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Original article

Response of Walnut (*Juglans regia* L.) Seedlings to Organic Waste Formulations in Ile-Oluji

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Abstract
A nursery experiment was conducted at the Teaching and Research Farm, Federal Polytechnic, Ile-Oluji, Ondo State, to investigate the impact of organic waste on walnut growth and performance in the nursery. The study utilized formulated organic waste from Teaching and Research Farm that involved the use of organic manure such as; cocoa pod husk (CPH), stone dust (SD), Cocoa dry leaves (CDL), Pig manure biochar (PB), and poultry manure biochar (PMB) which were all made up to 25 Kg in different proportions. The formulated manure was later mixed with the top soil in varying proportions (25%, 50%, 75%, and 100%). Each treatment had five levels including control, all were replicated three times, resulting in 15 plots arranged in a Completely Randomized Design (CRD) across blocks A, B, and C, covering 150 m² of experimental area. Growth and yield parameters were evaluated, and the data underwent analysis of variance (ANOVA) at a 5% significance level (LSD). The findings revealed that the 50% level of the manure exhibited the most favorable growth characteristics and yield, suggesting its recommendation for farmers in Ile-Oluji.

Keywords: Walnut, Fertilizers, Biochar, Organic manure, Composting

Introduction

Nutritional needs of Africans are threatened by declining household incomes due to scarce economic resources and there is need to explore crops with high potential nutritional contents such as walnut. This crop is considered an underutilized tree crop because it has the potential to provide significant economic and environmental benefits, but its cultivation and production are not as widespread as other tree crops like cocoa and oil palm in Nigeria. The cost of raising tree crops nowadays has increased due to high cost of fertilizers depriving poor families cheap source of protein. The consumption of this fruit is not only beneficial for human health but also useful for animal feed formulations. However, the challenges related to its availability throughout the year have not been thoroughly documented. This lack of information puts the plant at risk of genetic extinction and potential disappearance, limiting its development opportunities (Oke *et al*., 2020). In recent years, the production of horticultural crops has seen significant changes due to the adoption of innovative technologies, including advancements in nutrient management practices (Agbona *et al*, 2024). Nutrient management plays a crucial role in enhancing the yield and quality of walnuts. In order to meet up with these challenges, composting of farm residues are adopted (Ayeni *et al*., 2020). Adejobi *et al*., 2017, positioned that addition of organic based substrates to tree crops improved its performance in the nursery. Nowadays, composting is a practical solution for managing crop residues (Adebisi *et al*., 2020), but the accurate proportion to the crops may be a problem, as a way out, an emerging alternative is the conversion of crop residue biomass into biochar, which can be used as organic manure in proportions for effective performance. (Agbona *et al*., 2023). This approach is a more sustainable alternative to traditional methods such as composting and crop residue burning (Srinivasarao, *et al*., 2014).

Biochar which is produced through pyrolysis process can be combined with other organic materials to create organic fertilizers, which are beneficial for crop cultivation (Adebisi *et al*., 2022). This approach not only addresses waste management issues but also adds value to the agricultural and industrial by-products (Agbona *et al*., 2023). Moyinjesu and Atoyosoye (2002) observed a significant enhancement in the

growth and performance of cocoa seedlings in the nursery through the application of organic plant waste. Similarly, Agbona et al. (2023) found that using organic plant waste for cocoa led to improved growth characteristics, and enhanced soil temperature and properties. Organic manures have long been utilized to enhance soil quality (Adebisi and Agbona, 2020). Furthermore, both plant waste and organic materials are deemed safe for human health, as they do not leave behind any residual health hazards (Agele *et al*., 2014). This research is to evaluate the potential of using formulated organic manure package to raise walnut in the nursery in order to reduce the cost of producing walnut seedlings for farmers in Ile-Oluji/Okegbo Local government of Ondo State, Nigeria.

Materials and Methods

The study was conducted at the Teaching and Research Farm, Federal Polytechnic, Ile-Oluji, Ondo State, Nigeria. The Teaching and Research Farm is located in the rainforest zone of Nigeria on latitude 7.240828° and longitude 4.866063° and altitude of 427 meters with average rainfall of 130cm and mean annual temperature between 28.8℃ to 35℃. The annual relative humidity is 81.2 percent. (Atmos, 2018 as cited by Adebisi and Agbona, 2019).

The formulated organic materials consisted of: (cocoa pod husk) CPH, (stone dust) SD, (cocoa dry leaves) CDL, (pig manure biochar) PB, and (poultry manure biochar) PMB. All were milled separately and allowed to stay for three days before been mixed together in the ratios shown in table 1.

Table 1: Soilless materials in different mixing ratios in 25kg bag

S/N	Soilless Materials	Percentage (%)	Mixing ratio	Quantity (Kg)
1	CPH	50	50/100 x 25	12.5
2	SD	5	5/100 x 100	1.25
3	CDL	10	10/100 x 25	2.5
4	PB	20	20/100 x 25	5
5	PMB	15	15/100 x 25	3.75
	Total			25

(Source: Agbona *et al*., 2023)

The materials were later kept in a mildly perforated rice bag that was completely covered for 21 days (Agbona *et al*., 2023) to allow the microorganisms present in the materials to interact and decompose effectively. Thereafter, the mixture was transformed into a processed organic material used for this experimental trial. A total of one hundred and eighty polythene bags were filled with the formulated organic materials which was mixed in a ratio of 25%, 50%, 75% and 100% respectively with top soil and wetted to field capacity. The polythene bags were left to stand for 14 days (Agbona *et al*., 2023) to allow the micro-organisms full establishment under irrigation for the two weeks. Water was applied every three-days regime before planting of seeds. The experiment was replicated three times given a total of eighteen plots which was arranged in Completely Randomized Design (CRD) in the nursery. A total of one hundred and eighty walnut plants were used for the experiment.

The stoned seed fruit was soaked in water for some hours and later set in a warm, dry spot where it was staked on the plate daily to make sure they don't clump and that they dry evenly for three days after they have been lightly cracked before planting to give room for early sprouting due to its hard shell (Agbona *et al*., 2023). The bags were later arranged in their respective plots for the commencement of the research. Watering was done twice a week throughout the period of the experiment. Weeds were controlled through hand picking. Karate was used to control mites and Basudin for caterpillar. Also, kaocide was used to control leaf rot, a fungus and nematicide for organic materials treatment before planting of the seedlings (Agbona *et al*., 2020). The parameters measured in the course of this experiment were: germination percentage, plant height, numbers of leaves, stem girth, fresh shoot weight, fresh root weight and total biomass. Samples for the experiment were collected and sieved with a 2mm sieve before being subjected to laboratory analysis. The samples were then analyzed for routine chemical analysis following the procedure outlined by Carter (1993 as cited by Agbona *et al*., 2023). After collection, the samples were air-dried and sieved using a 2mm sieve before conducting the determinations. Organic matter content was determined using the Walkley and Black method, which involves dichromate wet oxidation (Nelson and Sommers, 1996). Total nitrogen content was determined through the micro-Kjeldahl digestion method (Bremner, 1996). Available phosphorus content was determined by Bray-1 extraction followed by molybdenum blue colorimetry (Frank *et al*., 1998). Exchangeable potassium, calcium, and magnesium were extracted using 1.0 N ammonium acetate. Subsequently, potassium was determined using a flame photometer, while calcium and magnesium were determined using the EDTA titration method (Hendershot and Lalande, 1993). The pH of the samples was determined in a water (1/2) medium using a digital electronic pH meter. Data collected were subjected to analysis of variance (ANOVA) while significant treatment means were separated using the Least Significance Difference (LSD) test at 5% level of probability using Genstat software.

Results and Discussion

Samples of the organic materials used for the purpose of this experiment were taken and analysed as shown in the table 2 and 3 below; On display are the nutrients composition of the substrates. The substrates contained nutrients such as N, K, Na, Ca, and Mg. The pH of the formulated organic materials is 5.57 as presented in table 2. The nutrients status meets up with the requirement of tree crops nursery needs (Agboola 1982 as cited by Agbona *et al*., 2023). Table 4 shows the toxicity level of the soil and elements such as Ni, Zn and Cu are at safety limit levels of crop use in the soil.

Germination percentage

The bar chart in Figure 1 presented germination percentage of the seedlings according to their treatment levels. T3 (50%) produced the highest germination percentage of 97%. Equally, all the treatment combinations improved germination percentage of the seeds across board but the material needs more time to undergo decay process so as to give room for easy mineralization.

Table 2: Chemical composition of the organic materials

S/N	Organic materials	1:2 H_20 pH	ASH	% C	N	Mg/100g				
						P	K	Na	Ca	Mg
1	Substrate organic materials formulated	5.57	14.53	85.47	1.68	25.78	9.43	7.52	8.24	3.96
2	Cocoa dry leaves	3.8	17.822	82.178	1.16	51.89	0.8	0.6	6.02	2.84
3	Pig biochar	3.81	31.357	68.421	1.5	17.53	1.12	0.7	7.38	3.14
4	Poultry biochar	5.71	2.326	97.674	1.58	45.79	9.9	0.4	31.36	12.96
5	Stone dust	5.67	97.976	2.024	0.11	1.32	0.1	0.02	1.26	0.72

Table 3: Chemical composition of the formulated organic waste

1:2 H_2O:pH	(%)			mg/Kg	Cmol/Kg			
5.67	OC	OM	N	P	K	Na	Ca	Mg
	0.1	0.17	0.11	2.33	1.03	1.36	3	1.2

Table 4: Effect of treatment toxicity on plant height, numbers of leaves and stem girth (weeks after planting)

TRT	Mean at 6 WAP	Mean at 7 WAP	Mean at 8 WAP	Mean at 9 WAP
T1R1	0.02333	15.03333	0.33333	0.33333
T1R2	-0.15333	14.53333	0.76667	0.76667
T1R3	-6.01	6.86667	-12.13333	-12.13333
T2R1	-6.22	6.83333	-7.93333	-7.93333
T2R2	-5.75333	7.36667	-6.86667	-6.86667
T2R3	-3.73333	3.4	-17.73333	-17.73333
T3R1	-4.13333	3.43333	-19.96667	-19.96667
T3R2	-3.47667	7.36667	-13.46667	-13.46667
T3R3	-2.68667	7.3	-6.83333	-6.83333
T4R1	-2.88667	8.86667	-3.63333	-3.63333
T4R2	-1.97667	9.96667	-3.56667	-3.56667
T4R3	-2.86667	10.4	-9.03333	-9.03333
T5R1	-2.13333	10.96667	-5.13333	-5.13333
T5R2	-2.1	10.06667	-4.93333	-4.93333
T5R3	0.02333	15.03333	0.33333	0.33333
F-test	**	**	**	**
F-test (6 WAP)	0.255 (Not Significant)	0.304 (Not Significant)	0.376 (Not Significant)	0.376 (Not Significant)
CV%	10.212	10.421	10.113	10.113
LSD (0.05)	0.946	0.66	0.751	0.751

The germination percentage was very low in T1 (0%) which was the control experiment where there were no organic manure formulations but higher in others with the treatments at various levels. There was a distinct increase in the germination percentages of 25,50, and 75% compared to 100%.

Effects of the treatments on growth parameters

The effects of organic waste package on growth parameters are as presented on table 5.

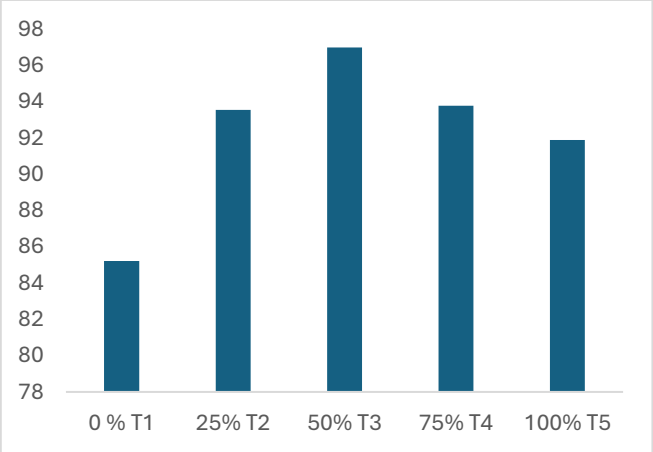

Figure 1: Bar chart showing the effects of the treatments on germination

Although the effects of the treatment were not statistically significant but the treatment improved the growth characters as presented on figures (1,2,3,4 and 5) with T3 (50%) of the formulated. The effects of organic waste package on growth parameters are presented on table 4. Although the effects of the treatment not statistically significant but the treatment improved the growth characters of walnut (Figures 1,2,3,4 and 5) with T3 (50%) of the formulated package producing the highest growth characters. There was a close level of growth at 25% interval from 25-75%. This may be as a result of slight increase in Copper and Nickel levels which may initiate toxicity in the treatments and thereby impede levels of growth as the percentage increases from 25-100% in the formulated organic waste package used as treatment in this research. As indicated from research evidences, the normal values of Cu in uncontaminated soils varied from 2 to 109 mg Kg^{-1}, and the Cu content reduces with high pH, soil organic carbon, and clay content (de Vries *et al*., 2013). As the clay content in the soil is low coupled with moderate level of soil pH, the effects might be the limited level of growth as the percentages of the formulated organic package increases in the experiment.

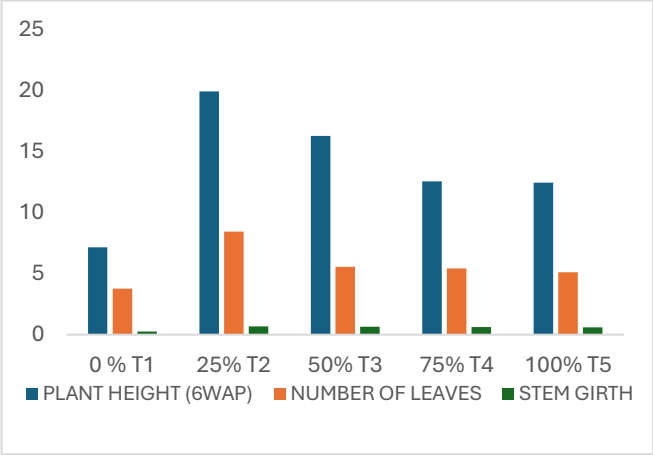

Figure 2: Bar chart showing plant height, numbers of leaves and stem girth (6 weeks after planting)

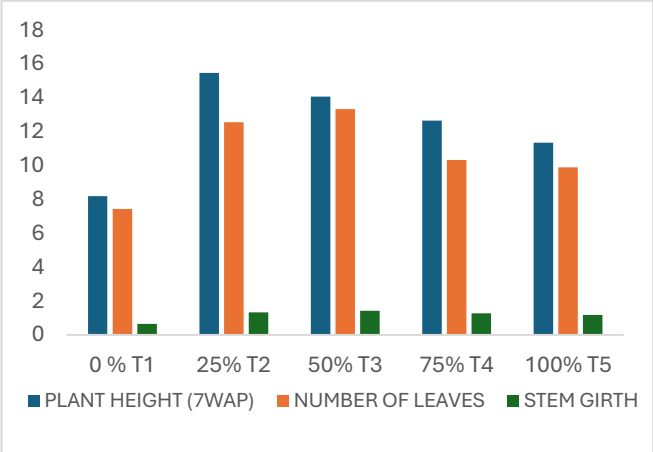

Figure 3: Bar chart showing plant height, numbers of leaves and stem girth (7weeks after planting)

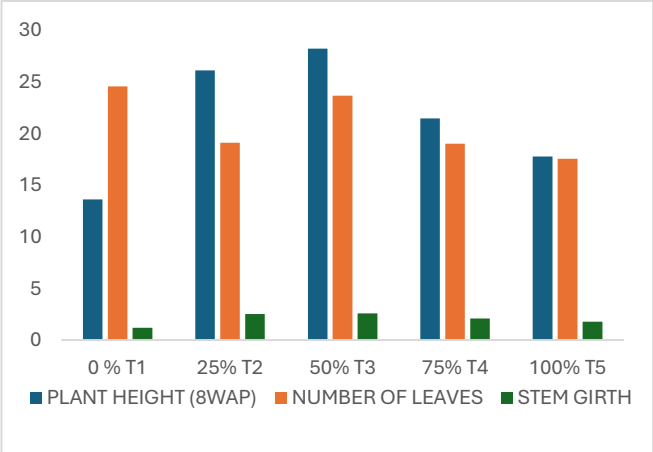

Figure 4: Bar chart showing plant height, numbers of leaves and stem girth (8 weeks after planting)

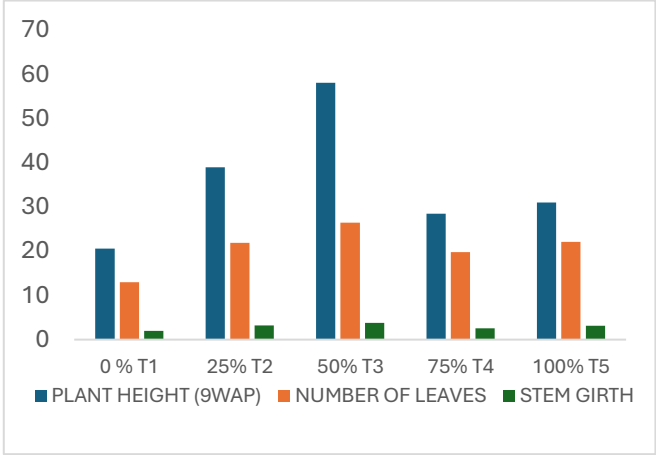

Figure 5: Bar chart showing plant height, numbers of leaves and stem girth (9 weeks after planting)

Table 5: Effect of treatment on yield characters at termination of experiment

TREATMENT COMBINATIONS	Mean
T1R1	-0.1
T1R2	-0.82
T1R3	-15.64
T2R1	-39.72
T2R2	-17.38
T2R3	-58.94000*
T3R1	-73.30000*
T3R2	-53.90000*
T3R3	-29.96
T4R1	-30.3
T4R2	-30.66
T4R3	-36.84
T5R1	-40.6
T5R2	-41.5
T5R3	-0.1
F-test	**
F-test (Termination of Experiment)	1.815 (Not Significant)
CV%	10.727
LSD (0.05)	0.857

Effects of the treatment on plant yield characters of Walnut

The effects of the treatments on the yield of walnut were presented on Figure 6 and Table 5. In all the stages T3 (50% level) of the formulated organic waste produced the highest fresh shoot weight, dry shoot weight, root length, wet root weight and dry root weight. This may be due to the rich nutrients in the CPH (see Table 2). This was in line with Agele and Agbona (2008) work on cashew seedlings in the nursery. They positioned that application of 3% proportion level of CPH significantly improved the yield of Cashew.

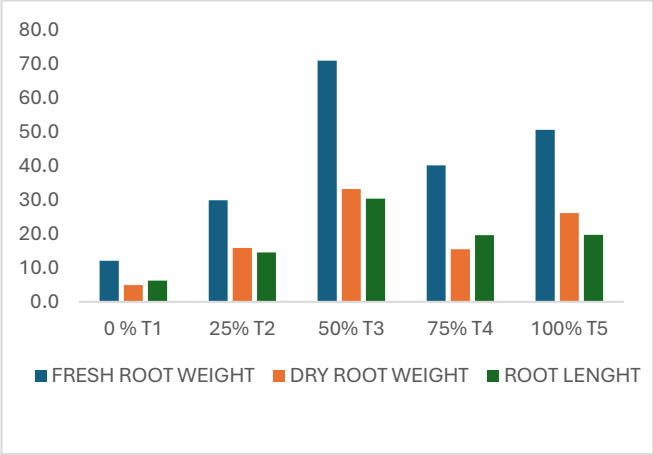

Figure 6. Bar chart showing fresh root weight, dry root weight, and root length at termination of experiment

Conclusion and Recommendation

The result of this experiment has confirmed that application of organic package to walnut in the nursery improved its growth characters and yield. This was in line with the position of Agele and Agbona (2008) and Adebisi et al, (2020) that recorded similar growth performance with crops raised using organic manure. Since the materials are from local and natural sources, it poses no harm to the crop and human health. The cost is very cheap and affordable to nursery farmers in Ile-Oluji which will assist to increase their revenue. Based on the findings emanating from this research, it is recommended that 50% of the formulated organic package should be used for growing walnut seedlings in the nursery in Ile-Oluji.

Conflict of Interest: We declare that there is no conflict of interest in this research article.

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