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Effect of fertilizer application on growth performance of *Mansonia altissima* (A. Chev.) seedlings

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Abstract

The experiment comprised of two different factors such as three fertilizer media: Poultry droplet, Cow dung and NPK 15.15.15 and six fertilizer concentration levels with 2kg of top soil each. The experiment was set up in Two-factor factorial experiment in Completely Randomized Design (CRD) with five replications.Two weeks after fertilizer treatment (WAP), data were collected fortnightly. Data collected were subjected to analysis of variance and treatment means found to differ significantly were separated using Duncan Multiple Range Test (DMRT) at p = 0.05. Results indicate significant differences in seedlings heights, collar diameter and in leaves count. All results obtained show that poultry droplet medium performed better. Since the use of cow dung improved the seedlings growth significantly, it is therefore recommended that it should be used to raise M. altissima seedlings in nurseries.

Keywords: Effect, fertilizer, application, seedlings.

Introduction

In most regions of the world, forests, trees on farms and agroforestry systems play important roles in the livelihoods of rural people by providing employment, energy, nutritious foods and a wide range of goods and ecosystem services[1]. In Nigeria, the demand for indigenous tropical hardwoods such as *Mansonia altissima* for export and domestic consumption is increasing, while the natural forest is being depleted as a result of over-exploitation.

According to Hartmann, H.T. et al.[2], seed germination is influenced by many factors such as the type of substrate used, environmental factors such as oxygen, water and temperature and for some plant species, light. Generally, growth medium has been adjudged to be the most critical factor determining seedling quality in the nursery[3]. The growth medium physical properties can also have a profound effect on the supply of water and air to the growing plant[4].

Nutrient requirements for tree species in nursery differ in relation to environmental conditions[5]. In case a particular nutrient is limited in a forest nursery soil, seedlings may forage with their roots to some level in other to compensate for the deficiency or can pick up the element from the atmosphere through leaf pores[6].

Fertilizers are materials that deliver necessary nutrients for increased plant growth, yield or nutritive value, it contain nutrients that are used in large quantities by all plants[7]. *Mansonia altissima* was one of the indigenous species used in the early plantation trials in Nigeria; however further development of the species along with other indigenous tree species was abandoned in preference of exotic species[8]. Biodiversity studies have indicated low abundance of *Mansonia altissima* in Nigeria natural forest ecosystems. In addition, *Mansonia altissima* has been listed as an endangered species in the International Union for Conservation of Nature (IUCN) Red list.

The generally faster growth rates of exotic tree species have led to them being favored for plantation establishment rather than indigenous tree species. Due to the preference of exotic trees for plantation establishment, the regeneration of the indigenous tree species has been restricted to the natural forests[9]. Unfortunately, information about their ecology, their silviculture and their slow growth compared to exotic species does not encourage their use in forest plantation[8]. In order to conserve the threatened indigenous tree species in natural forests of Nigeria, it is expedient to examine their growth characteristics, which commences with the investigation growth performance of their seedlings in the nursery and therefore, the need for this study arise.

It is therefore necessary that the best quantity of fertilizer that will supply the highest nutrient needed for fast growth rate should be investigated for *M. altissima* seedling, which is the focus of this study.

Methodology

Study area: The experiment was conducted in the permanent nursery site of the Department of Forestry and Wood Technology, Federal University of Technology, Akure, Ondo

State, Nigeria. The University is located between latitude 7°17' and 7°18' N and longitude 5°06' and 5°09' E, with an altitude of 350 m above sea Level. The rainfall pattern of the study area is bimodal, with mean annual rainfall of about 2000mm. The mean annual humidity is about 80% while the mean daily temperature is about 26°C.

Method of Data collection: Seed Collection: Mansonia altissima seeds were picked from the ground after natural fall from the arboretum site of the Forestry Research Institute of Nigeria (FRIN), located at Jericho, Ibadan, Oyo state, Nigeria.

Seed Processing: Seeds were de-winged after collection, after which the seed coat were removed and soaked in water at room temperature for about 2 hours. The seeds were then broadcasted on river sand, which was the medium used for seed germination.

Cow dung and Poultry Droplets Collection and Processing: The cow dung and poultry droplets used for this study were collected from the animal farm section of the teaching and research farm, Federal University of Technology, Akure, Ondo State, Nigeria.

They were sun-dried for some weeks after which they were crushed into smaller particles and sieved. The sieved portion was weighted on a weighing scale according to the requirement of each treatment and mixed with the specified amount of topsoil for the experiment.

Sample of the poultry droplet, cow dung and the topsoil used in this study were analyzed in the laboratory to determine the amount of nitrogen (N), phosphorus (P) and potassium (K) nutrients present in them. The analyses were conducted in the soil analytical laboratory of the Department of Forestry and Wood Technology, Federal University of Technology, Akure.

Experimental Procedure: Three hundred (300) seeds of *Mansonia altissima* were broadcasted on rivers and in a germination box and seeds covered lightly with a thin spread of soil. A shade was provided in other to reduce the amount of light reaching the seedbed and to ensure maximum seed germination. After germination, 90 seedlings of fairly uniform size (height) were pricked-out and transplanted into already prepared polythene pots containing different levels of the sowing media. The polythene pots were setup a greenhouse. Three different potting/growing media were used for the experiment. These media, which constitute Factor A of the experiment, are: i. 2kg of topsoil and 0g, 10g, 20g, 30g, 40g and 50g of poultry droplet, ii. 2kg of topsoil and 0g, 10g, 20g, 30g, 40g and 50g of cow dung, iii. 2kg of topsoil and 0g, 1.0g, 2.0g, 3.0g, 4.0g and 5.0g level of NPK(15.15.15), which were applied in a ring form after transplanting.

The fertilizers were applied at six different levels, which are (Factor B); 0g, 10g, 20g, 30g, 40g and 50g of poultry droplet with 2kg topsoil; 0g, 10g, 20g, 30g, 40g and 50g of cow dung with 2kg of topsoil and0g, 1.0g, 2.0g, 3.0g, 4.0g and 5.0g of NPK(15.15.15) with 2kg topsoil. Each treatment combination was replicated 5times. The 0g fertilizer levels served as control. Thus, a total of 90 seedlings were used for experiment. The NPK fertilizer was applied in a ring form after the seedlings have been transplanted into their growing media. Watering was done once a day in the early morning hours throughout the duration of the experiment. Weeding of polythene pots was only undertaken when necessary. After the first 3 weeks of growth assessments, the seedlings were packed from greenhouse and carefully moved under a shade constructed outside the greenhouse. The seedlings growth performance was monitored for a period of 12 weeks. Early growth characteristics that were measured every two weeks were total height (cm) of the seedlings, leaf count, collar diameter (mm), root length (cm) and total length.

Experimental Design: The treatment design used for this research was Two-factor (3x6) factorial experiment in Completely Randomized Design (CRD). The Factor A has three levels; a_0 (poultry droplet), a_1 (cow dung), and a_2 (NPK) while the Factor B consist of six levels; b_0 (0g), b_1 (10g), b_2 (20g), b_3 (30g), b_4 (40g), b_5 (50g). The statistical model for two-factor factorial in CRD is shown in equation 1 while the layout of the experiment

$$Y_{ijk} = \mu + A_i + B_j + (AB)_{ij} + \varepsilon_{ijk} \quad (1)$$

Where: Y_{ijk} = Individual observation, μ = General mean, A_i = Effect of Factor A, B_j = Effect of Factor B, $(AB)_{ij}$ = Effect of interaction AB, ε_{ij}= Experimental error

Method of Data Analysis: The data on seedlings early growth assessment and biomass were subjected to Analysis of Variance (ANOVA) to compare the effect of the factors on early growth performance of *Mansonia altissima* seedlings. Treatment means found to differ significantly ($P<0.05$) was separated using Duncan Multiple Range Test (DMRT) and their result was summarized in Tables and Figures.

Results and discussion

The experiment was conducted on 'effect of fertilizer application on growth performance of *mansonia altissima (*a. chev.) seedling' and the results on effectiveness of various treatments including an untreated control for the management of *Mansonia altissima* have been described and discussed below in detail under the following heading.

Seedlings Growth Characteristics: **Mean Number of Leaves**: Mean number of leaves at the two weeks of growth was at the range of 1 to 4 for all the treatments (Figure-1, 2 and 3). As the growth period increased, the number of leaves also increased marginally, except for seedlings grown in 50g concentration of poultry droplet and all NPK treatments which both experience dryness and therefore stop producing more leaves starting from week 4 of the study (Figure-1 and 3). Result showed that after twelve (12) weeks of growth mean leave produced ranges

between 2 and 10. Mansonia altissima seedlings planted in Cow dung media at 50g and 20g concentration had the highest mean number of leaves of 10 and 9 respectively than seedlings in other growing media (Figure-2). Seedlings planted in poultry droplet at 20g, 30g and 40g had 8 mean numbers of leaves (Figure-1). The control had 7 mean leaves number as its highest (Figure-1, 2 and 3). The mean leaves number of seedling planted in NPK medium was 5 at 3g concentration level (Figure-3).

Table-1: Pre-planting growing media analysis

Growing media	Nutrient level		
	Nitrogen	Phosphorus (mg/kg)	Potassium
Soil	0.28	142.1	0.76
Poultry droplet	0.25	406.88	54.87
Cow dung	0.26	246.23	30.51

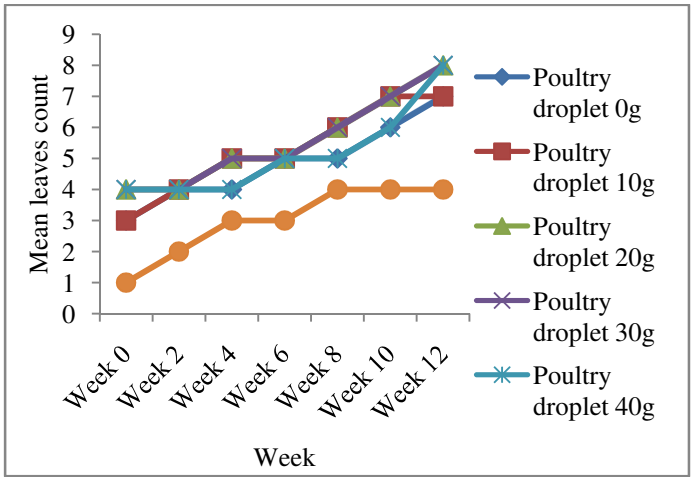

Figure-1: Effect of poultry droplet on number of leaves produced by *Mansonia altissima* seedling.

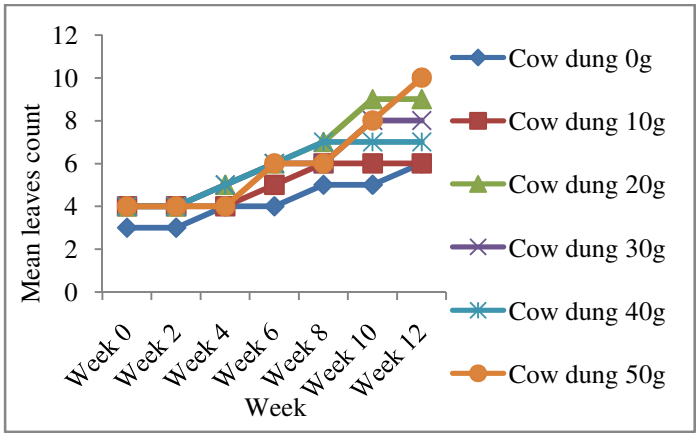

Figure-2: Effect of cow dung on number of leaves produced by *Mansonia altissima* seedlings.

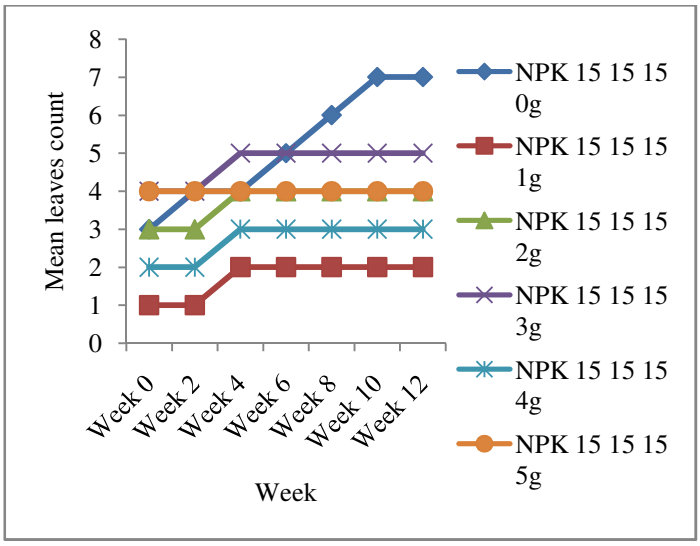

Figure-3: Effect of NPK15.15.15 on number of leaves produced by *Mansonia altissima* seedlings.

The results of analysis of variance (ANOVA) revealed a significant difference ($P<0.05$) in fertilizer type, fertilizer concentration and in the interaction between fertilizer and fertilizer concentration in relation to the number of leaves produced by *Mansonia altissima.* Result from mean separation in Table-2 showed that the seedlings planted in Cow dung medium has the highest value of leaves count but was not significantly different from the number of leaves produced by seedling planted in poultry droplet. Both cow dung and poultry droplet media are significantly different ($P<0.05$) from the leave number produced by the NPK medium (Table-2). Mean separation result also shown that the 30g (for cow dung and poultry droplet) and 3g (for NPK) fertilizer concentration level has the highest number of leaves which was significantly different ($P<0.05$) from number of leaves produced in other concentration level (Table-3). Fertilizer concentration level; 20g and 2g; control (0g): 40g and 4g; and 50g and 5g the control of all the growing media are not significantly different($P>0.05$) from each other but they were different significantly($P<0.05$) from 10g and 1g fertilizer concentration level of all the media (Table-3).

Table-2: Post-Hoc Test results for the effect of fertilizer application on leave count, height and collar diameter of *Mansonia altissima* seedlings.

Fertilizer	Leaf count	Height	Collar diameter
Cow dung	2.29^{a}	9.17^{a}	2.49^{a}
Poultry droplet	2.18^{a}	7.07^{b}	2.23^{a}
NPK 15.15.15	1.91^{b}	5.54^{c}	1.68^{b}

Values in the same column followed by the same alphabet are not significantly different ($P>0.05$).

Table-3: Follow-up Analysis result of effect of fertilizer concentration on number of leaves and height produced by *Mansonia altissima seedlings.*

Fertilizer concentration	Leaf count	Height
30g and 3g	2.31[a]	7.81[ab]
20g and 2g	2.25[ab]	7.62[ab]
0g	2.16[abc]	7.00[abc]
40g and 4g	2.09[bcd]	7.97[a]
50g and 5g	2.01cd[cd]	6.64[bc]
10 g and 1g	1.93d[d]	6.33[c]

Values in the same column followed by the same alphabet are not significantly different (P >0.05).

Mean Height: The mean height growth development of *Mansonia altissima* seedlings after twelve weeks (12) of growth is presented in Figure-4, 5 and 6. Height growth of seedlings under poultry droplet and cow dung is almost similar with both treatments given the best height growth for the seedlings (Figure-4 and 5).

Tree seedlings planted in NPK 15.15.15 medium does not perform well in comparison to other treatment media because the seedlings treated showed dryness symptoms at the third day of application which eventually became dried after 6 weeks of the experiment (Figure-6).

During the first week of growth, total height of individual *Mansonia altissima* ranged from 3.2cm to 8cm in all the growth media (Figure-4, 5 and 6). At week 2 and 4, there was steady growth increased for all seedlings except for seedling grown in; 50g poultry droplet concentration and all NPK treated seedlings which had marginal growth increase (Figure-4, 5 and 6). At week 6, 10 and 12, the growth continues steadily mostly for seedlings grown in cow dung medium (Figure-5). Growth was marginal for seedlings grown in poultry droplet medium and it was constant for 50g poultry droplet concentration and all NPK treated seedlings (Figure-4 and 6).

By the end of 12 weeks, the highest mean height growth for *Mansonia altissima* seedlings planted in poultry droplet medium was 10.4cm which was observed in 10g and 20g concentration level (Figure-4). For *Mansonia altissima* seedling grown under cow dung, the highest mean height was 15.40cm at 30g and 40g concentration level which is the highest of all the treatments (Figure-5). The highest mean height of the control was 11.2cm (Figure-5, 4 and 6) and that of NPK treatments was 7.8cm (Figure-6).

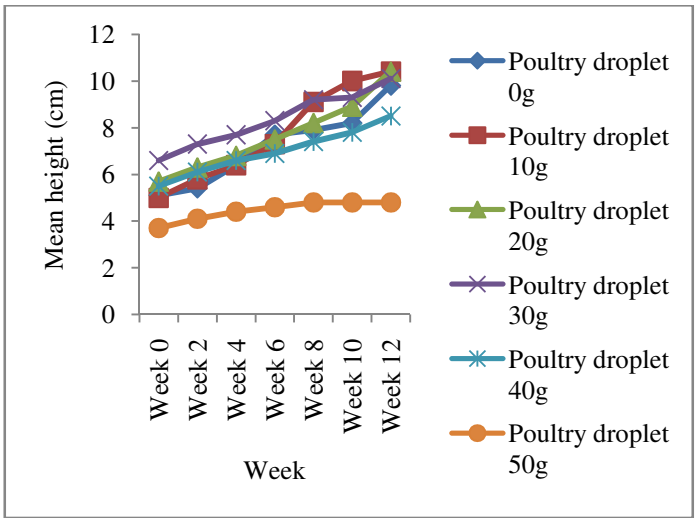

Figure-4: Effect of poultry droplet on height growth of *Mansonia altissima* seedlings.

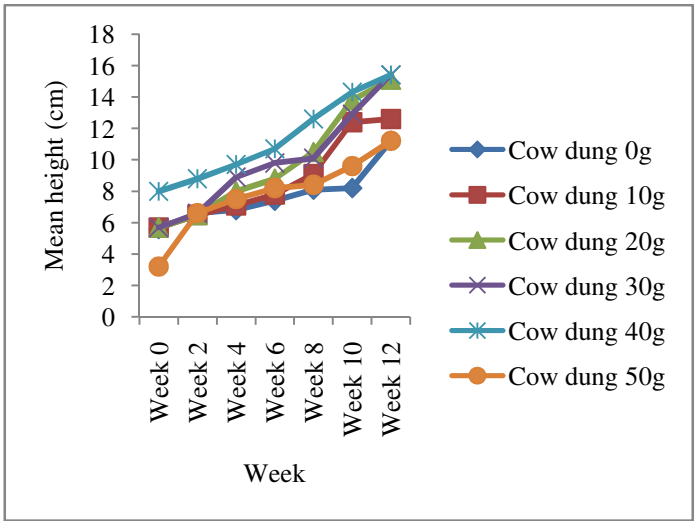

Figure-5: Effect of cow dung on height growth of *Mansonia altissima* seedlings.

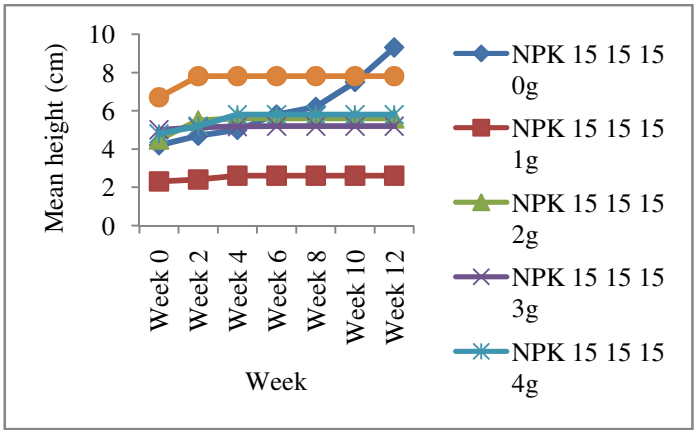

Figure-6: Effect of NPK 15.15.15 on height growth of *Mansonia altissima* seedlings.

The results of analysis of variance (ANOVA) revealed a significant difference (P<0.05) in fertilizer type, fertilizer concentration and in the interaction between fertilizer and fertilizer concentration in relation to the height increment of *Mansonia altissima.* Mean separation showed that height growth of seedlings under cow dung fertilizer has the highest value, which was significantly different (P<0.05) from the height of seedling produced under poultry droplet which is also significantly different (P<0.05) from the height of NPK (Table-2). The result from fertilizer concentration follow-up analysis revealed no significant difference (P>0.05) among the concentration levels except for 10g and 1g level which contributed to the least height increment of the seedlings (Table-3).

Mean collar diameter: Figure-7, 8 and 9 below shows the development of mean collar diameter for *Mansonia altissima* seedlings planted in different fertilizer media and concentration for twelve weeks. By the second week of measurement, Collar diameter ranged from 0.65mm to 2.08mm for all treatments (Figure-7, 8 and 9). As the two week interval measurement continues, there was a marginal increase in the mean collar diameter of *Mansonia altissima* seedlings planted in all the various fertilizer media, except for seedlings planted in 50g poultry droplet concentration and all NPK treated seedlings whose girth increment was constant as at the fourth week to the end of the study (Figure-7, 8 and 9).

Result obtained at the end of twelve weeks of growth showed that *Mansonia altissima* grown in 10g concentration level of cow dung had the highest mean collar diameter of 4.28mm, which was followed in poultry droplet by 10g and 20g concentration level with 4.16mm mean collar diameter (Figure-7 and 6). The control had 3.07mm mean collar diameter while NPK had 2.08mm at 5g (Figure-7, 8 and 9).

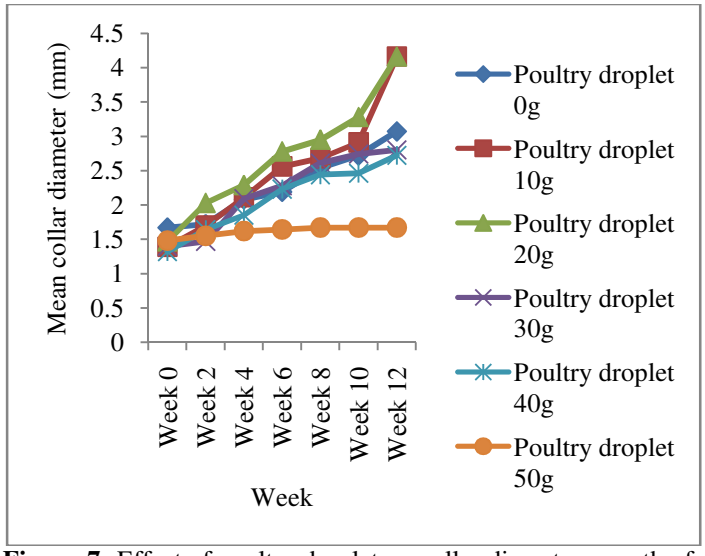

Figure-7: Effect of poultry droplet on collar diameter growth of *Mansonia altissima* seedlings.

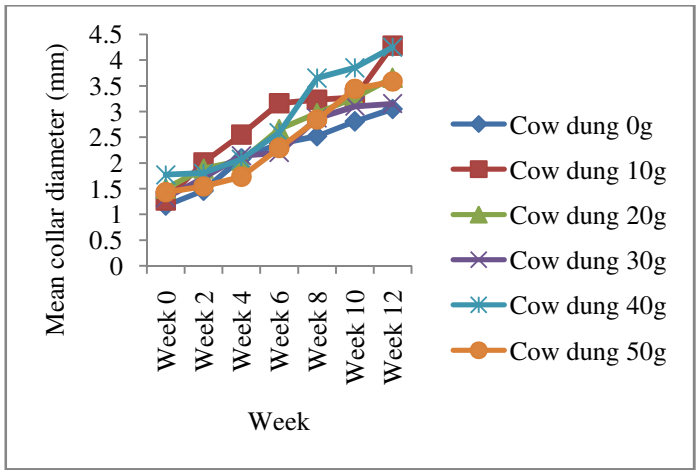

Figure-8: Effect of cow dung on collar diameter growth of *Mansonia altissima* seedlings.

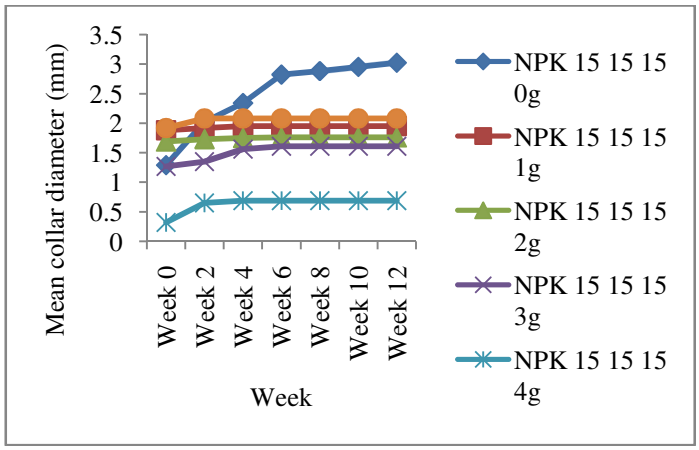

Figure-9: Effect of NPK 15.15.15 on collar diameter growth of *Mansonia altissima* seedlings.

The result of analysis of variance showed a significant difference (P<0.05) in the effect of fertilizer and in the interaction between fertilizer and fertilizer concentration on the collar diameter increment of *Mansonia altissima*. There was no significant difference (P>0.05) in the effect of fertilizer concentration on the collar diameter growth increment of *Mansonia altissima*. Result from mean separation showed that the seedlings planted in Cow dung medium has the highest collar diameter increment but which was not significantly different from the value of collar diameter produced by seedling planted in poultry droplet while the both are significantly different (P<0.05) from the collar diameter produced by the NPK medium (Table-2).

Discussion: The inherent characteristics of tree species and genotypes within species play a major role in restricting or enhancing efficiency of plants in the uptake, use and tolerance to mineral elements. Physical characteristics are the visually determinable attributes of nursery tree seedlings.

The major morphological criteria often used to describe tree seedling potentials for timber production and nursery establishment are stem height, leaf number and seedling collar diameter.

Stem height is an important phenotypic plant character controlled genetically which differs within the varieties. Under the present study, stem height was significantly influenced by fertilizer type and fertilizer concentration at $P<0.05$ (Table-2 and 3). This is in conformity with results obtained for seedlings of C*edrelalilloi*, *Dryobalanopslanceolata* Burck and *Shoreaplatyclados treated* with different nutrients (10, 11). Stem height increments were highest (15.40cm mean height) with treatment the combination cow dung at 10g and 20g concentration level and followed by the control having 11.2cm stem height. 20g poultry droplet produced the next treatment height with 10.4cm mean height. NPK medium recorded the least stem height of 7.8cm among other treatments. The highest stem length (15.40cm) was indicated with the treatment of cow dung (20g), this shows that cow dung aids stem increment of *Mansonia altissima* seedlings better than when the seedlings is planted without fertilizer or with other type of fertilizer. This finding is in conformity with the study conducted on *Brassica oleracea*[12].

Mansonia altissima seedlings planted in Cow dung media at 50g and 20g concentration had the highest mean number of leaves of 10 and 9 respectively than seedlings in other growing media (Figure-2). Seedlings planted in poultry droplet at 20g, 30g and 40g had 8 mean numbers of leaves (Figure-1). The control had 7 mean leaves number as its highest (Figure-1, 2 and 3). The mean leaves number of seedling planted in NPK medium was 5 at 3g concentration level (Figure-3). The leaf counts is different significantly and mean separation test revealed cow dung to be the best fertilizer for leave production. This result is not in agreement with the finding of A. P. Aluko who reported that the seedling groups treated with poultry droplet performed better than those treated with other fertilizer.

From the ANOVA table in Table-2, result from mean separation showed that the seedlings planted in Cow dung medium has the highest collar diameter increment but which was not significantly different from the value of collar diameter produced by seedling planted in poultry droplet while the both are significantly different from the collar diameter produced by the NPK medium (Table-2). It was shown that the seedlings planted in Cow dung medium has the highest collar diameter increment but which was not significantly different from the value of collar diameter produced by seedling planted in poultry droplet while both were significantly different from the collar diameter produced by the NPK medium. Result obtained at the end of twelve weeks of growth showed that *Mansonia altissima* grown in 10 g concentration level of cow dung had the highest mean collar diameter of 4.28mm, which was followed in poultry droplet by 10 g and 20g concentration level with 4.16mm mean collar diameter (Figure - 7 and 6). The control had 3.07mm mean collar diameter while NPK had 2.08mm at 5g (Figure-7, 8 and 9). The highest value (3.07mm) of mean collar diameter recorded in the control experiment is lower to the highest mean value recorded for cow dung (4.28mm at 10g concentration level) and poultry droplet (4.46mm at 10g and 20g concentration level). NPK medium had the least collar diameter increment (2.08mm at 5g concentration level). This finding shows cow dung to be the most active medium that increases seedling girth. A. E. Gbadamosi also reported similar results for tree seedlings.

Conclusion

The study revealed that the fertilizer type and concentration of fertilizer application can influence the growth performance, development and biomass estimation of *Mansonia altissima (*A. Chev.) seedlingsin the nursery. It has been observed that *Mansonia altissima* seedlings may successfully be raised with organic fertilizers (either cow dung or poultry droplet). The study also indicated that the observed differences among *Mansonia altissima* seedlings subjected to different fertilizer treatments were generally significant. The best result is obtained with 40g concentration of cow dung. Leaf number, collar diameter and stem height are increased by addition of the fertilizers.Since the results of this study indicated that seedlings of *Mansonia altissima* grows better in cow dung and most especially at 40g concentration level, it is therefore recommended that seedlings of *M. altissima* be raised in 40g concentration level of cow dung so as to obtain maximum nursery productivity for plantation establishments and other purposes.

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