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ORGANIC AND INORGANIC FERTILIZERS INFLUENCE ON EARLY GROWTH OF *Terminalia ivorensis* A. Chev.

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ABSTRACT

The use of organic and inorganic fertilizers during forest seedling culture is one of the most crucial factors which have positive effect on seedling quality especially the slow growing tree species. This study investigated the effect of organic and inorganic fertilizers on early growth of *Terminalia ivorensis*. Uniform seedlings were transplanted into 2kg of soil amended with different levels of fertilizers as follows:T_1 = 10g of Cow dung, T_2 = 10g of Poultry manure, T_3 = 5g of Poultry manure + 5g of Cow dung, T_4 = 6g of N:P:K: 20:10:10, T_5 = 3g of NPK + 3g of Urea, T_6 = 6g of Urea, T_7 = 5g of Poultry manure + 0.13g of Urea, T_8 = 0.13g of Cow dung + 3g of NPK, T_9 = 5g of Cow dung + 0.13g of Urea, T_{10} = Control (Topsoil only). There were ten (10) treatments, replicated three (3) times and laid in Completely Randomized Design (CRD). Seedling height (cm), stem diameter (mm), number of leaves, leaf area (cm^2) and biomass production were assessed. Data were subjected to Analysis of Variance (ANOVA) at 0.05 level; of probability. There were no significant differences among the treatments on seedling height, leaf area and collar diameter while there was significant difference among the treatments on leaf production. The T_5 had the highest mean height of 34.03±8.19cm and highest collar diameter (0.24±0.07 mm) while T_{10} had collar diameter of 0.13±0.03mm. the T_3 had highest leaf number and leaf area with 7.33±2.52 and 24.51±13.35$cm^{2,}$ respectively. Combination of organic and inorganic fertilizers as well as mixture of different organic fertilizers enhances the early growth of *T. ivorensis* seedlings.

Keywords: Amendment, Cow dung, Poultry manure, N. P. K, Growth media

Introduction

Trees are perennial plants with an elongated stem or trunk, supporting branches and leaves in most species. According to Crowther *et al.* (2015), trees are vital as the biggest and longest plants on the planet, in which they tend to be long-lived. Trees have been in existence for 370 million years and it is estimated that there are just over 3 million mature trees in the world (Crowther *et al.*, 2015). Trees play significant role in reducing soil erosion, moderating the climate, removal of carbon dioxide from the atmosphere and storage of large quantities of carbon, they provide habitat for many species of plants and animals, timbers for construction, sources of fuel for cooking, heating and charcoal production, some trees provide fruits as food for man and animal consumption. It is of high advantage that woodlands, rainforests and trees in urban settings, such as parks, forest reserves, are preserved and sustainably managed across the world because it helps to regulate and maintain the climatic condition also preventing natural resources from going into extinction (Crowther *et al.*, 2015).

Terminalia ivorensis. is a tree species in the family Combretaceae, it is commonly known as Black Afara, and in Yoruba; Idigbo, mostly found in Cameroon, Ivory coast, Ghana, Guinea, Liberia, Nigeria and Sierra Leone (Masoko *et al*., 2005), According to Orwa *et al*. (2009), *T. ivorensis* is described as a large deciduous forest tree ranging in height from 15 to 46 meters, the bole is very straight with small buttresses and is sometimes fluted, it can be branchless for up to 30 meters with a diameter from 200 - 400.75 cm, its wood has an approximated density of 560 kg per cubic inch, pale yellow-brown in colour.

Poorter, (2004) reported that *T. ivorensis* is of great value which is an important component of the forest industries in many countries, where it is mostly used in agro-forestry system as a shade tree in cocoa, banana and coffee plantations, it can also be planted at roadsides. The tree species plays a major role in increasing soil fertility where fall off leaves decomposed and add more nutrients to the soil, it is widely used for medicinal purposes in Africa (Nichols, 2001; Norgrove and Hauser, 2002). It provides timbers and sources of fuel, the durable heartwood is used as timber in joinery and high-class furniture (Masoko *et al*., 2005).

The proper application of inorganic and organic fertilizers to forest nursery soils is of considerable importance since it may profoundly influence growth of seedlings. The primary purpose of forest nurseries is to produce and supply quality seedlings to form new forests and re-forest overexploited forest stands (Ang and Maruyama,1995). Improving the fertility of nursery soil is essential to guarantee the production of high-quality seedlings for nursery establishment (Rafiqul *et al.*, 2004). Most tropical soils and forests are deficient in nitrogen and phosphorus nutrients and uptake of these limited quantities of nutrients by plant roots from litter is difficult (Jose, 2003). Therefore, inadequate management of nursery soil can result in depletion of site fertility and reduction in seedling growth (Ang and Maruyama,1995; Hoque *et al.*, 2004). A healthy seedling must be well supplied with all the nutrients in the proper proportions for efficient growth (Craven *et al.*, 2006; Gbadamosi, 2006). Species vary in nutrient requirements and the demand for a particular element or nutrient depends upon the growth requirements of the species in question. Nutrient requirements for species in nursery also differ with environmental conditions (Pinkard *et al.*, 2007). In case a particular nutrient is limited in a forest nursery, seedlings may forage with their roots to some extent to compensate for the deficiency or pick up the element from the atmosphere through leaf pores (Hoque *et al.*, 2004; Rafiqul *et al.*, 2004).

The use of organic and inorganic fertilizers during forest seedling production is one of the most crucial factors which have positive effect on seedling quality, performance and establishment (Rafiqul *et al.*, 2004). Soil amendment, for forest nursery usually with organic matter, has also been reported to promote seedling quality (Foncho *et al.*, 2011). Moreover, Honque *et al.* (2004) opined that maintaining adequate fertility of forest nursery soils is of paramount importance to assure production of high-quality planting stock, fertilization permits seedling growth to continue longer through the growing season than unfertilized stock. Hence, high quality planting stocks will have better adaptation, resistance to environmental stress and will have better field performance over long term (Davis and Jacobs, 2005).

Inorganic and organic fertilizers vary based on their proportion with macro nutrients (Nitrogen, Phosphorus, Potassium), three-secondary macro nutrients (Calcium, Magnesium, Sulphur) and micro nutrients (Copper, Iron, Manganese, Molybdenum, Zinc, Boron, Vanadium, Cobalt, Silicon) (Dittmar *et al.*, 2009). However, man's negative impacts on the ecosystem have increased the rate at which nutrients are lost from the soil and this has led to difficulties in seedling growth and establishment also some forest tree species have gone into extinction. These tree species can be regenerated either by direct seed sowing or natural process into the forest through afforestation, reforestation in which seeds of tree germinate and been planted-out in the area to be established (Dittmar *et al.,* 2009). After seedling emergence, growth rate can be increased through application of organic or inorganic fertilizer. For optimum growth of *Terminalia species*, there must be adequate soil nutrients supporting the tree growth either the nutrients occur naturally or artificially through application of organic or inorganic fertilizers. According to Orwa *et al. (*2009) *T. ivorensis* is a slow growing species, but its growth can be enhanced by fertilizer application towards soil improvement. This study therefore investigated effect of different levels of organic and inorganic fertilizers on early growth of *T. ivorensis* with a view to identify the appropriate level and types of fertilizers required for optimum growth and development of *T. ivorensis* seedlings.

Materials and Methods

Study area

The experiment was carried out in the Nursery of the Department of Forestry and Wildlife Management, located along Faculty of Agriculture Teaching and Research farm at Adekunle Ajasin University Akungba-Akoko Ondo State. The Nursery area is located from latitude 7° 2.87” to 7° 28.87” N of the equator and from longitude 5° 45.72” to 5° 45.73” E of Greenwich meridian. The topography of the Nursery is mountainous; soil type is basically volcanic making it suitable for agriculture (Cable, 1998), the soils in the nursery are mainly sandy loaml. It falls under derived Savannah with which the climate is equatorial with two peaks of rainfall where the first peak comes between April and July and the second peak falls between late August and October, these two peaks are marked by heavy rainfall with mean annual rainfall of 1500-2000mm, relative humidity varies from 75-95% which resulted into severe cold condition in most cases (Olabode, 2014), the mean annual temperature is 23-26°C. The dry season is between November to March.

Preparation of Potting Mixture

Top soil used for the experiment was collected at 0-15cm soil depth from a fallow land at Adekunle Ajasin University Akungba-Akoko (AAUA) campus. The soil was air dried and visible roots, leaves and other debris were removed by sieving. A 2kg soil was used to fill each 8cm x 16cm polythene bag for the experiment. Cow dung were collected from cattle ranch and poultry manure from poultry house of Teaching and Research farm of AAUA which were sun dried for eight (8) days and grounded into powdery form, then sieved to separate the residues and air dried. The inorganic fertilizers (N: P: K: 20:10:10 and Urea) were procured from Agricultural Development

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Research Project Farm at Ikare-Akoko. Soil and organic manures were analyzed for physico-chemical properties (Table 1). Seeds of *T. ivorensis* were sown and after germination, thirty uniformly growing seedlings were transplanted into polythene bags, each treatment consists of three (3) replicates.

Different levels of fertilizers were added to 2kg of soil with the following treatments:T_1 = 10g of Cow dung, T_2 = 10g of Poultry manure, T_3 = 5g of Poultry manure + 5g of Cow dung, T_4 = 6g of N:P:K: 20:10:10, $T_{\backslash 5}$ = 3g of NPK + 3g of Urea, T_6 = 6g of Urea, T_7 = 5g of Poultry manure + 0.13g of Urea, T_8 = 0.13g of Cow dung + 3g of NPK, T_9 = 5g of Cow dung + 0.13g of Urea, T_{10} = Control (Topsoil only). Treatment(s) were measured with electronic weighing scale (FA2104A) according to the measurements for each fertilizer(s) where inorganic fertilizers (Urea and N: P: K: 20:10:10) were dissolved into solution before applying it to the filled polythene bags also Poultry manure and Cow dung were thoroughly mixed with the sieved topsoil then filled into the polythene pots and laid out randomly, each treatment was watered after fertilizer application which were left for a week for proper decomposition of organic fertilizers. Watering was done three times a week.. Data on height (cm), collar diameter (mm), leaf area (cm^2) and leaf number were recorded fortnightly from the day of fertilizer(s) application. Also, biomass assessment was carried at the end of study. Fresh weights of harvested seedlings were determined with the use of electronic weighing scale and thereafter oven dried at 105ºC until constant weights were attained for estimation of biomass accumulation.

The experimental design used was Completely Randomized Design (CRD) with (10) treatments and 3 replicates.

Assessment of Growth Parameters

The seedlings height (cm) were measured from the ground level to the tip of the seedling shoots using a meter rule. Collar diameter was determined with the use of a veneer caliper. The numbers of leaves produced by seedlings were counted. Leaf area measurements were done using Clifton-Brown's method which is 0.74(L×W), (Clifton-Brown, 1997). Data were collected fortnightly for ten (10) weeks. For biomass assessment, seedlings were harvested and separated into leaf, stem and root components. The fresh and dry weights (g) of the different seedling components were determined using Electronic weighing balance. Total biomass (Total Dry Weights) was obtained by adding dry weights of leaves, stems and roots (Foncho *et al*., 2011). Also root to shoot ratio was determined and recorded.

Data Analysis

Data collected were subjected to statistical analysis such as descriptive statistics and Analysis of Variance (ANOVA) at 5% probability level. Where there were significant differences among treatment means, Least Significant Difference (LSD) was used to separate the means.

Results

Table 2 shows the results of the effect of organic and inorganic fertilizer(s) on early growth variables of *T. ivorensis.* Under organic fertilizer; cow dung improved seedling height more than poultry manure. However, these responses were not significant different with those 10g dose treatment (Table

2). Improvement of plant growth was significantly found by the application of both organic and inorganic source of mineral nutrition, where 3g NPK and 5g cow dung treatment (T_5) gave the best height increase of 34.03±8.19cm while the least height is urea and NPK treatment (T_8) of 21.33±4.83cm.

On leaf production, T_3 has the best performance of 7.33±2.52 while the least leaf number is from cow dung and urea treatment (T_9) of 0.33±0.58 (Table 3). T_3 (5g poultry manure and 5g cow dung treatment) has the highest leaf area of 24.51±13.35cm^2 while poultry manure and urea treatment (T_7) had the least of 4.19±3.76cm^2 (Table 2). The collar diameter was highest with T_5 (0.24±0.07 mm) while control treatment (T_{10}) had the least collar diameter of 0.13±0.03mm (Table 2)

Table 1: Physio-chemical properties of the soil and Chemical components of organic fertilizers used in the study

Parameters	Values		
	Soil	Cow dung	Poultry manure
PH	5.92	6.56	7.12
O.C (%)	2.34	30.26	27.96
O.M (%)	4.03	52.17	48.20
K(Cmol/kg)	23.33	82.05	16.54
Na (Cmol/kg)	38.26	88.26	17.83
Ca (mMol/100mg)	4.1	7.0	5.0
Mg (mMol/100mg)	1.3	7.3	5.1
P (mg/kg)	0.92	51.2	52.5
Total N (%)	0.16	0.94	0.77
CEC (Cmol/kg)	7.39	-	-
Acidity (mMol/100g of soil)	12	50.66	115.99
Particle size			
Sand (%)	70.24		

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Clay (%)	17.20
Silt (%)	12.56
The soil is sandy loam	

Table 2: Effect of organic and inorganic fertilizer(s) on mean values of growth variables of *Terminalia ivorensis* within period of study

Treatments	Height (cm)	Leaf number	Leaf area (cm^2)	Collar diameter (mm)
T_1	32.07 ± 9.29^{a}	$2.67\pm2.52^{a,bc}$	12.85 ± 20.28^{a}	0.24 ± 0.05^{a}
T_2	24.43 ± 5.87^{a}	$5.67\pm3.79^{a,b,c}$	6.68 ± 4.37^{a}	0.19 ± 0.04^{a}
T_3	29.43 ± 4.39^{a}	7.33 ± 2.52^{a}	24.51 ± 13.35^{a}	0.23 ± 0.06^{a}
T_4	28.67 ± 5.54^{a}	$5.67\pm5.13^{a,bc}$	17.97 ± 8.31^{a}	0.21 ± 0.02^{a}
T_5	34.03 ± 8.19^{a}	$6.67\pm6.03^{a,b}$	20.94 ± 19.26^{a}	0.24 ± 0.07^{a}
T_6	29.83 ± 8.83^{a}	$0.67\pm0.58^{b,c}$	16.06 ± 5.64^{a}	0.16 ± 0.11^{a}
T_7	33.07 ± 9.15^{a}	$3.33\pm3.06^{a,bc}$	4.19 ± 3.76^{a}	0.15 ± 0.04^{a}
T_8	21.33 ± 4.83^{a}	$1.33\pm0.58^{a,bc}$	11.28 ± 4.57^{a}	0.14 ± 0.04^{a}
T_9	22.03 ± 5.16^{a}	0.33 ± 0.58^{c}	7.57 ± 1.53^{a}	0.14 ± 0.05^{a}
T_{10}	24.50 ± 5.37^{a}	$5.67\pm0.58^{a,bc}$	8.26 ± 0.16^{a}	0.13 ± 0.03^{a}

Values are mean ± SD; Values in the same column for each variable with the same superscript are not significantly different from each other

The analysis of variance (ANOVA) results of the effect of organic and inorganic fertilizers on early growth of *T. ivorensis* is presented in Table 3. It was observed that there were no significant differences (P>0.05) among the treatments on seedling height, leaf area and collar diameter while there was significant difference among the treatments on leaf production within period of study.

Table 3: Analysis of Variance (ANOVA) on seedlings height, leaf area, number of leaves and collar diameter as influenced by different organic and inorganic fertilizer(s)

VARIABLE	SV	df	SS	MS	F-cal	P-value
HEIGHT	Treatments	9	568.352	63.150	1.320ns	0.288
	Error	20	956.920	47.846		
	Total	29	1525.272			
LEAF NUMBER	Treatments	9	181.200	20.133	2.007*	0.049
	Error	20	200.667	10.033		
	Total	29	381.867			

LEAF AREA	Treatments	9	1205.969	133.997	1.199ns	0.349
	Error	20	2235.851	111.793		
	Total	29	3441.820			
COLLAR DIAMETER	Treatments	9	0.050	0.006	1.783ns	0.135
	Error	20	0.063	0.003		
	Total	29	0.113			

***=** significant at P<0.05
ns = not significant at P>0.05

Table 4 reveals that there were significant differences among treatments on dry weights of leaves, shoots heights, roots and root to shoot ratio of *T. ivorensis* seedlings.

Table 5 present the results of effect of organic and inorganic fertilizer(s) on dry weight of *T. ivorensis* seedlings. The T_3 (5g poultry manure and 5g cow dung treatment) had the highest dry leaves weight of 0.43±0.18g, while 10g poultry manure treatment (T_2) had the least leaf dry weight of 0.04±0.03g. The T_5 had the highest dry shoots weight of 1.38±0.21g, while 0.13g urea and 5g NPK treatment (T_8) had the least shoot dry weight of 0.33±0.10g (Table 5). The T_5 had the highest mean dry roots weight of 0.86±0.13g, while T_9 had the least mean dry roots weight of 0.10±0.01g (Table 5). The T_5 had the highest mean root to shoot ratio weight of 1.38±0.21g, while the least was recorded for T_9 (0.31±0.09g) (Table 5)

Table 4: Analysis of Variance (ANOVA) of the effect of organic and inorganic fertilizer(s) on biomass production of *T. ivorensis*

VARIABLE	SV	df	SS	MS	*F*	*P*
LEAF DRY WEIGHT	Treatments	9	0.288	0.032	7.498*	0.000
	Errors	20	0.085	0.004		
	Total	29	0.374			
SHOOT DRY WEIGHT	Treatments	9	1.013	0.113	10.087*	0.000
	Errors	20	0.223	0.011		
	Total	29	1.236			
ROOT DRY WEIGHT	Treatments	9	1.494	0.166	8.020*	0.000
	Errors	20	0.414	0.021		
	Total	29	1.908			

ROOT to SHOOT RATIO	Treatments	9	2.616	0.291	2.638*	0.034
	Errors	20	2.204	0.110		
	Total	29	4.819			

*= significant at $P<0.05$

Table 5: Effect of organic and inorganic fertilizer(s) on biomass (Dry weight) of *Terminalia ivorensis*

Treatments	Leaves Dry Weight (g)	Shoot Dry Weight (g)	Root Dry Weight (g)	Root to shoot ratio (g)
T_1	0.12 ± 0.01^{b}	$0.44\pm0.09^{c,d}$	0.24 ± 0.15^{a}	0.50 ± 0.21^{b}
T_2	0.04 ± 0.03^{b}	$0.47\pm0.02^{c,d}$	$0.39\pm0.14^{b,c,d}$	$0.83\pm0.27^{a,b}$
T_3	0.43 ± 0.18^{a}	0.92 ± 0.00^{a}	0.60 ± 0.32^{b}	0.65 ± 0.35^{b}
T_4	0.13 ± 0.02^{b}	$0.78\pm0.05^{a,b}$	$0.50\pm0.03^{b,c}$	0.64 ± 0.01^{a}
T_5	0.16 ± 0.08^{b}	$0.62\pm0.00^{b,c}$	0.86 ± 0.13^{a}	1.38 ± 0.21^{b}
T_6	0.14 ± 0.02^{b}	$0.60\pm0.17^{b,c}$	$0.37\pm0.14^{b,c,d,e}$	0.59 ± 0.08^{b}
T_7	0.11 ± 0.00^{b}	$0.44\pm0.03^{c,d}$	0.29 ± 0.16^{a}	0.65 ± 0.29^{b}
T_8	0.12 ± 0.01^{b}	0.33 ± 0.21^{d}	$0.18\pm0.02^{c,d}$	$0.91\pm0.84^{a,b}$
T_9	0.14 ± 0.02^{b}	0.33 ± 0.10^{d}	0.10 ± 0.01^{d}	0.31 ± 0.09^{b}
T_{10}	0.15 ± 0.01^{b}	$0.43\pm0.12^{c,d}$	$0.13\pm0.02^{c,d}$	0.33 ± 0.11^{b}

Values are mean ± SD; Values in the same column for each variable with the same superscript are not significantly different from each other

Discussion

It was observed from this study that the fertilizer application, especially the organic fertilizer has further enhanced better growth performance of the seedlings in all the parameters measured compared to the inorganic urea. The addition of organic matter content resulting from organic fertilizer application helps to improve nutrient availability to plants, especially in tropical soils that are generally low in soil organic matter and clay (Ogunwale, 2002). The growth enhancement is evident in seedling height, leaf production, leaf area and collar diameter which are the main morphological parameters for seedling quality evaluation and the vital structures to assess quality of seedlings in the nursery (Foncho *et al.*, 2011). The results of this fertilizer application study support the expected general response that seedlings treated with appropriate fertilizer (s) either organic or inorganic form of nutrient will yield better growth performance than seedlings with no fertilizer application (Ogunwale, 2002).

Contribution of Combined organic and inorganic fertilizer to the development of seedling heights depicts that plants which received adequate nitrogen are inclined to vigorous elongation of stem (Pinkard *et al.*, 2007). Thus, presence of nitrogen promotes vegetative growth of stems and leaves. Phosphorus is intimately associated with all life processes and is a vital constituent of every living cell. It is also important because a high concentration of phosphorus is found in plant parts that are growing rapidly (Hoque *et al*., 2004). This observation was similar to observation on *Entandrophragma angolensis* where the addition of Urea and Super Phosphate Simple (SPS) at 112.5 mg and 60 mg respectively produced the best height of 10.79 cm. The least heights were observed in situations where poultry manure produced 8.57 cm. This is also in conformity to Foncho *et al.,* (2011), who observed that the best height increases of *Khaya ivorensis* (Chev.) seedlings was 15.2 cm recorded for the treatment combination of 0mg Urea; 30mg Super Phosphate Simple (SPS) and the least height recorded was 11.2 cm observed in the control treatment (That is, no fertilizer).

In the same vein, the highest value of collar diameter in combination of organic and inorganic fertilizers; 3g NPK and 5g cow dung treatment demonstrated slow release of nutrients from organic fertilizer which gives rooms for maximum utilization of nutrients for cell division, enlargement and building of stem biomass of seedlings (Offiong *et al*., 2010). The gradual release of nutrient prevented leaching of nutrients and allows ample time for fine roots to take up nutrients for biomass increment (Offiong *et al*., 2010). This is in conformity with Awosan *et al*. (2018) who observed that in terms of organic fertilizer application, 5kg of cow dung was used to produce the highest collar diameter of *Deinbolia pinnate* seedlings. In terms of inorganic fertilizer application 1.5kg/pot gave highest mean value for collar diameter. It is also observed in Eneke *et al.* (2018) that the maximum collar diameter was recorded with treatment combination NPK fertilizer and decomposed poultry manure.

Nitrogen has been called the growth element because it is a vital part of plant protoplasm. Protoplasm is the seat of cell division and, therefore, plant growth (Pinkard *et al*., 2007). It is also one of the fundamental units in proteins, nucleic acid and chlorophyll; it controls the formation of seedlings foliage (Offiong *et al*., 2010). The influence of organic and inorganic fertilizers on leaf production is in conformity with Awosan *et al.* (2018) that 0.5kg/ha of cow dung gave highest value for number of leaves of *Deinbolia pinnata.* It is also reported by Eneke *et al. (*2018), from an experiment on *Cedrela odorata*, *Terminalia superba* and *Entradrophragma angolensis* that the maximum leaf number in his study was obtained with treatment combination 112.5mg urea; 0mg SPS.

The highest mean leaf area in combination of organic fertilizers 5mg cow dung; 5mg poultry manure could be attributed to presence of Phosphorus which might have contributed to increasing the leaf area by promoting photosynthesis, thus enhancing energy formation for cell division and expansion (Foncho *et al.,* 2011). This is in line with findings of Eneke *et al.*, (2018) that phosphorus (P) at 30mg produce highest collar diameter of *C. odorata* and increase the leaf area of *T. superba*.

Combination of NPK and cow dung treatment also influenced highest performance of the seedlings in term of biomass production. This is attributable to increased availability of nitrogen in the root zone that encourages uptake by seedlings resulting in higher growth and eventual accumulation of biomass. Similar results of increased biomass of seedlings due to nitrification were reported on *Pseudotsuga menziesii* (Douglas fir) seedlings by (Jose, 2003).

Conclusion

It is clear indication that organic fertilizers (cow dung and poultry manure) and inorganic fertilizer NPK contains required nutrients needed for plant growth in which combination of organic and inorganic fertilizer as well as mixture of different organic fertilizers proved to be the best treatments for raising *T. ivorensis* seedlings. By and large, fertilizer application helps in soil nutrients replenishment which supports plants growth and development. Therefore, the growth of trees planted on degraded soil can be enhanced by application of fertilizer containing the three major nutrients (Nitrogen, Phosphorous and Potassium).

It is therefore recommended that combination of organic and inorganic fertilizers as well as combination of different organic fertilizers in different ratio can be adopted to improve the growth of *T. ivorensis* seedlings.

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