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World News of Natural Sciences

An International Scientific Journal

WNOFNS 30(2) (2020) 287-297 EISSN 2543-5426

Impact of soil amendments on the early growth of *Streculia setigera* Del. in the nursery

A. Buochuama* and **E. F. Akhabue**

Department of Forestry and Wildlife Management, University of Port Harcourt, PMB 5323, Port Harcourt, Nigeria

*E-mail address: alexanderbuochuama@yahoo.com

ABSTRACT

There exists an inadequate research on the propagation and nutrient needs of most tropical tree species. Hence, this work involves the developmental impact of soil amendments on the early growth of *Streculia setigera* Del. in the nursery. Different soil amendments; poultry waste (F_1), goat manure (F_2), cow manure (F_3) and the control, normal soil (F_4) were applied to several viable seeds of *Streculia setigera* in the nursery. The seeds were subjected to the same routine nursery practices. The experiment was laid in a Completely Randomized Design (CRD) and lasted for ninety (90) days. Descriptive statistics and ANOVA were used in the data analysis. The findings revealed that the entire growth response of *Streculia setigera* seedlings were only sparely affected by the soil amendments ($P<0.05$). F_3 was found to be the most preferred soil amendment for this species, followed by F_2 and F_4 consecutively. The result obtained from F_1 was very poor and thus it is not ideal for this species.

***Keywords*:** early growth, nursery, nutrient requirement, propagation, soil amendments

1. INTRODUCTION

Fertilization with organic and inorganic fertilizers during forest seedling culture is one of the most critical factors with a positive effect on seedling quality, performance and establishment. Environmental conditions also influence nutrient requirements for plant species in nursery and in the field (Kraiser *et al.*, 2011). Maintaining adequate fertility of forest nursery soils is of paramount importance to assure production of high quality planting stock (Hoque *et*

(Received 26 March 2020; Accepted 18 April 2020; Date of Publication 19 April 2020)

al., 2004). High quality planting stocks will have better adaptation, resistance to environmental stress and will have a better field performance over long term (Davis and Jacobs, 2005).

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 (Lawrence, 1998; Jose, 2003). Therefore, inadequate management of nursery soil can result in depletion of soil fertility and a corresponding reduction in seedling growth (Hoque *et al.,* 2004).

However, a healthy seedling must be supplied with all the nutrients in the proper proportion for efficient growth (Craven *et al*., 2006; Gbadamosi, 2006) and development following out planting. Literatures on the nutrient requirement of plants in the nursery are available, but more of such information would be necessary, since conditions change and also because species-specific records are very essential for producing quality seedlings for out planting (Rafiqul *et al*., 2004).

One way to improve soil fertility is the application of fertilizer which obviously is a means required for optimum crop yield (Dania *et al.*, 2004). It has been reported that organic manure can serve as soil amendment to improve soil nutrient status and the growth of crops (Stoffella *et al.*, 1997).

Various research efforts have been made on the nutritional need of tree plant like *Terminalia ivorensis* (Aluko, 1987), *Pinus caribbean* (Kadeba, 1986) and various other tree species. Little or no research has been carried out on the nutritional need of this species. In Senegal, several studies were carried out on *S. setigera*. These studies had concerned with socio-economic values (Johnson *et al*., 2005), agroforestry management (Bakhoum *et al*., 2012) seedling germination, vegetative propagation and "In vitro" micro-grafting of adult material (Niang, 2010).

In view of sustainable conservation and improvement gum yield, several studies were realized, particularly on *S. urens* in India (Hussain *et al*., 2008) and *S. setigera* in Senegal (Niang, 2010). In Togo, studies focused on *S. setigera* are scanty until this day, although this tree species is found throughout the country.

Despite its socio-economic importance, the species is threatened. Its organs withdrawal mainly for medicinal purposes, socio - cultural status (fetish tree or evil spirits home) and the total ignorance of the economic value of its gum (Atakpama *et al*., 2013) compromise the species survival and regeneration (Atakpama, 2010).

Based on the economic value and various types of pressures on *S. setigera*, it becomes imperative to carry out this research. Hence, this paper aims to assess the best soil amendment for *Sterculia setigera* seeds in the nursery.

2. MATERIALS AND METHODS

2. 1. Study Site

The research was conducted at the nursery of the Federal College of Wildlife Management, Forestry Research Institute of Nigeria, New Bussa, Borgu Local Government Area. Borgu Local Government Area is located in Niger state, Nigeria (**Figure 1**). It is situated on latitude 9º53'N and longitude 4º31'E, covering a land mass of about 16,200 km^2 (Adeniji *et al*., 2015).

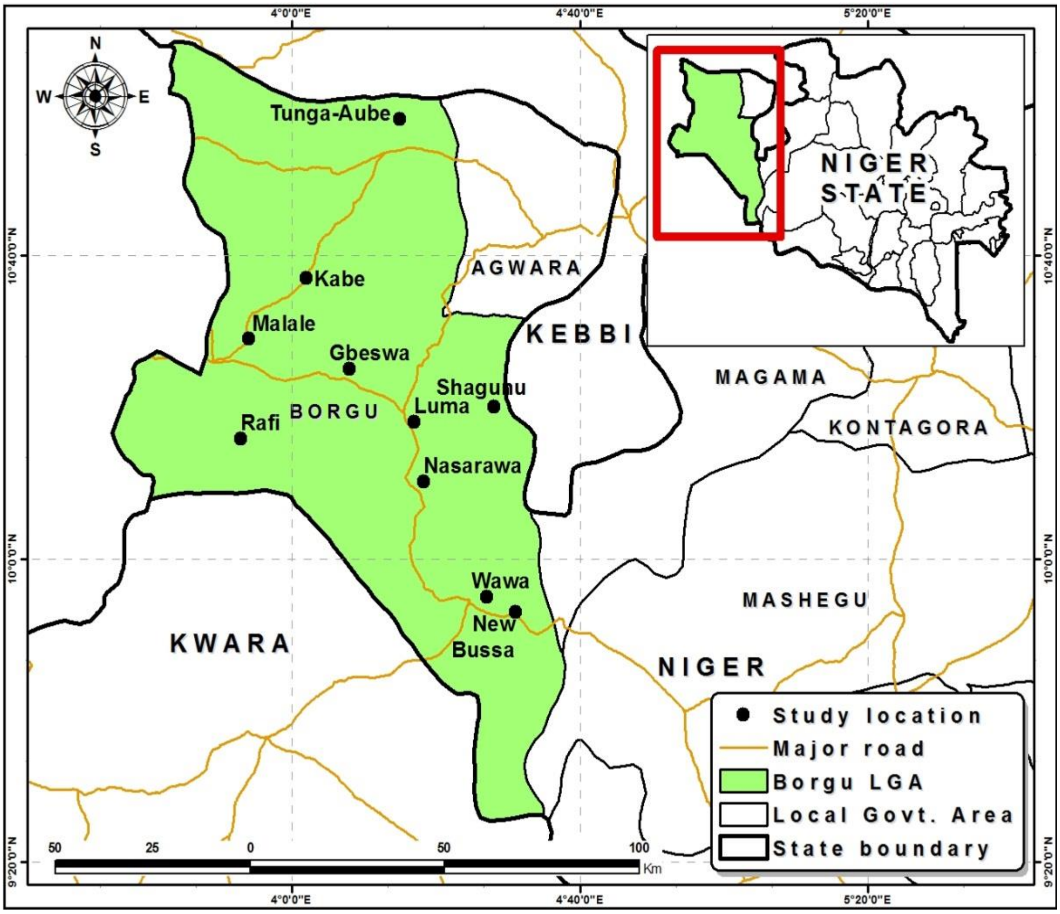

Figure 1. Map of Borgu LGA, showing the study area

2. 2. Data collection and analysis

The seeds and the soil amendments used for this study were obtained in the woodlots and in the farm of Federal College of Wildlife Management, Forestry Research Institute of Nigeria, New Bussa. Poultry waste (F_1), goat manure (F_2), cow manure (F_3) and the control, normal soil (F_4) were the soil amendments used for this study. The treatments were subjected to the same routine nursery practices. A Completely Randomized Design was used with four replicates. The experiment lasted for twelve (12) weeks and the parameter measurements were done every fourteen (14) days. The main morphological parameters measured for all the seedlings were: sprouting rate, number of leaves, stem girth and seedling height. The soil analysis was carried out in the laboratory of Federal College of Wildlife Management, Forestry Research Institute of Nigeria, New Bussa. Descriptive analysis and one-way ANOVA were used for the data analysis. The mathematical model for this research design is as follows:

$$Y_{ij} = \mu + t_j + e_{ij}$$

where:

Y_{ij} = response of the *j*th individual unit belonging to the *i*th group

μ = overall population mean
t_j = effect of being in the *i*th treatment
e_{ij} = random error.

Figure 2. Top view of *Streculia setigera* leaf

3. RESULTS

Figure 2 shows the physical properties of the topsoil in this experiment. It can be observed that the soil used for this study is of sandy loam. **Table 1** shows the one-way ANOVA for the rate of sprouting of *Sterculia setigera.* It denotes that there exists no significant difference in the sprouting rate of *Sterculia setigera* seedlings when the different soil amendments were applied. **Table 2** reveals the one-way ANOVA for the plant height of *Sterculia setigera.* It means that no significant variation was observed when the soil amendments were used. **Table 3** shows the one-way ANOVA for the number of leaves of *Sterculia setigera.* The result shows an insignificance difference in the number of leaves when the soil amendments were applied. The result in Table 4 reveals a one-way ANOVA for stem girth of *Sterculia setigera.* It can be observed that there is no significant difference in the stem girth for all the soil amendments. **Figure 3** shows a graph of disparity in the sprouting rate of *Sterculia setigera*, relative to the soil amendments. **Figure 4** reveals a graph of disparity in the heights of *Sterculia setigera* seedlings relative to soil amendments. **Figure 5** shows a graph of disparity in the number of leaves of *Sterculia setigera* seedlings relative to the soil amendments.

Figure 6 also shows a graph of disparity in the stem girth of *Sterculia setigera* seedlings relative to soil amendments.

Table 1. One-way ANOVA for the rate of sprouting of *Sterculia setigera*

Source	DF	SS	MS	F-cal	F-tab
Treatment	3	1.32	0.44	1.63	3.49
Error	12	3.22	0.27		
Total	15	4.54			

Table 2. One-way ANOVA for the plant height of *Sterculia setigera*

Source	DF	SS	MS	F-cal	F-tab
Treatment	3	56.25	18.75	0.855	3.49
Error	12	263.33	21.94		
Total	15	319.58			

Table 3. One-way ANOVA for the number of leaves of *Sterculia setigera*

Source	DF	SS	MS	F-cal	F-tab
Treatment	3	1.56	0.52	1.182	3.49
Error	12	5.23	0.44		
Total	15	6.79			

Table 4. One-way ANOVA for stem girth of *Sterculia setigera*

Source	DF	SS	MS	F-cal	F-tab
Treatment	3	0.04	0.013	2.60	3.49
Error	12	0.06	0.005		
Total	15	0.1			

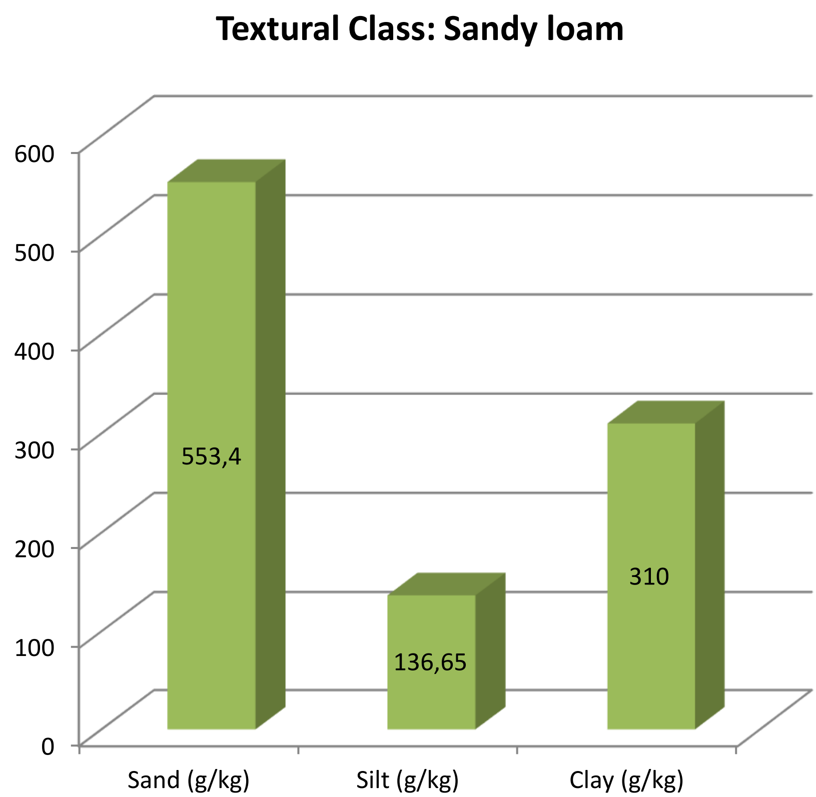

Figure 3. Physical properties of the topsoil used in this experiment

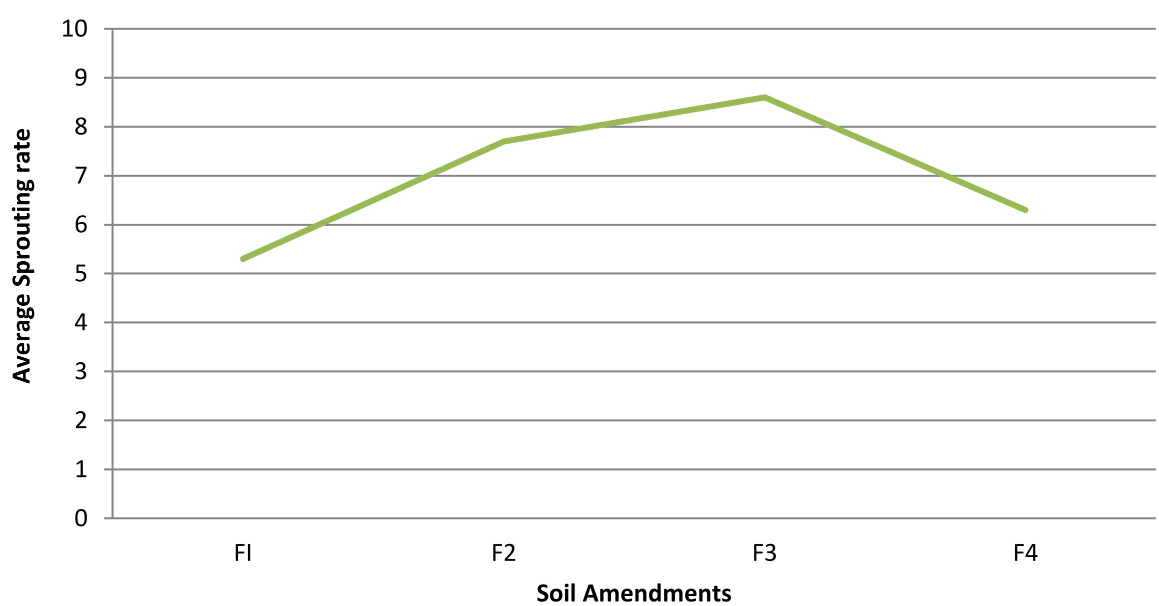

Figure 4. A graph of disparity in sprouting rate relative to soil amendments

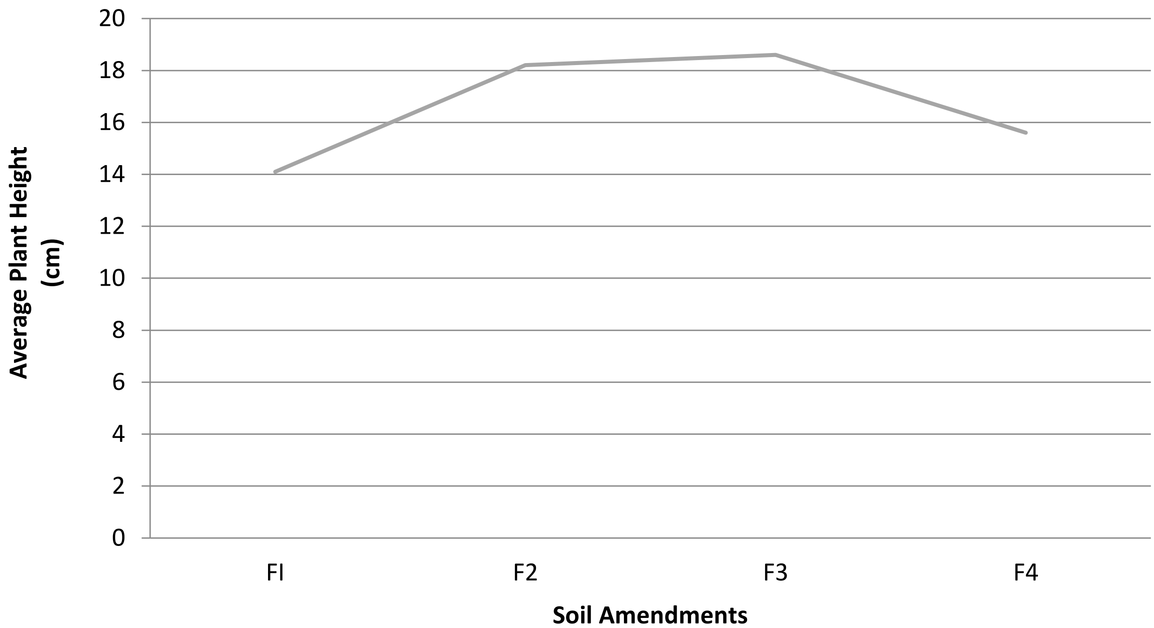

Figure 5. A graph of disparity in the plant heights relative to soil amendments

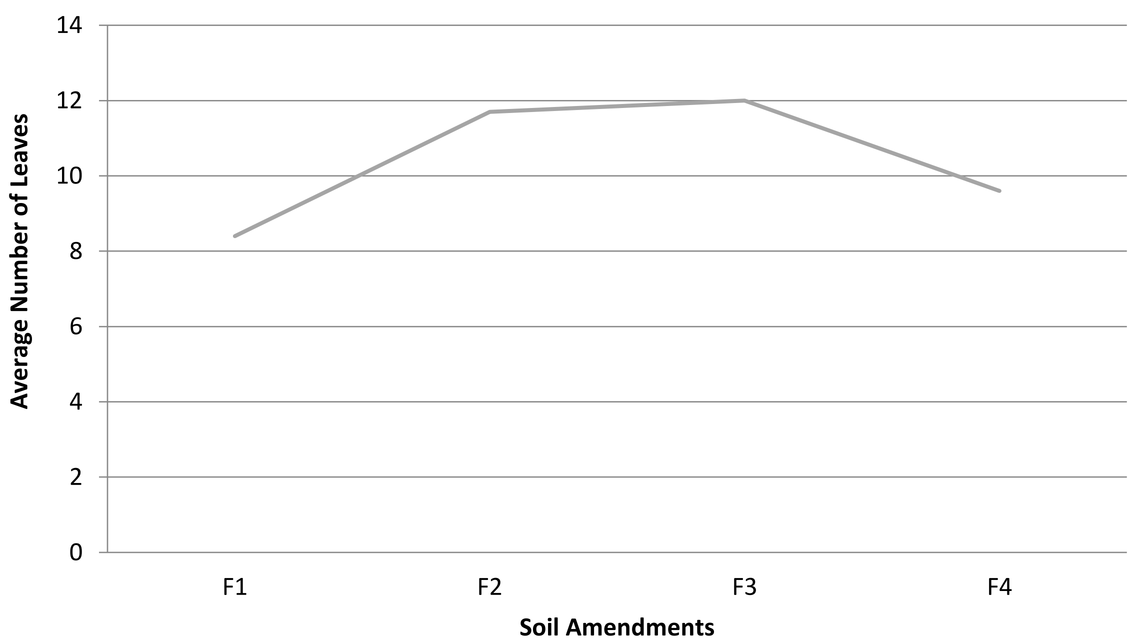

Figure 6. A graph of disparity in the number of leaves relative to soil amendments

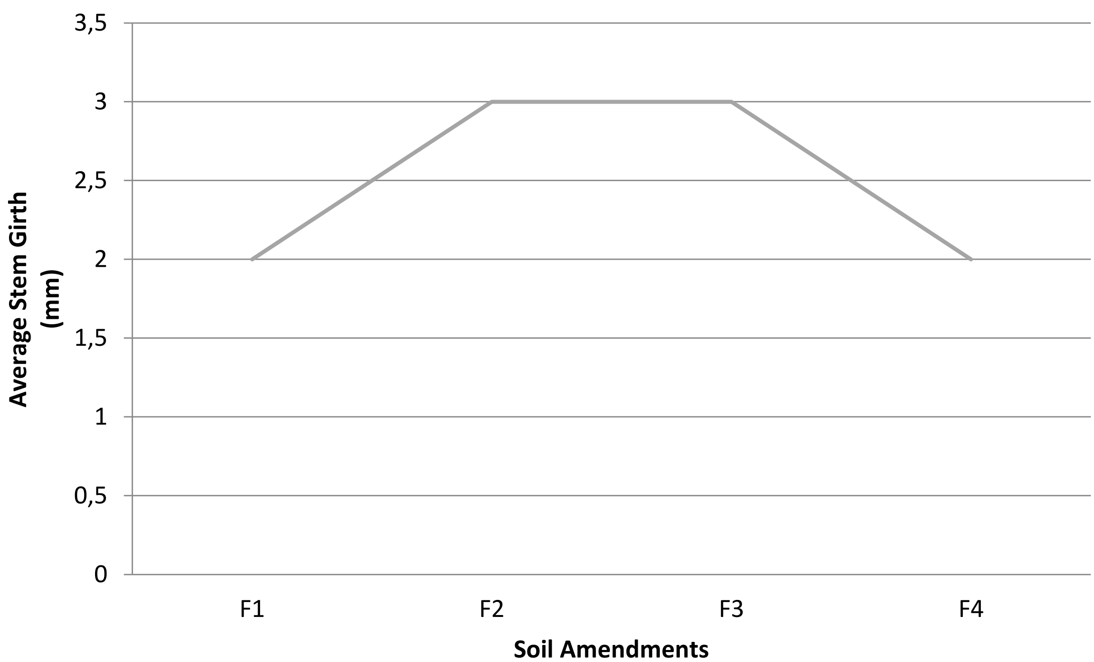

Figure 7. A graph of disparity in stem girth relative to soil amendments

4. DISCUSSION

The results presented in Table 1 above show that the addition of soil amendments led to an insignificant adjustment in the sprouting rate of *Sterculia setigera* seedlings. Figure 3 above clearly confirms this, with the average sprouting rate reading close to each other, vacillating from 5.3 to 8.6. In this study, F_3 was observed to be the best option, followed by $F_{2.}$ Focho *et al.* (2011) asserted that, soil amendment, for forest nursery usually with organic matter, has also been reported to promote seedling quality.

F_1 obtained the least average sprouting rate of 5.3. An average sprouting rate of 7.7 was seen at the completion of the investigation when F_2 was used. *Sterculia setigera* seeds sprouted earlier when F_3 was used, while F_4 obtained an average sprouting rate of 6.3. Addition of soil amendments during forest seedling culture is among the major factors with an encouraging outcome on forest seedling quality and performance in the field.

The result from Table 2 shows that the seedling height of *Sterculia setigera* was insignificantly affected by the soil amendments used. This could be confirmed in Figure 4 showing the average seedling height gauging adjacent to each other, ranging from 14.1 cm to 18.6 cm. It was observed that F_3 is the best option for a relatively rapid shoot growth of *Sterculia setigera*. F_1 was found to have the lowest mean shoot height of 14.1 cm. A mean plant height of 18.2 cm was observed at the end of the research when F_2 was used. *Sterculia setigera* seedlings recorded the highest plant height when F_3 was applied, while F_4 had a mean shoot height of 15.6 cm. Several studies observed different results in their findings. For instance, Imoro *et al.* (2012) noted that the shoot height of seedlings, treated with poultry manure, produced the highest length compared to those treated with cow dung manure and controls, respectively. He went further to state that those seedlings treated with cow dung manure also outperformed the controls in terms of plant height. The mean shoot height in the poultry manure-treated seedlings (0.49 m) and cow dung manure-treated seedlings (0.42 m) were significantly higher ($p > 0.01$) than seedling shoot height (0.35 m) of the control set-up.

The numbers of leaves of Sterculia setigera seedlings were not profoundly affected by the soil amendments (Table 3). Figure 5 reveals that treatment three (F_3) had the highest mean number of leaves (12), followed by F_2 (11.7) and F_4 (9.6). The least was observed in F_1 (8.4). In this study, F_3 could be said to be the best option for *Sterculia setigera*.

The stem girth of *Sterculia setigera* seedlings were not expressively affected by the soil amendment used. Figure 6 reveals that both, treatment three (F_3) and F_2 had an average stem girth of 3 mm, respectively, while F_3 and F_4 obtained an average stem girth of 2 mm, respectively.

Generally, for all measured morphological parameters, it can be confidently stated that F_3 is the ideal amendment for this species. This finding differs from the work done by Imoro *et al.* (2012) who asserted that the nutrient quality in poultry manure might surpass the ones in cow dung manure leading to more enhanced plant growth in those treated with poultry manure. The bulk of cow dung manure might probably be materials that do not significantly enhance plant growth, as compared to those found in the poultry manure.

5. CONCLUSION

This work has revealed different soil amendments that can be used for this species in the nursery. However, cow manure shows a promising result and is the ideal soil organic amendment for this species.

Acknowledgement

We greatly appreciate the management of Federal College of Wildlife Management, Forestry Research Institute of Nigeria, New Bussa, Nigeria, for granting the opportunity to carry out this research.

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