2, 3 and 4).

3.8 Plant Height

The tallest plants were from Cross River accession treated with organic fertilizer while the shortest plants were those Abia and Imo accessions. Plant height ranged from 1.18 cm to 27.38 cm (Tables 2, 3 and 4).

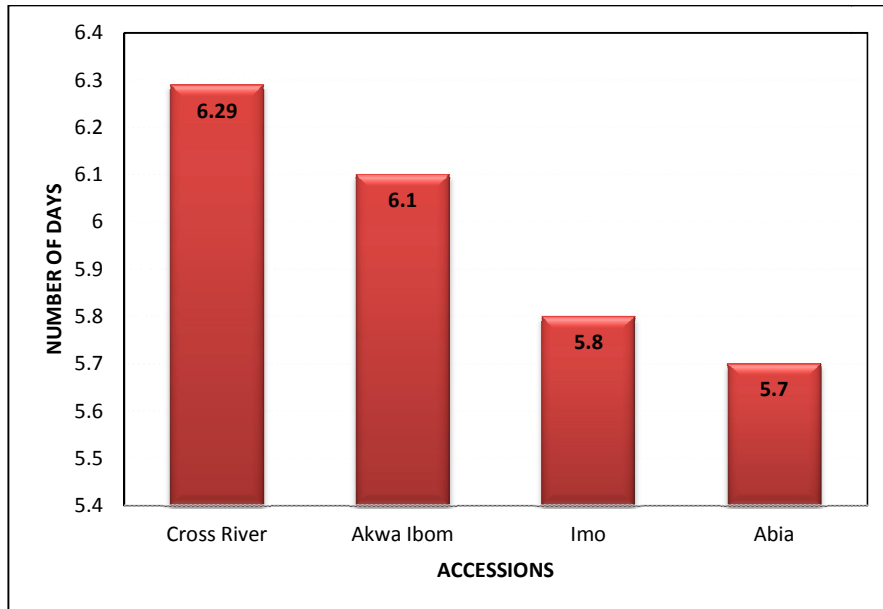


Fig. 1. Mean days to 50% seedling emergence of 4 accessions of *T. tetraptera*

Table 2. Morphological parameters of *T. tetraptera* treated with three fertilizer types at 4 weeks after planting

Accessions	Fertilizer types	Leaf area (cm ²)	Stem diameter (cm)	Secondary internode length (cm)	Number of branches	Primary internode length (cm)	Plant height (cm)	Leaf length (cm)-	Number of leaves
A	1	0.76±0.02 ^f	0.33±0.02 ^b	0.83±0.03 ^c	10.5±0.33 ^{cd}	0.33±0.02 ^e	16.88±0.67 ^d	1.16±0.03 ^e	49.3±0.86 ^e
	2	1.00±0.04 ^h	0.61±0.02 ^f	0.65±0.03 ^a	13.13±0.61 ^e	0.36±0.02 ^a	21.63±0.49 ⁱ	1.59±0.04 ^g	5693±0.79 ^h
	3	0.90±0.05 ^h	0.88±0.02 ^c	0.76±0.02 ^b	10.75±1.01 ^d	0.65±0.04 ^d	19.38±0.86 ^t	1.34±0.07 ^t	51.8±1.06 ^g
B	1	0.68±0.02 ^{cd}	0.33±0.02 ^g	1.00±0.03 ^e	8.38±0.37 ^b	0.94±0.05 ^f	14.88±0.77 ^c	0.94±0.06 ^d	46.4±0.86 ^c
	2	0.86±0.07 ^g	0.53±0.02 ^e	0.69±0.03 ^a	10.63±0.46 ^d	0.39±0.03 ^{ab}	20.12±0.48 ^{fg}	1.53±0.04 ^g	55.6±0.46 ^h
	3	0.84±0.04 ^g	0.36±0.02 ^e	0.80±0.04 ^b	9.38±0.60 ^c	0.66±0.04 ^d	18.50±0.18 ^f	1.24±0.07 ^e	51.4±1.22 ^f
C	1	0.54±0.03 ^b	0.30±0.02 ^a	1.11±0.05 ^e	7.88±0.40 ^a	1.19±0.04 ^g	13.63±0.65 ^b	0.55±0.09 ^b	45.3±0.62 ^b
	2	0.84±0.03 ^g	0.45±0.04 ^d	0.7±0.03 ^a	9.25±0.37 ^c	0.45±0.04 ^b	19.25±0.59 ^f	1.41±0.05 ^f	51.6±1.05 ^f
	3	0.78±0.04 ^f	0.35±0.02 ^{be}	0.85±0.02 ^c	7.88±0.35 ^a	0.68±0.63 ^d	15.95±0.88 ^d	0.91±0.03 ^d	48.0±0.59 ^d
D	1	0.45±0.02 ^a	0.26±0.02 ^a	1.2±0.04 ^f	7.63±0.26 ^a	1.13±0.08 ^g	11.88±0.93 ^a	0.44±0.05 ^a	44.0±0.38 ^a
	2	0.73±0.02 ^{de}	0.44±0.03 ^d	0.89±0.04 ^c	8.38±0.37 ^b	0.53±0.82 ^c	17.25±0.82 ^c	1.24±0.04 ^e	47.9±0.58 ^d
	3	0.65±0.05 ^e	0.33±0.02 ^b	0.95±0.02 ^d	7.63±0.26 ^a	0.69±0.04 ^d	12.50±1.16 ^a	0.80±0.05 ^c	46.0±0.84 ^c
LSD		0.06	0.04	0.05	0.74	0.07	0.93	0.08	1.10

Mean values with different superscript along the same column are significantly different at $p < 0.05$; A- Cross River Accession; B- Akwa Ibom Accession; C- Imo Accession; D- Abia Accession; 1- Control; 2- Organic fertilizer; 3- Inorganic fertilizer

Table 3. Morphological parameters of *T. tetraptera* treated with three fertilizer types at 8 weeks after planting

Accessions	Fertilizer types	Leaf area (cm ²)	Stem diameter (cm)	Secondary internode length (cm)	Number of branches per plant	Primary Internode length (cm)	Plant height (cm)	Leaf length (cm)	Number of leaflet per plant
A	1	1.01±0.05 ^{cd}	0.56±0.02 ^d	1.0±0.03 ^{de}	15.5±0.27 ^e	0.66±0.04 ^e	18.9±0.67 ^d	1.76±0.42 ^j	53.75±0.65 ^b
	2	1.91±0.07 ^f	0.83±0.02 ^f	0.78±0.02 ^a	17.88±0.44 ^e	0.66±0.02 ^a	23.6±0.49 ^f	1.20±0.10 ^g	56.88±0.98 ^g
	3	1.51±0.04 ^h	0.66±0.03 ^c	0.94±0.03 ^c	16.50±0.27 ^f	0.81±0.02 ^b	21.3±0.84 ^e	1.60±0.03 ^f	58.38±0.71 ^f
B	1	0.96±0.05 ^g	0.48±0.03 ^f	1.08±0.03 ^f	13.50±0.88 ^b	1.20±0.04 ^f	18.4±0.79 ^d	1.30±0.05 ^{cd}	52.00±0.86 ^{ab}
	2	1.25±0.03 ^e	0.68±0.02 ^e	0.85±0.02 ^b	16.40±0.56 ^f	0.85±0.02 ^b	22.3±0.45 ^e	1.65±0.02 ^{fg}	58.88±0.85 ^f
	3	1.06±0.04 ^d	0.55±0.03 ^{cd}	0.89±0.05 ^b	14.40±0.68 ^{cd}	1.01±0.01 ^e	19.0±0.99 ^d	1.46±0.03 ^e	56.75±0.84 ^d

Accessions	Fertilizer types	Leaf area (cm ²)	Stem diameter (cm)	Secondary internode length (cm)	Number of branches per plant	Primary Internode length (cm)	Plant height (cm)	Leaf length (cm)	Number of leaflet per plant
C	1	0.76±0.03 ^g	0.39±0.03 ^a	1.24±0.03 ^g	12.63±0.37 ^b	1.30±0.03 ^g	15.9±0.55 ^b	1.09±0.04 ^b	51.50±0.63 ^a
	2	1.04±0.03 ^c	0.50±0.03 ^b	0.95±0.03 ^{cd}	15.00±0.3 ^{de}	0.91±0.04 ^c	9.0±0.48 ^a	1.54±0.02 ^{ef}	57.75±1.56 ^{ef}
	3	0.98±0.02 ^b	0.40±0.02 ^a	1.01±0.04 ^e	13.28±0.26 ^b	0.99±0.05 ^{de}	18.10±0.44 ^{cd}	1.28±0.03 ^c	56.13±0.52 ^{cd}
D	1	0.70±0.03 ^a	0.38±0.02 ^b	1.36±0.04 ^h	11.88±0.29 ^a	1.59±0.03 ^h	15.10±0.61 ^b	0.91±0.02 ^a	50.88±0.39 ^a
	2	1.01±0.01 ^{cd}	0.49±0.04 ^b	1.01±0.03 ^e	14.88±0.48 ^d	1.00±0.03 ^e	19.80±0.45 ^d	1.43±0.04 ^{de}	57.13±0.64 ^{de}
	3	0.9±0.03 ^a	0.33±0.02 ^a	1.1±0.02 ^f	12.63±0.26 ^b	1.28±0.06 ^{fg}	17.30±0.56 ^c	1.13±0.04 ^b	53.13±0.69 ^b
LSD		0.05	0.02	0.05	0.06	0.05	0.98	0.13	1.13

Mean values with different superscript along the same column are significantly different at $p < 0.05$; A - Cross River Accession; B - Akwa Ibom Accession; C- Imo Accession; D - Abia Accession; 1 - Control; 2- Organic fertilizer; 3- Inorganic fertilizer

Table 4. Morphological parameters of *T. Telraptera* treated with three fertilizers types at 12 weeks after planting

Accessions	Fertilizer types	Leaf area (cm ²)	Stem diameter (cm)	Secondary Internode length (cm)	Number of branches per plant	Primary internode length (cm)	Plant height (cm)	Leaf length (cm)	Number of leaflet per plant
A	1	1.66±0.03 ^f	0.66±0.03 ^g	1.08±0.04 ^{da}	18.13±0.30 ^{de}	1.43±0.02 ^g 0.8±0.03 ^a	23.34±0.37 ^d	1.53±0.03 ^d	56.88±0.29 ^a
	2	1.99±0.03 ^g	0.93±0.03 ^f	0.83±0.04 ^a	20.13±0.44 ^f		27.38±0.46 ^g	1.94±0.03 ^h	66.75±0.41 ^e
	3	1.50±0.03 ^e	0.80±0.02 ^e	1.01±0.04 ^a	19.00±0.29 ^e	0.99±0.03 ^{bc}		24.50±0.19 ^e	1.81±0.02 ^g
B	1	1.08±0.03 ^c	0.68±0.02 ^{bc}	1.23±0.02 ^a	16.25±0.25 ^{bc}	1.61±0.03 ^a	21.63±0.37 ^c	1.51±0.02 ^d	56.38±0.26 ^a
	2	1.68±0.04 ^f	0.76±0.02 ^{de}	0.98±0.02 ^a	9.75±0.31 ^f	0.91±0.02 ^b	26.25±0.19 ^f	1.83±0.04 ^g	64.13±0.87 ^d
	3	1.19±0.03 ^c	0.68±0.02 ^{bc}	1.06±0.03 ^a	18.63±0.03 ^e	1.15±0.02 ^{de}	23.50±0.19 ^{de}	1.65±0.03 ^f	57.88±0.48 ^a
C	1	0.83±0.02 ^a	0.56±0.02 ^a	1.33±0.02 ^a	15.75±0.25 ^b	1.75±0.02 ^h	19.25±0.25 ^a	1.30±0.03 ^b	55.25±0.25 ^a
	2	1.56±0.03 ^{ef}	0.69±0.01 ^c	1.06±0.03 ^a	19.12±0.04 ^{et}	1.08±0.02 ^{cd}	23.50±0.19 ^{de}	1.76±0.02 ^f	62.88±0.56 ^{cd}
	3	1.04±0.03 ^b	0.58±0.02 ^a	1.25±0.03 ^a	17.13±0.29 ^{cd}	1.18±0.04 ^e	21.00±0.32 ^b	1.46±0.02 ^c	60.13±0.44 ^b
D	1	0.76±0.03 ^a	0.53±0.02 ^a	1.50±0.03 ^a	14.38±0.18 ^a	1.86±0.02 ^c	19.13±0.23 ^a	1.00±0.02 ^a	54.25±0.16 ^a
	2	1.36±0.03 ^d	0.58±0.02 ^a	1.18±0.02 ^a	17.00±0.19 ^c	1.25±0.02 ^f	21.13±0.58 ^b	1.61±0.02 ^e	60.00±0.42 ^b
	3	0.88±0.03 ^a	0.54±0.03 ^a	1.30±0.03 ^a	15.75±0.16 ^b	1.49±0.07 ^g	19.25±0.25 ^a	1.31±0.02 ^b	57.25±0.45 ^a
LSD		0.12	0.06	1.34	1.03	0.09	1.31	0.13	1.77

Mean values with different superscript along the same column are significantly different at $p < 0.05$; A - Cross River Accession, B- Akwa Ibom Accession, C- Imo Accession D - Abia Accession; 1- Control; 2 - Organic fertilizer; 3- Inorganic fertilizer

3.9 Number of Leaves per Plant

At 4 weeks after planting, accession from Imo and Abia state treated with inorganic fertilizer, as well as those without fertilizer treatment, had the least no leaves per plant which differed significantly ($P < 0.05$) from all other groups. The highest number of leaves were from Cross River given organic fertilizer treatments. At 8 to 12 weeks after planting, plantlets from Cross river with no fertilizer application had the least number of leaves while Cross River accessions treated with organic fertilizer had the highest (Tables 2, 3 and 4). Number of branches ranged from 8 to 20.

3.10 Leaf Length

The longest leaves were from Cross River accession treated with organic fertilizer while the shortest were from Abia without fertilizer application. Leaf length ranged from 0.44 cm to 1.94 cm (Tables 2, 3 and 4).

4. DISCUSSION

Fertilizer requirement of species differ, as such, efforts must be made to identify and select the appropriate fertilizer preference of any specie [16]. The inherent characteristics of species and genotypes within species play an important role in restricting or enhancing efficiency of plants in the uptake, use and tolerance to mineral elements [16]. Chicken litter fertilizer significantly affected some important morphological traits of *T. tetraptera* evaluated in this study due to high nitrogen content of the organic fertilizer used. This result is in agreement with the earlier findings of Aluko, [17] who reported that organic fertilizer application increased stem diameter, leaf area, number of leaves, internode length, number of branches and leaf length of *Khaya ivorensis* seedlings at nursery. All accessions treated with organic fertilizer performed better than those with inorganic fertilizer. The study revealed that potassium and nitrogen component of the experimental soil which were low, were adequately complemented for by the two fertilizers. It is probable that this greatly enhanced the performance of these plants. This observation is in harmony with Hector [18] who reported that organic (compose manure) and inorganic (NPK) fertilizer at 40 kg/hectare enriched nitrogen, potassium, phosphorous and organic matter of the soil.

Although seed yield was not part of this report, however some morphological traits that point to yield performance were observed to increase

with fertilizer application. This finding is in line with Hall, et al. [19] who reported that increase in leaf area, leaf length, number of branches and number of leaves, plant height and stem diameter of *Ceredrella lilloi* treated with chicken litter led to a better yield.

The tallest plants with the largest leaves were obtained from Cross River accession treated with chicken litter which did better than accessions treated with NPK. This may be attributed to the presence of high mineral composition in chicken litter (organic) fertilizer which enhances growth by stimulating cell differentiation and multiplication leading to size increment in this species. The biggest stem diameters were observed in accessions treated with organic (chicken litter) fertilizer. This may again be due to the high mineral composition and organic matter in chicken litter fertilizer which stimulates growth, protein formation, rapid cell division and differentiation resulting in stem diameter increment [20].

This study revealed that the least primary and secondary internode length were observed in Cross River accession treated with chicken litter fertilizer. These results are in conformity with the findings of Gbadamosi, et al. [21] who reported that seedling of *Shorea platyachados* showed very low secondary and primary internode length when treated with poultry droppings. The highest number of branches and leaves were observed from Cross River accession given chicken litter fertilizer which comparatively performed better than accession from Cross River treated with NPK fertilizer. Abia accession with no fertilizer application had the least number of branches and leaves. It is probable that Nitrogen and the presence of high mineral composition in chicken litter stimulate rapid leaf production and played essential role in branching.

5. CONCLUSION

Generally, the best performances were observed in Cross River accession treated with chicken litter fertilizer. It is apparent that Cross River accession has adequately adapted to the climatic and agro-geological conditions of this zone.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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