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GROWTH RESPONSE OF *Annona muricata* L. AS INFLUENCED BY DIFFERENT ORGANIC MANURE.

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ABSTRACT

Generally, soil productivity maintenance is a major constraint in forestry, without the use of fertilizers, tree crops are moved between fields to utilize only fertile soils for some years, which may not meet the yearning for global foods security. This experiment x-rayed the potentials of biochar (poultry source) and cow dung on the growth performance of *Annona muricata* seedlings. The experiment was a completely randomized design with fifteen (15) treatments replicated four (4) times. Treatments used were biochar and cowdung and were applied at different rates mixed with river sand of 3kg pot. Data were collected every three (3) weeks for 18 weeks on plant height, stem girth, and number of leaves. Data analysis was through descriptive statistics and ANOVA. The results obtained shows that there were no significant differences in all the treatments for plant height. However, the interaction of Biochar (20t/ha) + Cowdung (135kg/N) exhibited the highest growth among all the treatments in plants height and number of leaves with mean value of 27.10cm and 24.00 respectively as it was also deduced that there was significant differences at all weeks after transplanting for number of leaves. The highest diameter was observed when Biochar (10t/ha) + Cowdung (135kg/N) and Biochar (10t/ha) + Cowdung (90kg/N) was applied with mean value 4.37mm and 4.24mm respectively while Biochar (20t/ha) + Cowdung (180kg/N),gave the lowest value of 3.79mm in diameter as compared with the control that had a value of 3.79mm. It is on this basis that the interaction of Biochar (20t/ha) + C5 (135kg/N) of the experiment is recommended because of its effects on the seedlings height, diameter and number of leaves increment of *A. muricata*.

Keywords: Biochar, Cowdung, *Annona.muricata*, Soil productivity

INTRODUCTION

Annona muricata L. is known as soursop (English), graviola (Portuguese), guana´bana (Latin American Spanish) and other local indigenous names. This plant is species of the genus Annona, of the Annonaceae family, order Magnoliales and Division Magnoliophyta (Pinto *et al*., 2005). The genus Annona comprises over 70 species. The soursop tree is about 5–10 m tall and 15–83 cm in diameter with low branches (Orwa *et al*., 2009). It tends to bloom and fruit most of the year, but there are more defined seasons depending on the altitude (Pinto *et al*., 2005). *A. muricata* has been widely studied in the last decades due to its therapeutic potential. The medicinal uses of the Annonaceae family were reported by Leatemia and Isman, 2004, and since then, this species has attracted the attention due to its bioactivity and toxicity. Ethnobotanical studies have indicated that *A. muricata* has been used as insecticide (Leatemia and Isman, 2004) .Fruit juice, leaves or branches of *Annona muricata* has its medicinal values and has been used to treat fever respiratory and malaria (Boyom *et al*., 2011).

Generally, most soils have organic matter content falling below one percent, low phosphorus and high acidic medium (pH below 5) leading to low plant productivity (Agyenim-Baoteng *et al.*, 2006). Furthermore, the rising cost of inorganic fertilizers coupled with their inability to condition the soil has directed attention to organic manures in recent times. (Agyenim-Baoteng *et al.*, 2006). The use of organic manure as fertilizer releases many important nutrients into the soil and also nourishes soil organisms, which in turn slowly and steadily make minerals available to plants (Erin, 2007). Organic materials serve not only as sources of plant nutrients but also as soil conditioners by improving soil physical properties, as evidenced by increased water infiltration, water holding capacity, aeration and permeability, soil aggregation and rooting depth; and by decreased soil crusting, bulk density and erosion (Allison, 1973) Usually, when organic wastes of acceptable quality are returned to agricultural soils on regular basis they contribute greatly to the overall maintenance of soil fertility and productivity, and reduce the need for mineral fertilizer (Parr and Colacicco, 1987).

Organic fertilizers: farmyard manure (FYM), sheep manure (SM), poultry manure (PM), compost, among others have been used for crop production for centuries. The use of these forms

of fertilizers certainly pre-date chemical (mineral) fertilizers, which is of more recent development in comparison with organic' fertilizers. Organic fertilizers are more environmentally friendly, since they are of organic sources. Contrary, observations showed that continuous use of mineral fertilizers create potential polluting effect on the environment (Oad *et al*., 2004), in addition to the fact that synthesis of this fertilizer form consumes large amount of energy with often financial implications. Although organic fertilizers exist in readily available forms; cheap and easy to assess, they need to be applied in large amounts to meet the nutrient requirements of crops (Prabu *et al*., 2003). Thus, a combination of organic and mineral nutrients have been advocated (Prabu *et al*., 2003). As the integration of organic sources and synthetic sources of nutrients not only supply essential nutrients but also have some positive interaction with chemical fertilizers to increase their efficiency and thereby reduce environmental hazards (Bocchi and Tano, 1994).

There is growing interest in the use of organic manures due to soil fertility depletion in most African soils coupled with the scarcity and cost of mineral fertilizers. In addition, economic premiums for certified organic grains in most developed countries: United States of America and Europe, have been driving many transition decisions related to organic farming (Delate and Camberdella, 2004). Thus, the efficient use of nutrients within crop production systems has been the focus of research for several decades. .This study; therefore, sought to compare the effects of biochar (poultry manure source) and cow dung manure on the growth and biomass accumulation of *A. muricata* seedlings with a view to raising the seedlings commercially and to determine the effects of these amendments (organic manure) on the growth performance of *A. muricata* seedlings.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out at the Soil and Tree Nutrition section Screen house of Forestry Research Institute of Nigeria, Jericho Ibadan located on Longitude 4.51^{o}E and Latitude 7.23^{o}N The dry season usually commences from November to March while the rainy season starts from

April to October. The average temperature is about 32°C; annual rainfall ranges from 1400-1500mm and an average relative humidity of about 65% (FRIN, 2016).

Biochar Production Procedure

A biochar reactor was used in producing the biochar. Biomass (poultry manure) was filled inside the biomass chamber inside the reactor and hot charcoal (fuel) was also filled in external compartments inside the reactor, the reactor was covered. A gas analyser was used to take the atmospheric temperature at 36°C, starting temperature of the fuel at 171°C and the final temperature at which the biomass was charred at 363°C.(Author observation)

To prevent the materials from complete combustion, little amount of water was poured in order to put off the fire at the end of the required time. The charred materials were then crushed into smaller particles.

Experimental Set-up and data collection

Treatments used were Biochar (B) and cowdung (C): B+C (10t/ha+90kgN), (10t/ha+135kgN), (10t/ha+180kgN), B+C (20t/ha + 90kgN), (20t/ha + 135kgN and (20t/ha+180kgN), B+C (30t/ha + 90kgN),(30t/ha+ 135kgN) and (30t/ha+ 180kgN), Biochar (20t/ha, 30t/ha), Cowdung (90kg/N, 135kg/N and 180kg/N and control (No amendments). It was a completely randomized design with 15 treatments and four (4) replicates. *A. muricata* seedlings were raised in a nursery tray for 6 weeks, seedlings were selected. Soil was mixed with treatments at different level at three (3) weeks. A control experiment was also set up in such a way that no organic manure was applied to the soil. The bulk soil samples (River sand) used for the planting was collected at the Asanmagbe river bank in Forestry Research Institute of Nigeria. The soil was washed and sterilized.

The sterilized soil was filled into 3kg polyethylene pots. Organic manure was added and was allowed to mineralize for 3weeks before 60 healthy seedlings were pricked into the potting media watered and then monitored for stability. Assessment of the following growth parameters commenced every three (3) weeks after potting for a period of twelve (18) : These include; plant height (cm) with the aid of a graduated ruler; stem diameter (mm) with the aid of vernier caliper

at the soil level; leaf production by counting the number of leaves on each stem. Dry matter yield (g/pot) was also determined by washing the roots of the plant off any soil particles and divided into root and shoot components for each treatment and then weighed with the use of sensitive scale. Each component were also put in separate envelopes and dried in an oven for 7days set at 60°C to constant weight. The dried- plant materials were removed from the oven and allowed to cool under desiccators and their dry weights determined with an electronic weighing balance. The treatments compositions were as follows:

Treatments	**biochar (B)**	**cowdung(C)**
B+C1	10	90
B+C2	10	135
B+C3	10	180
B+C4	20	90
B+C5	20	135
B+C6	20	180
B+C7	30	90
B+C8	30	135
B+C9	30	180
Biochar only (B10)	20	-
Biochar (B11)	30	-
Cowdung only (C12)	-	90
Cowdung only (C13)		135
Cowdung only (C14)		180
Control (river sand)		3kg soil

LABORATORY AND DATA ANALYSES

Physico-chemical properties of soil status and amendments used were subjected to laboratory analyses and data collected on the growth parameters were analyzed using Analysis of Variance (ANOVA). Means were separated using Duncan's Multiple Range Test (Duncan, 1995) at 5% probability level.

Table 1: ANALYSES OF SOIL, BIOCHAR AND COWDUNG

Elements	soil	Biochar	Cowdung
pH (1:1)	6.36	-	-
Mg cmol/kg	2.10	3.79	0.66
Na cmol/kg	0.40	1.14	0.84
K cmol/kg	0.06	2.65	2.81
Ca cmol/kg	5.84	2.60	0.59
P mg/kg	0.70	0.88	0.14
Mn mg/kg	40.4	0.03	0.02
Fe mg/kg	468	0.90	1.33
Zn mg/kg	34.0	0.04	0.003 -
N g/kg	0.90	1.37	1.18
Carbon	-	86.41	-
Sand	80.5		
clay	15.0		
silt	4.5		
textural class	Sandy soil		

The chemical properties of the soil and treatments used were as presented in Table 1. The pH of the river sand is shown to be an average of 6.36 which is slightly acidic; its total Nitrogen present was moderately low with a value of 0.90g/kg; the available Phosphorus was relatively low with 0.70.mg/kg with high Potassium concentration (0.06cmol/kg). The organic carbon content of biochar is relatively high. The total Nitrogen in biochar is 75% higher than of cowdung. The available P and exchangeable K in both biochar and cowdung were relatively low and high respectively.

RESULTS AND DISCUSSION

Table 1: Effects of organic manure (biochar and cowdung) on the height (cm) of *A. muricata* seedlings

Treatments	3	6	9	12	15	18
B + C1	9.12	11.35	13.25	15.62	18.00	23.40
B + C2	9.88	12.88	15.25	18.88	21.12	22.50
B + C3	8.12	12.00	13.88	18.00	22.00	27.00
B + C4	7.62	10.50	14.62	16.50	18.38	20.40
B + C5	11.75	13.25	15.75	19.25	23.00	27.10
B + C6	9.00	11.75	14.62	18.12	20.88	24.50
B + C7	10.00	13.00	16.62	18.75	21.25	24.10
B + C8	7.25	9.12	12.50	16.38	20.12	23.10
B + C9	10.12	12.25	14.75	17.75	20.00	25.60
B10	8.38	11.15	14.25	17.12	18.62	21.60
B11	8.75	11.50	14.88	17.25	19.38	21.50
C12	6.62	8.28	9.75	11.38	13.75	16.90
C13	8.75	13.12	15.50	18.50	21.25	25.60
C14	8.12	10.38	13.88	17.75	20.38	25.50
Control	7.00	9.50	11.50	13.38	13.50	15.20
LSD	3.81	4.23	4.53	6.86	8.20	11.35

There was no significant variation observed in all treatments used. The highest plant height of *A. muricata* seedlings was recorded when B + C5 and B+C7 was used as an amendment with a mean value of 11.75cm and 16.62cm at 3 and 9 weeks after transplanting (WAT) respectively as compared to the control and Cow dung only (C12) which gave the least height with mean value of 7.00cm and 9.75 at 3WAT and 9WAT respectively (Table 1). The highest plant height was observed at 18WAT when B+C5 was applied with value 27.10cm as compared with the control that recorded the least with mean value 15.20cm (Table 1)

Table 2: Effects of organic manure (biochar and cowdung) on the Diameter (mm) of *A. muricata* seedlings

Treatments	3	6	9	12	15	18
B + C1	1.68	2.49	3.35	3.30	3.91	4.24
B + C2	1.85	2.46	2.97	3.10	3.93	4.37
B + C3	1.50	1.95	2.27	3.00	3.71	3.97
B + C4	1.25	1.59	2.12	2.80	3.39	3.74
B + C5	1.45	1.87	2.52	3.10	3.62	4.09
B + C6	1.20	1.59	2.08	2.70	3.13	3.33
B + C7	1.56	2.19	2.44	3.10	3.29	3.86
B + C8	2.15	2.69	3.53	2.90	4.16	3.36
B + C9	1.83	2.30	2.72	3.33	4.00	4.16
B10	1.34	1.86	2.72	2.80	3.23	3.62
B11	1.79	2.20	2.84	3.33	3.70	3.88
C12	1.42	1.99	2.40	2.90	3.31	3.67
C13	1.53	2.14	2.68	3.30	3.58	3.86
C14	2.09	2.31	2.66	3.20	3.41	3.79
Control	1.66	1.92	2.58	3.20	3.46	3.79
LSD	0.84	0.97	1.30	1.43	1.49	1.49

The diameter was significantly affected by all treatments at 12WAT. Highest diameter was observed when B+C9, B11 and C13 was used as an amendment with mean value 0f 3.33mm ,3.33mm and 3.30mm respectively while the lowest diameter was recorded when B + C6 was applied with mean value 2.70mm as compared with the control that had a mean value of 3.20mm

The overall highest diameter was observed at 18WAT when B + C2 and B + C1 was applied with mean value 4.37mm and 4.24mm respectively as compared with the B+C6 that gave the lowest value of 3.79mm in diameter.

Table 3: Effects of organic manure (biochar and cowdung) on the Number of Leaves of *A. muricata* seedlings

Treatments	3	6	9	12	15	18
B + C1	6.00	9.75	12.25	14.75	16.75	17.50
B + C2	8.75	11.00	11.25	12.00	18.50	23.50
B + C3	4.25	6.25	9.25	12.75	15.50	19.00
B + C4	3.50	5.50	8.00	12.25	14.00	17.50
B + C5	5.50	7.00	14.25	18.50	20.25	24.00
B + C6	3.75	6.25	9.00	12.50	14.50	18.50
B + C7	5.00	7.25	9.25	13.25	15.25	18.00
B + C8	6.50	7.50	10.50	12.00	14.00	17.00
B + C9	5.25	9.50	10.75	14.00	16.00	20.50
B10	4.50	7.50	9.75	12.25	13.75	16.50
B11	5.25	7.75	10.00	13.00	16.25	20.50
C12	3.75	5.25	8.25	9.50	12.00	14.75
C13	4.75	7.00	9.00	13.75	15.00	18.75
C14	4.50	6.25	8.50	12.75	14.00	18.00
Control	4.25	6.25	6.25	9.00	10.50	12.25
LSD	2.84	3.39	3.74	5.63	6.82	7.69

The number of leaves was significantly affected by all treatments used at all weeks after transplanting .At 3WAT, B + C2 and B + C5 had the highest number of leaves with mean value 6.00 and 5.50 as and B+C4 had the lowest mean value of 3.50 as compared to the control that recorded 4.25 in number of leaves of *Annona. muricata* seedlings (Table 3). At 9, 12 and 15 WAT, B + C5 and B + C2 had the highest leaves number with mean value (14.25, 18.00, 20.50) and (12.25, 14.75 and 16.75) respectively when compared with Control that the lowest mean value of 6.25, 9.00 and 10.50 respectively.

Table 4: Effects of organic manure (biochar and cowdung) on the total biomass (dry weight) (cm) of *A. muricata* seedlings

Treatments	Leaves	Stem	Root
B + C1	0.81	0.53	1.35
B + C2	1.21	0.65	1.64
B + C3	1.15	0.62	1.17
B + C4	0.68	0.44	0.93
B + C5	0.93	0.42	0.98
B + C6	1.56	0.65	0.99
B + C7	0.80	0.68	1.03
B + C8	0.61	0.43	0.71
B + C9	1.25	0.62	0.58
B10	0.60	0.38	1.31
B11	0.99	0.48	1.47
C12	0.34	0.39	0.24
C13	1.13	0.66	1.73
C14	1.95	0.69	1.52
Control	0.46	0.21	1.08
LSD	1.07	0.66	1.25

Table 5: Effects of organic manure (biochar and cowdung) on the total biomass (Wet weight) (cm) of *A. muricata* seedlings

Treatments	Leaves	Stem	Root
B + C1	3.10	1.61	3.81
B + C2	2.29	1.09	4.47
B + C3	4.96	2.28	3.78
B + C4	5.46	2.76	5.81
B + C5	3.59	1.62	1.77
B + C6	6.04	3.19	4.39
B + C7	3.33	1.58	2.96
B + C8	3.85	1.64	3.57
B + C9	5.04	2.30	4.91
B10	2.58	1.32	3.94
B11	2.97	1.60	4.59
C12	1.32	0.86	2.30
C13	4.64	2.16	5.06
C14	4.50	2.25	4.53
Control	1.62	0.65	3.97
LSD	4.78	2.35	3.08

Source: field survey, (2018)

The overall wet and dry weight of *A. muricata* seedlings were not significantly different from one another as no variation was observed in all parameters assessed .The total dry weight shows no significant differences for the leaves, stem and roots when compared with the wet weight .The highest overall biomass for dry weight was recorded at C14 with a value of 1.52g while the lowest overall biomass for dry weight was recorded at 0.20g when there was no amendments (control).

DISCUSSION

The experimental soil was sandy soil and the pH was slightly acidic. Total nitrogen (N) and Available phosphorus (P) content were very low compared with the critical levels of 0.1% for N and a range of 10-12mg/kg for Av. P (Adeoye and Agboola, 1985) obtained for soils in Southwestern Nigeria, (FMANR, 1990). Using the critical levels of 0.16-0.20 cmol/kg, exchangeable K was also low (Agboola and Obigbesan 1974). The micronutrients (Cu, Mn, Fe and Zn) ranges from medium and high conforming with (Adeoye and Agboola, 1985). The medium to high values of these micronutrients may be due to long period of fallow of the land which has not been under cultivation for many years, according to Nigeria Country Profile, the Country's soils are found to be of medium to high potentials.

The study revealed that biochar and cowdung generally enhanced the growth of *A. muricata* seedlings in the nursery. However, the combination of Biochar (20t/ha) + Cowdung (135kg/N) exhibited the highest growth among all the treatments in plants height and number of leaves while Biochar (30t/ha) + Cowdung (180kg/N) and Biochar (30t/ha) exhibited the highest in collar diameter of *A. muricata* seedlings this was in correlation with the findings of Adekiya, (2009) who explains the suitability and usefulness of farm yard manure as an organic fertilizer which has been attributed to high availability of NPK content. Okunomo (2010) reported that organic manure significantly affected the leaves production, height and collar diameter of *Adansonia digitata* seedlings and these was compared with *A. muricata* which exhibited same results. The results on biomass accumulated of *A. muricata* seedlings is in correlation with the findings of Imoro *et al.*,(2012) who reported that Organic manure applied significantly affect the biomass accumulated by *Moringa oleifera* seedlings. It could therefore be concluded that biochar and cowdung application is more advisable for use especially on river sand to improve its soil properties such as structures and fertility alternatives to inorganic fertilizers for the production of *A. muricata* seedlings. Wastage resulting from decomposition of farm yard after its primary use can be converted to biochar and other form of manure to be mixed with soil for raising seedlings in the nursery.

It is on this basis that the interaction of Biochar (20t/ha) + C5 (135kg/N) of the experiment is recommended because of its effects on the growth parameters of *A. muricata* seedlings (height and diameter) increment.

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