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Residual Effect of Organic Manure (Biochar and Cowdung) on the Growth of *Pterocarpus osun*

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Authors' contributions

This work was carried out in collaboration among all authors. Authors FBM and FMJ designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors VAO, EAA and FOA managed the analyses of the study. Authors FBM and FOA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The present study aims to determine the residual effects of organic manure (biochar and cowdung) growth of *P. osun* under a screen house condition. Implementing the use of biochar and different organic sources has been proposed as an option for improving soil fertility, restoring degraded land and sequester large amounts of carbon (C) over the long-term. The study was carried out in Forestry Research Institute of Nigeria. *Pterocarpus osun* seeds were collected from the botanical garden at the University of Ibadan. The media for planting (soil) and treatments used had already been established from previous experiments done by using same species (*Pterocarpus osun*). Seedlings of *P. osun* were raised in a germination basket for four (4) weeks and twenty four (24) healthy seedlings were selected from the basket on the basis of uniform treatments and then transplanted into the already established media and the experiments were arranged in a completely randomized design (CRD). Data on growth parameters (plant height, number of leaves), collar diameter and dry matter yields were generated and subjected to analysis of variance. The significant

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means were separated by using LSD at 5% level of significance. The results showed that the interaction of Biochar + Cow dung (30 t/ha +135 g) had the highest diameter with a value of 5.17 mm when compared with the control (no amendments). The highest plant height was recorded by the interaction of biochar and cow dung at 20 t/ha +135 g with mean value of 11.73 cm while sole application of cow dung also performed well in number of leaves with a mean value 11.50 as compared with the control (no amendment). It is concluded that there is a residual effect in the interaction of biochar and cow dung, which ultimately improves the performance of *Pterocarpus osun*.

Keywords: Pterocarpus osun; biochar; cowdung; growth; performance.

1. INTRODUCTION

Pterocarpus osun is a woody tree belonging to Fabaceae family [1]. It is a multipurpose large tree and deciduous in nature, grows about 60m in height and 8 m in girth with a spreading crown [2]. The leaflets are mostly rounded at each end (7.14 cm long, 3.5 cm broad). The common name is padduk or cam wood (other names are mukwa and narre), the scientific name is Latinized in an ancient greek and meaning "wing fruit" due to the unusual shape of the seed pod in the genus. It is brown and red color with various mordant [3]. It grows in both tropical and subtropical region of the world and can be grown in areas of low rainfall and marginal sites and can be used to reclaim and retained degraded and eroded areas. *P.osun* is recognized for its physical and aesthetic qualities as one of the most significant and valuable hardwoods in the world [4]. The tree is of great economic value and medicinal purposes it is used for walking sticks, drums and mortal. Recent studies at National Institute for Pharmaceutical Research and Developments (NIPRD) Abuja showed that *P.*osun has medicinal significance, and *P.osun* in combination with extracts of *Piper guineense* seeds, *Sorgum bicolor* leaves and *Syzgium aromaticum* fruit can be used successfully to control sickle cell disorder [5].

Decline in soil nutrient is one of the major constraints of crops and tree production in Nigeria. In past few years, inorganic fertilizer was advocated for increase production to ameliorate low inherent fertility of the soils in the tropics [6]. However high cost and scarcity of inorganic fertilizer as well as cause of soil acidity and nutrient imbalance pose a constraint to use of inorganic fertilizer [7]. In order to sustain soil fertility over a long period of time, the use of organic manure has been advocated [8]. In general, soil amended with organic manure (plants and animal materials) improves its physical properties (infiltration rate, water-holding capacity, and bulk density) and increases biological activity (respiration) for a long time more than inorganic fertilizer [9]. The slow release nature of organic nutrients prevents leaching, losses of some nutrients as when compared with inorganic fertilizer [7].

Biochar from pyrolysis and charcoal produces through natural burning shared key characteristic including long residence time in soil and a soil conditioning effects [10]. Biochar can be produced from a wide range of biomass sources including woody materials as well as agricultural wastes. Biochar production and application has received a growing interest and have proposed a sustainable technology to improve highly weathered or degraded soils, to decrease atmosphere CO_2 concentrations, sequester organic carbon in the terrestrial ecosystems for the long term and to decrease greenhouse gas emissions from the soil [11].

Cow dung also known as cow pats, cow pies or cow manure, is the waste product of bovine animal species, these species include domestic cattle (Cows), cow dung is an undigested residue of plants matter which has passed through animal's gut, the resultant faecal matter is rich in minerals. Cow dung is significantly important in most of the nutrient required for plant growth. The manure can replace or reduce the need for commercial nutrient in crop production. However, the nutrient composition of feed, ration, climate, manure storage and manure handling. The resultant faecal matter is rich in minerals, its color from greenish to blackish often darkening soon after exposure to air [12].

Residual effects of applied organic manures on soil properties vary based on the different factors including type, rate and timing of application and soil characteristics. Extensive research has reported that improved soil properties including a higher content of residual soil nutrients over a long period of time due to soil amendments. For example, manure and vermicomposting

significantly increased soil organic carbon (SOC) and decreased the bulk density over time, and the residual effect of total SOC and soil lasted up to seven to eight years when the manure was applied in a semi- arid dry land agriculture [13].

The benefits of such amendments are, however, often short-lived, especially in the tropics, since decomposition rates are high and the added organic matter is usually mineralized to CO_2 within only a few cropping seasons [14]. Therefore, organic amendments should be applied each year to sustain soil productivity. Management of black carbon (C) increasingly referred to as bio-char may overcome some of those limitations. Therefore, this study was carried out to determine the residual effects of organic manure (biochar and cowdung) growth of *P.osun* under a screen house condition.

2. MATERIALS AND METHOD

2.1 Experimental Site

The experiment was carried out in Forestry Research Institute of Nigeria, Ibadan located within the government Reserve Area (GRA), Jericho Ibadan and South-West local Government area of Oyo state, Nigeria. It lies on latitude 7°26 N and longitude 3°54 E. The climate pattern of the area is tropically dominated by annual rainfall which ranges from 1,300-1,500 mm and average temperature of about 26°C. The eco-climate of the dry season (usually commencing from November- March) and the raining season start from April to October [15].

2.2 Procurement of Materials

Pterocarpus osun seeds was collected from the Botanical garden in the University of Ibadan. The media for planting (soil) and treatments used had already been established from previous experiments done using same species [16]. Biochar that was used for the previous experiments were procured and pyrolyzed using a biochar reactor at the Mechanical engineering department University of Ibadan.

2.3 Raising of Seedlings

Seedlings of *P.osun* was raised in a germination basket for four (4) weeks and twenty four (24) healthy seedlings was selected from the basket based on the uniform treatments and then transplanted into the already established media. Watering was done on regularly basis.

2.4 Data Collection

Data was collected fortnightly on plants height by using meter rule, collar diameter using veneer caliper, number of leaves for a period of 20 weeks while biomass was also done to determine the wet and dry weight of the plants samples using a sensitive scale.

2.5 Experimental Design and Layout

The experiments were arranged in a completely randomized design (CRD) with 6 treatments replicated four (4) times making a total of 24 samples.

Pre-cropping and post cropping soil analysis were done before and after the experiments and all data collected on the growth parameters were subjected to Analysis of Variance (ANOVA) by using Genstat at 5% probability level of significance.

3. RESULTS AND DISCUSSION

Table 1 shows the analysis of the chemical properties of soil after harvesting of the direct experiment (which serves as the residual pre-cropping results). The soil pH used for the experiment ranges from 6.6 – 7.4 (Near neutral to slightly acidic). The results of the soil analysis shows N ranges from 1.1-1.3, Phosphorus (P) ranges from 1.1-1.9 and Potassium (K) ranges 0.10- 0.12 respectively.

Table 1. Analysis of the soil used for the experiment

Treatments	pH	N%	P (mg/kg)	K (cmol/kg)
Control	7.1	1.3	1.2	0.10
Biochar (20 t/ha)	7.4	1.1	1.2	0.11
Biochar (30 t/ha)	7.4	1.3	1.8	0.11
Cowdung (135)	6.6	1.1	1.8	0.11
Bio+CD (20 t/ha:135 g)	7.4	1.3	1.9	0.12
Bio+CD (30 t/ha:135 g)	7.4	1.3	1.1	0.12

Biochar only (20 t/ha), Biochar only (30 t/ha), Cow dung (135 g), Control (no amendments)
BIO= Biochar, CD= Cowdung

3.1 Collar Diameter

The residual effect of organic manure on stem diameter of *P.osun* at 2, 4, 6, 8, 10 and 12 weeks after transplanting were depicted in Table 2. There were no significant differences among the treatment used from 0 to 12 WAT. However, the interaction of Biochar +Cow dung (30 t/ha :135 g) had the highest diameter with a value of 5.17 mm while the least collar diameter was recorded with no amendment(control) with mean value of 4.42 mm at 12 WAT. The findings is in line with [17] reported that organic manures on plant have significant and positive residual effect on the stem diameter of plants.

3.2 Plant Height

The residual effect of organic manure on plant height of *P.osun* at 0, 2, 4, 6, 8, 10 and 12 weeks after transplanting were presented in Table 3. There was no significant difference among the treatment used from 0 to 12 WAT. The highest height was observed with the interaction of biochar and cowdung (20t/ha +135 g) with mean value (11.73 cm) and the least plant height was recorded with sole biochar at 20 t/ha with mean value of 8.00 cm. This is in line with [18] endorsed that organic manures have a larger residual effect on height of the plant. Analysis of variance shows that the means have insignificant difference among the treatments at 5% level of probability and also implies that the use of varying quantities of organic manure gave no significant effects on height development of *P. osun.*

3.3 Number of Leaves

The highest number of leaves was recorded when the soil amended with biochar at 20t/ha and also with 135 g of cowdung with a mean value of 11.00 and 11.50 respectively and the least number of leaves were recorded when the soil was not amended with mean value (9.50). This is in accordance with [19] who reported that once soil are given an initial boost by addition of organic manures the plant leave will be increasing and the effect will be self-sustaining for a long period of time. This also implies that there was no significant effect of biochar and cow dung at varying quantities on leaf production of *P. osun.*

Table 2. The residual effect of organic manure on collar diameter (mm) of *Pterocarpus osun* seedlings

	Weeks after transplanting						
Treatments	**Initial**	**2**	**4**	**6**	**8**	**10**	**12**
Control	2.73	3.31	2.74	4.18	4.33	4.36	4.42
Biochar (20 t/ha)	2.99	3.17	3.20	3.67	4.41	4.44	4.49
Biochar (30 t/ha)	2.14	2.67	3.23	3.41	4.27	4.33	4.45
Cowdung(135 g)	2.61	3.00	3.53	3.94	4.31	4.44	4.46
Bio + CD (20 t/ha:135 g)	2.31	2.49	3.73	4.06	4.56	4.59	4.62
Bio + CD (30 t/ha:135)	2.21	2.87	3.18	4.64	4.67	5.02	5.17
LSD (0.05)	Ns	Ns	Ns	Ns	Ns	Ns	Ns

Treatments does not show significant changes. Ns: not significant at 0.05 level
Biochar only (20 t/h), Biochar only (30 t/ha) t/ha, Cowdung (135 g), Control (no amendments)
BIO= Biochar, CD= Cowdung

Table 3. The residual effect of organic manure on plant height (cm) of *Pterocarpus osun* seedlings

	Weeks after transplanting						
Treatments	**Initial**	**2**	**4**	**6**	**8**	**10**	**12**
Control	7.00	8.00	10.00	10.33	11.00	11.50	10.33
Biochar 20t/ha	5.00	7.33	7.55	7.67	7.90	8.67	8.00
Biochar 30t/ha	7.75	8.00	8.33	8.75	9.68	10.60	10.80
Cowdung 135g	4.00	5.50	7.75	8.50	10.38	10.57	11.35
Bio + CD (20t/ha:135g)	6.00	6.67	6.75	7.33	7.33	7.87	10.30
Bio + CD (30t/ha:135g)	5.50	8.00	9.00	9.70	10.67	10.93	11.73
LSD(0.05)	Ns	Ns	Ns	Ns	Ns	Ns	Ns

Treatments does not show significant changes. Ns: not significant at 0.05 level
Biochar only (20t/ha), Biochar only (30 t/ha), Cowdung 135 g), Control (no amendments)
BIO = Biochar and CD = Cowdung

Table 4. The residual effect of organic manure on leaves number of *Pterocarpus osun* seedlings

	Weeks after transplanting						
Treatments	**Initial**	**2**	**4**	**6**	**8**	**10**	**12**
Control	4.75	6.50	7.25	8.00	8.23	9.50	9.50
Biochar 20t/ha	4.25	5.25	7.00	7.33	10.00	10.50	11.00
Biochar 30t/ha	4.25	4.85	6.75	6.75	8.85	9.10	9.88
Cowdung 135g	3.75	3.75	7.25	7.25	8.25	8.50	11.50
Bio + CD (1:1)	5.50	5.50	7.25	7.25	9.25	9.75	10.25
Bio + CD (1.5:1)	2.50	5.25	6.25	7.25	7.75	9.50	10.23
LSD(0.05)	Ns	Ns	Ns	Ns	Ns	Ns	Ns

Treatments does not show significant changes. ns: not significant at 0.05 level
Biochar only (20 t/ha=1), Biochar only (30 t/ha, Cowdung (135 g), Control (no amendments).
BIO= Biochar, CD= Cowdung

Table 5. Biomass production

Treatments	**Leaves**	**Root**	**Stem**
Control	0.15	0.05	0.24
Biochar (20t/ha)	1.31	1.06	0.77
Biochar (30t/ha)	1.72	0.75	1.09
Cowdung (135g)	1.22	0.89	0.81
Bio + CD (20t/ha:135g)	1.64	0.59	0.81
Bio + CD (30t/ha:135g)	0.77	0.55	0.40
LSD (0.05)	Ns	Ns	Ns

Treatments does not show significant changes. ns: not significant at 0.05 levels
Biochar only (20 t/ha=1), Biochar only (30 t/ha, Cowdung (135 g), Control (no amendments)
BIO= Biochar, CD= Cowdung

There was no significant difference in the biomass of leaves, stem and roots in this experiments and this is similar to the previously established experiment (direct experiment) on the same species. The highest biomass recorded for leaves was observed when 30 t/ha of cow dung was used as an amendment, the interaction of biochar and cow dung (30 t/ha + 135 g) also did relatively well with a mean value of 1.72 g and 1.64 g respectively as compared with the control (no amendments) that had the lowest leaves biomass recorded with a mean value of 0.15 g. However, the highest biomass recorded for roots and leaves was also observed when sole biochar 20 t/ha and 30 t/ha was used with a mean value of 1.06 g for root and 1.09 g for stem respectively.

4. CONCLUSION

This study shows evidence of the ability of organic manure having a long term effects on soil particularly to increases plant productivity and also improves soil quality. Based on the result obtained from this study, it can be concluded that the interaction of Biochar + Cowdung (30 t/ha +135 g) had the highest diameter with a value of 5.17 mm. The highest plant height was recorded with the interaction of biochar and cowdung (20 t/ha +135 g) with mean value 11.73 cm while cowdung shows the best performance in number of leaves with a mean value 11.50 as compared with the control (No amendment).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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