



Comparative studies on Nutrients need and uptake in *Enthandrophragma angolense* seedlings

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ABSTRACT

This study examined comparative studies on nutrients needs and uptake in *Enthandrophragma angolense* seedlings to evaluate the effect of organic manure (Cow dung; 20g, 10g; Poultry manure: 20g, 10g; Water hyacinth 20g, 10g and control). The variables measured were plant height, collar diameter and leaf numbers. The experiment was laid out in a Completely Randomized Design (CRD), the data collected were subjected to Analysis of Variance (ANOVA) and Mean separation using Least Significant Difference (LSD). The results showed that seedlings grown with cow dung of 20g produced the highest mean height (12.45cm), collar diameter (5.68mm) and leaf production (7). The best performance was observed in seedlings grown with cow dung at the rate of 20g. 20g of cow dung mixed with 2kg of forest top soil can be used to raise *E. angolense* seedlings for good growth in the Nursery.

Keywords: *Enthandrophragma angolense*, organic manure, leaf numbers, collar diameter and seedling height

INTRODUCTION

Forest and savanna woodland ecosystems play multiple roles at global and local levels as well as provide a range of economic, social and environmental goods and services such as food, medicine, wood and fibres. They impact on the wellbeing of resource-poor farmers, local and national economies and global environmental health FAO (2005). Forest trees improve micro-climate, reduce wind damages to crops, reduce erosion and restore soil fertility. Forest tree reduce sedimentation in the river stream and water bodies and improve water quality. However, forests are disappearing at an alarming rate due to human activities (Adeyanju, 2001; Offiong *et al.*, 2010).

Entandrophragma angolense has been a component of both forest and savannah parklands due to selective protection of mother trees. However, increased anthropogenic and economic activities have reduced both mother trees and regeneration of stand to an unsustainable level. It has a medicinal potential for the treatment of ailments such as stomach ache, pelvic ulcer, ear ache and kidney rheumatism pain (Arbonnier, 2004).

Despite these potentials, there is a decreased population of *E. angolense* mother trees as well as the absence of both seedlings and samplings in parklands (Gijssbers *et al.*, 2004). Due to the changing ecological situation in terms of distribution, regeneration, and phytosociology relationship, *E. angolense* has long been widely recognized as important indigenous tree species which belong to the mahogany family.

Entandrophragma angolense is considered threatened; it is included in the capital IUCL red list as a vulnerable species (Hawthorne, 1998). Pressure on existing timber resources brought about by an ever increasing world population has led to a new effort to find alternative raw materials for many of traditional uses of woods. The rapid and steady increase in worldwide demand for timber and forest products, coupled with the decline in the availability of wood supply is placing increasing emphasis on the potentials of indigenous hardwood species. Successful stand establishment is

essential for efficient production of forest trees. Many factors are known to be related to tree growth. Among these environmental factors are; edaphic (soil textural classes) and light intensity variations. Since a tree derives almost all of its nutrients from the soil, the rate of water movement into seedling depends on the pore structure (texture). The soil packing/closeness and the distribution of the seedling-soil contact (Hartmann *et al.*, 2007). The quantity and quality of light have significant effects on tree growth which can be highly variable depending on the shade tolerance of the species (Bartlett and Remphrey, 1998). However, there is a gap in knowledge concerning the silvicultural requirements of this species (Hawthorne, 1998). *E. angolense* has neither been domesticated nor established in organized plantations in Nigeria.

Hence, this study is to examine the comparative studies on nutrients needs and uptake in *E. angolense*.

MATERIALS AND METHOD

The experiment was carried out at the Silviculture nursery in the Department of Sustainable Forest Management, Forestry Research Institute of Nigeria (FRIN), Ibadan, Oyo State. FRIN is located on the longitude 07°23'18"N to 07°23'43"N and latitude 03°51'20"E to 03°51'43"E. The climate of the study area is the West African monsoon with dry and wet seasons. The dry season is usually from November through March and is characterized by dry cold wind of harmattan. The wet season usually starts from April to October with occasional strong winds and thunderstorms. Mean annual rainfall is about 1548.9 mm, falling within approximately 90 days. The mean maximum temperature is 31.9°C, minimum 24.2°C, while the mean daily relative humidity is about 71.9% (FRIN 2015).

Experimental Design

The experiment was laid out in Completely Randomized Designs (CRD) with 7 treatments replicated 15 times. The statistical model is:

$$Y_{ij} = \mu + T_i + e_{ij} \dots \dots \dots \text{Equation 2}$$

Where;

Y_{ij} = individual observation
 μ = overall mean

E_{ij} = Experimental error.
 T_i = Effect of Treatment

Experimental Layout

T	1	2	3	4	5	-	15
T1	T1R1	T1R2	T1R3	T1R4	T1R5	-	T1R15
T2	T2R1	T2R2	T2R3	T2R4	T2R5	-	T2R15
T3	T3R1	T3R2	T3R3	T3R4	T3R5	-	T3R15
T4	T4R1	T4R2	T4R3	T4R4	T4R5	-	T4R15
T5	T5R1	T5R2	T5R3	T5R4	T5R5	-	T5R15
T6	T6R1	T6R2	T6R3	T6R4	T6R5	-	T6R15
T7	T7R1	T7R2	T7R3	T7R4	T7R5	-	T7R15

Where:

T1	=	Water hyacinth 10 g	T5	=	Poultry Droppings 10 g
T2	=	Water Hyacinth 20g	T6	=	Poultry Dropping 20 g
T3	=	Cow Dung 10g	T7	=	Control (No Fertilizer)
T4	=	Cow Dung 20 g	R	=	Replicate

Experimental Procedure

One hundred and five (105) seedlings of relatively uniform growth with good vigour were randomly selected from the germination box and transplanted into (16 X 7 X 0.05 cm³) polypots of 2kg soil. Organic manures used were: poultry manure, cow dung and water hyacinth.

The different organic fertilizers were weighed into 10g and 20g respectively. After the addition of organic fertilizer into the polypots containing soil, they were watered daily for a period of four weeks for mineralization of organic fertilizer to take place after which the seedlings of *E. angolense* were transplanted

into the growth media. Fifteen (15) seedlings were allocated to each treatment. Water hyacinth 10g (T1), Water hyacinth 20g (T2), Cow dung 10g (T3) Cow dung 20g (T4), poultry manure 10g (T5), poultry manure 20g (T6) and control (T7), were the treatments used for this experiment. The experiment was monitored for the period of 16 weeks. Soil, water hyacinth, cow dung and poultry manure were analyzed before the setting up of the experiment.

Data collection: Data were collected on the following: plant height, collar diameter and number of leaves.

RESULT AND DISCUSSION

Table 1: Initial properties of the organic fertilizers

Parameters	Cow dung	Poultry dropping	Water Hyacinth
pH(H ₂ O)	6.75	6.46	6.51
Organic C (%)	29.76	27.7	24.01
Total N (%)	3.54	3.47	3.4
Avail P (mg/kg)	3	1.68	0.08
K (%)	2	1	1.46
Ca (cmol/kg)	23.26	21.23	1.08
Mg (cmol/kg)	0.19	0.11	0.34
Na (cmol/kg)	35	32	20
Mn (ppm)	93.34	86.5	41
Fe (ppm)	71.52	70.1	35
Cu (ppm)	14.97	4.2	1.5
+Zn (ppm)	1.53	3.28	0.8

Source: Laboratory Result. (2015)

Effect of Different Fertilizers on the Growth of *E. angolense* Seedlings

The growth trend in height after two weeks of planting revealed that there was continuous increase in height of the seedlings grown with the application of fertilizers, but the growth in height of seedlings grown without the application of fertilizer was slow compared to seedlings in other treatments (Fig. 1).

The mean seedlings height ranged from 7.08 to 12.45 cm, with the highest mean height obtained from the seedlings grown with 20 g of cow dung (CD) while seedlings grown without the addition of fertilizer (control) gave the least mean height (Table 2). Analysis of Variance (ANOVA) indicated that there were significant differences ($p \leq 0.05$) in height of *E. angolense* seedlings subjected to different applications of fertilizers (Appendix 1).

Mean separation result revealed that the mean height of seedlings of *E. angolense* grown with 10 g of Water hyacinth (WH), 20 g of WH, 10 g of CD, 20 g of CD, 10 g of Poultry manure (PM) and 20 g of PM were not significantly different ($p > 0.05$) from each other but significantly different ($p \leq 0.05$) from the seedlings grown with only degraded soil (control) (Table 2).

The growth trend in collar diameter after two weeks of planting revealed that there was continuous increase in collar diameter of the seedlings in all the treatments. However, growth in collar diameter of seedlings grown without the application of fertilizer was slow compared to seedlings in other treatments (Fig. 2).

The mean seedlings collar diameter ranged from 3.35 to 5.68 mm with the highest mean collar diameter obtained from the seedlings grown with 20 g of CD while seedlings grown without the addition of fertilizer (control) gave the least mean collar diameter (Table 2). Analysis of Variance (ANOVA) indicated that there were significant differences ($p \leq 0.05$) in collar diameter of *E. angolense* seedlings subjected to different application of fertilizers (Appendix 1).

Mean separation result revealed that the mean collar diameter of *E. angolense* seedlings grown without the application of fertilizer (control) is significantly different ($p \leq 0.05$) from the collar diameter of the seedlings of other treatments. However, collar diameter of *E. angolense* seedlings grown with 10 g of WH, 20 g of WH, 10 g of CD, 10 g of PM and 20 g of PM were not significantly different ($p > 0.05$) from each other. Also collar diameter of seedlings grown with 10 g of WH, 10 g of CD, 20 g of CD and 10g of PM were also not significantly different ($p > 0.05$) from each other (Table 2).

The leaves produced after two weeks of planting maintained a continuous increase in the production in all the treatments. However, leaves produced in seedlings grown without the application of fertilizer were slow compared to seedlings in other treatments. It was also observed that the leaves production stopped from the 10th week to 12th week in the seedlings of all the

treatments. Production of leaves continued after the 12th week (Fig. 3).

The mean seedlings leaf production ranged from 5 to 7 with the highest mean leaves production obtained from the seedlings grown with 20 g of CD and 20 g of PM while seedlings grown with 20g of WH and without the addition of fertilizer (control) gave the least mean leaves production (Table 2). Analysis of Variance (ANOVA) indicated that there were significant differences ($p \leq 0.05$) in leaf production of *E. angolense* seedlings subjected to different application of fertilizers (Appendix 1).

Mean separation result revealed that the leaves produced by the seedlings grown with 20g of WH and control were not significantly different ($p > 0.05$) from each other, leaves produced by seedlings grown with 10 g of WH, 20 g of WH, 10 g of CD and 10 g of PM were not significantly different ($p > 0.05$) from each other while leaves produced by seedlings grown with 10 g of WH, 10 g of CD, 20 g of CD, 10 g of PM and 20 g of PM were not significantly different from each other ($p > 0.05$) (Table 2).

Effect of Different Fertilizers on the Biomass Accumulation of *E. angolense* Seedlings

The dry weights of the seedlings of *E. angolense* selected from each treatment were used for the biomass accumulated.

Mean values of Leaf Dry Weight (LDW) presented in Fig. 3 showed that at the end of the experiment, seedlings grown with 20 g of PM had the highest mean value of leaf biomass (3.31 g) while seedlings grown without the application of fertilizer (control) had the lowest mean value of 0.67 g (Table 3). ANOVA indicated that there was no significant difference ($p > 0.05$) in the LDW of seedlings subjected to different applications of fertilizers (Appendix 2).

The result of Stem Dry Weight (SDW) presented in Fig. 3 showed that after the experiment, highest mean value of SDW was obtained from the seedlings grown on 20 g of PM, with the value 2.71 g while seedlings grown without the application of fertilizer (control) gave the lowest mean value of SDW with the value 0.49 g (Table 3). ANOVA indicated that the effect of different fertilizers on the SDW of *E. angolense* seedlings were not significantly different ($p > 0.05$) (Appendix 2).

The mean Root Dry Weight (RDW) of *E. angolense* seedlings ranged from 0.57 to 2.46 g, with the highest value recorded in the seedlings grown with 10 g of CD and the least value in seedlings grown without the application of fertilizer (control) (Table 3). ANOVA showed that RDW of seedlings subjected to different applications of fertilizers were not significantly different ($p > 0.05$) (Appendix 2).

The result of the Total Dry Weight (TDW) presented in Fig. 3 showed that after the experiment, the highest mean value of TDW was obtained from seedlings grown using 20 g of PM with the value of 8.28

g, while the seedlings grown without the application of fertilizers gave the lowest TDW with the value 1.73 g (Table 3). ANOVA revealed that there was no significant difference ($p>0.05$) in the TDW of seedlings subjected to different applications of fertilizers (Appendix 2).

Effect of Fertilizers on the Relative Growth Rate of *E. angolense* Seedlings

The best performance was recorded for seedlings grown with PM 20g ($0.55 \text{ g g}^{-1} \text{ month}$) while seedlings grown with Poultry manure (PM) at the rate of 10g performed least with $0.06 \text{ g g}^{-1} \text{ month}^{-1}$ for the first assessment from the 1st month to the 2nd month. At the second assessment, seedlings grown with water hyacinth (WH) at the rate of 20g performed best ($0.82 \text{ g g}^{-1} \text{ month}^{-1}$), while seedlings grown with WH at the rate of 10g performed least with $0.10 \text{ g g}^{-1} \text{ month}^{-1}$. At the final assessment from the 3rd month to the 4th month, WH at the rate of 20g performed best and seedlings grown with PM at the rate of 10g performed least with 0.93 and $0.21 \text{ g g}^{-1} \text{ month}^{-1}$ respectively (Table 4).

Soil Analysis

Since a tree derives almost all of its nutrients from the soil, chemical analysis of the soil might be expected to yield useful data for studying nutritional disorders. Before fertilizers are applied, chemical analysis of the soil is also needed to give an idea of what

nutrient to apply and what quantity should be applied (Evans, 2002).

Levels of Npk and their Interpretations Nitrogen

N content (% of soil by weight)	Rating / Interpretation
> 1.0	Very high
0.5 – 1.0	High
0.2 – 0.5	Medium
0.1 – 0.2	Low
< 0.1	Very low

PHOSPHORUS Olsen's method of bicarbonate extraction

Available P values in ppm	Rating / Interpretation
<11	Deficient
12 – 20	Questionable
>21	Adequate

12 POTASSIUM

Available K (me/100g of soil)	Rating / Interpretation
0.8 - 0.4	High
0.4 – 0.2	Medium
0.2 – 0.03	Low

Source: Booker Tropical Soil Manual, A Handbook for soil survey and Agricultural land evaluation in the Tropics and Subtropics by J R Landon, 1995.

Table 2: Mean Separation Result for the Effect of Fertilizers on the Growth of *E. angolense* Seedlings

Fertilizer	Height (cm)	Collar Diameter (mm)	Leaf Production
WH 10g	11.24 ± 0.67^a	4.91 ± 0.31^{ab}	6 ± 0.37^{ab}
WH 20g	10.33 ± 0.61^a	4.24 ± 0.28^b	5 ± 0.39^{bc}
CD 10g	10.78 ± 0.72^a	5.08 ± 0.31^{ab}	6 ± 0.35^{ab}
CD 20g	12.45 ± 0.73^a	5.68 ± 0.30^a	7 ± 0.42^a
PM 10g	10.78 ± 0.53^a	4.88 ± 0.28^{ab}	6 ± 0.32^{ab}
PM 20g	10.50 ± 0.85^a	4.32 ± 0.35^b	7 ± 0.42^a
Control	7.08 ± 0.59^b	3.35 ± 0.15^c	5 ± 0.30^c

Mean±SE followed by the same superscripts in column are not significantly different ($p>0.05$)

Table 3: Mean Values for the Effect of different fertilizers on the biomass accumulated by *E. angolense* seedlings

Fertilizer	LDW	SDW	RDW	TDW
WH10g	2.71 ± 0.35	1.40 ± 0.47	1.76 ± 0.24	5.87 ± 0.97
WH20g	2.40 ± 0.52	1.41 ± 0.43	1.68 ± 0.31	5.49 ± 1.24
CD10g	2.86 ± 1.25	2.07 ± 1.14	2.46 ± 1.34	7.39 ± 3.72
CD20g	2.64 ± 1.42	1.84 ± 1.10	1.60 ± 0.84	6.08 ± 3.35
PM10g	2.81 ± 0.51	1.36 ± 0.26	1.81 ± 0.42	5.98 ± 1.18
PM20g	3.31 ± 1.12	2.71 ± 1.48	2.26 ± 1.09	8.28 ± 3.63
Control	0.67 ± 0.35	0.49 ± 0.07	0.57 ± 0.18	1.73 ± 0.45

Mean±SE followed by the same superscripts in column are not significantly different (p>0.05)

Table 4: Effect of Fertilizers on the Relative Growth Rate (RGR) of *E. angolense* Seedlings

Fertilizers	RGR (gg ⁻¹)		
	Month 1	Month 2	Month 3
WH 10g	0.15	0.1	0.18
WH 20g	0.36	0.82	0.93
CD 10g	0.14	0.52	0.74
CD 20g	0.42	0.48	0.51
PM 10g	0.06	0.16	0.21
PM 20g	0.55	0.27	0.63
Control	0.12	0.25	0.36

Appendix 1: ANOVA Result for the Effect of Fertilizers on the Growth of *E. angolense* Seedlings

Variable	SV	Df	SS	MS	F	Sig.
Height (cm)	Fertilizer	6	243.43	40.57	5.90	0.00*
	Error	98	674.40	6.88		
	Total	104	917.82			
Collar Diameter (mm)	Fertilizer	6	50.11	8.35	6.30	0.00*
	Error	98	129.98	1.33		
	Total	104	180.08			
Leave Production	Fertilizer	6	49.01	8.17	4.33	0.00*
	Error	98	184.80	1.89		
	Total	104	233.81			

**significant at (p≤0.05)*

Appendix 2: ANOVA for the Effect of Different Fertilizers on the Biomass Accumulation of *E. angolense* Seedlings

Variable	SV	Df	SS	MS	F	Sig.
Leaves Dry Weight (g)	Fertilizer	6	12.86	2.14	0.91	0.52 ^{ns}
	Error	14	32.99	2.36		
	Total	20	45.85			
Stem Dry Weight (g)	Fertilizer	6	8.65	1.44	0.65	0.69 ^{ns}
	Error	14	31.06	2.22		
	Total	20	39.70			
Root Dry Weight (g)	Fertilizer	6	6.52	1.09	0.63	0.71 ^{ns}
	Error	14	24.31	1.74		
	Total	20	30.84			
Total Dry Weight (g)	Fertilizer	6	76.22	12.70	0.70	0.65 ^{ns}
	Error	14	254.06	18.15		
	Total	20	330.28			

ns- Not significant ($p>0.05$)

CONCLUSION

Different kinds of organic fertilizers could facilitate quality and hasten the growth performance of seedlings. This study confirmed that organic manure originating from livestock byproducts promoted the growth of *Entandrophragma angolense* seedlings. In view of this, organic manure is environmental friendly with no pollution effect and readily available and cheap because it is considered as a waste. Therefore, organic manure should be considered as an alternative to chemical fertilizers in nursery seedling production systems.

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