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Effect of Rooting Media, Nitrogen and Phosphorus Fertilization on the Seedling Growth of Gmelina (*Gmelina*) and Teak (*Tectona)*

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Authors' contributions

This work was carried out in collaboration between all authors. Author JOA designed the study, performed the statistical analysis and wrote the protocol. Authors OOO and BMT wrote the first draft of the manuscript. Author TBO managed the literature searches, did the final draft and other editorials. Author RAA the research is part of her project work. All authors read and approved the final manuscript.

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ABSTRACT

The rising increase in the quest for wood materials necessitates the need to produce more within the shortest time. This can be achieved by increasing the seedling growth of the tree species either by improving the fertility level of the rooting medium or using the most suitable rooting medium, thus necessitating the study. This study was laid out in a completely randomized design with three replications. Treatments include rooting media levels (soil, sawdust, soil: sawdust 1:1, 1:2, 2:1) and poultry manure (0, 5, 10 t ha^{-1}) for the first experiment while the second experiment involved varying rates of N fertilizers (0, 30, 60, 90, 120 kg ha^{-1}) and P fertilizers (0, 45 and 90 kg ha^{-1}). It involved two pot experiments carried out concurrently at the agro forestry arboretum of the Federal

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University of Agriculture, Abeokuta with each set transplanted to gmelina and tectona seedlings. Data were collected on plant height, stem girth and number of leaves fortnightly for 16 weeks. There was significant increase in height, stem girth and number of leaf gmelina at all weeks while tectona significantly increased only in height and stem girth using soil as a medium in comparison to other rooting media. N and P fertilizers produced no significant effect on the seedling growth of both tree seedlings. The use of N and P fertilizers on the seedling growth of the tree species was not encouraging as results obtained weeks after transplanting were not consistent. However, if there is a need for its use, 60 kg N ha^{-1} and 45 kg P ha^{-1} produced desirable seedling growth parameters. It is concluded that the use of soil and application of poultry manure at 5 t ha^{-1} remains the most effective rooting medium for gmelina and tectona seedlings.

Keywords: Agro forestry; soil pH; soil electrical conductivity; gmelina; tectona.

1. INTRODUCTION

The regeneration of natural forest in Nigeria is faced with over exploration coupled with the problem of poor seed germination, seedling establishment and survival [1]. Forest nurseries are an essential part of forestry in the whole world [2] with different nursery practices aimed towards the successful establishment of seedlings with good vigour [1]. Teak (*Tectona grandis*) is a deciduous tree with straight and cylindrical bole, sparse canopy and deep root system, which are the desired characteristics for agro forestry [3]. Teak is one of the most prized tropical timbers used commercially for door, frames and furniture making companies for its extraordinarily woodworking qualities and durability [4]. Another important tree species that is gaining attention in Nigeria is gmelina [5,6]. Gmelina (*Gmelina arborea*) is a valuable tree for timber production with good pulping characteristics [6]. In Nigeria, these tree species are exotic species [7] and can be integrated into the agricultural system to obtain higher economic return [3]. The soil is the principal supplier of nutrients to plant but this supply varies due to the inherent capacity of the soil which decline overtime as a result of continuous cultivation with no fertilization either by organic or inorganic sources [2]. This makes new seedlings suffer from an inadequate supply of nutrients reflected in low-quality seedlings and impaired seedling growth. Maintaining soil fertility in nursery soils becomes important to assure production of high-quality stocks of tree species. The policy of a nursery manager is to raise good quality plants at a lowest cost. But growing good quality seedlings with a lowest cost is only possible through intensive research and development of all aspects of nursery production, especially on soil fertility and nutrition management [2]. Fertilizer is a key factor for increasing agricultural production and its utilization has increased rapidly. The use of inorganic or organic fertilizer to replenish soil nutrient and increase yield has been found to be effective only within few years, demanding consistent use on long-term basis. Common examples of chemical fertilizers are NPK fertilizer, single super phosphate, muriate of potash. Using organic fertilizer like poultry manure in the amendment of agricultural soil can be beneficial and at the same time provide an efficient and cost effective method for its disposal. However, studies showed that different kind of organic waste can improve physical, chemical and biological properties of soil. Sawdust is the main component of particle wood and it is often used to mulch or amend soil, it improves soil structure and tilth, increase nutrient holding capacity. Sawdust is a component in soil potting media [8].

This is of interest as the research findings will be beneficial to farmers in the nursery plantations to boost initial growth which helps in the better establishment. Thus, we hypothesized that inclusion of sawdust as rooting media and poultry manure, N and P fertilizers at varying rate will result in high-quality seedling growth. The objective of this study was to determine the effects of sawdust inclusion as rooting media and various application rates of poultry manure, N and P fertilizers on the seedling growth of gmelina and tectona.

2. MATERIALS AND METHODS

2.1 Study Site

This study involved two pot experiments (experiment 1 and 2) carried out concurrently at the agro forestry arboretum of the Federal University of Agriculture, Abeokuta, Nigeria (latitude 7 58'N and longitude 3 25'E) in 2015.

2.2 EXPERIMENTAL SETUP

Experiment 1

Two factors were fitted into a completely randomized design and replicated three times. The first factor was rooting media (soil, sawdust, soil: sawdust 1:1, soil: sawdust 1:2, soil: sawdust 2:1) while the second factor was poultry manure (0, 5 and 10 t ha^{-1}).

Experiment 2

This also involved two factors which were N fertilizers at varying rates (0, 30, 60, 90 and 120 kg ha^{-1}) and P fertilizer (0, 45 and 90 kg ha^{-1}) each replicated three times arranged in completely randomized design.

2.3 Soil Sample Collection and Analysis

Subsoil samples were collected from the lowland area of the University; these samples were air-dried, allowed to pass through 2 mm sieve and taken to the laboratory for some physical and chemical analysis before the commencement of the experiments. Sub samples from the soils was collected and analyzed for the following properties: Soil pH was estimated in 1:2 (soil: water) using glass electrode pH meter, electrical conductivity was estimated in 1:5 (soil: water) with a calibrated EC meter. Particle size was determined according to hydrometer method. Total nitrogen was digested and analyzed using kjedahl method. Available phosphorus was extracted with Bray-1 and P was determined colorimetrically. Exchangeable cations were extracted with 1N ammonium acetate, Na and Kin the extract were determined by flame photometry, and Ca and Mg were determined by atomic absorption spectrophotometer. Poultry manure was digested with H_2SO_4 and analyzed for macro and micro nutrients by standard procedures.

2.4 Experimental Procedure

Five kilograms of the pre-sieved subsoil was filled into the individual pot; treatments were applied and allowed to mineralize for 4 weeks. Twelve weeks old vigorous seedlings of gmelina and tectona were sourced locally and transplanted into the pots.

2.5 Data Collection

Four weeks after transplanting (WAT), number of leaves by visual counting, plant height using a measuring tape, stem girth and collar diameter using vernier caliper was monitored. This measurement continued fortnightly until 16 weeks after the transplanting.

2.6 Post-Sampling Soil Analysis

Soil samples were also collected at each sampling time to determine the soil pH in water (1:2) using a glass electrode. The electrical conductivity of the soil was determined with an electrical conductivity meter.

2.7 Statistical Analysis

Data generated were subjected to analysis of variance (ANOVA) using Statistical Analysis Software (SAS) and means were separated using Duncan's Multiple Range Test at 5% probability level.

3. RESULTS

3.1 Soil Texture and Chemical Properties

The soil textural class is sandy having 89.20% sand, 5.00% silt and 5.80% clay, this is reflected in the water holding capacity which usually encourages leaching out of nutrients especially Nitrogen and Potassium. The sandy nature of the soil is also reflected in the CEC with fewer positions to hold cation on the exchange site. The soil has a pH of 6.52 (Table 1) which was slightly acidic. The soil organic-C was low (0.47%) which is typical of tropical soils and the total-N was equally low (0.04%) as a result of leaching of nutrients from soils.

3.2 Chemical Properties of Sawdust and Poultry Manure

The sawdust and poultry manure are slightly acidic and moderately alkaline respectively, with high organic carbon (Table 2). The total-N of the sawdust was low and this resulted to a high C: N ratio (Table 2), while the total-N of the poultry manure is very high hence low C: N. Available P was also observed to be very high in both sawdust and poultry manure, while K in both appears not to differ.

3.3 Effects of Rooting Media and Poultry Manure Rates on Height of the Tree Species Seedlings

There was a significant increase in the height of both tree seedlings as the week progresses under the different rooting media in gmelina, though the use of pure soil as rooting media increased the height of gmelina followed by soil –

sawdust at the ratio 2:1 while the use of sawdust alone resulted in seedlings with the least height (Table 3). This same trend was recorded for tectona. There was no significant difference in height of seedling of both tree species after manure was applied at 0, 5 and 10 t/ha (Table 3) WAT. The manure applied at 10 t ha^{-1} for gmelina significantly increased its height as compared to other rates of the application at 6 WAT, although this does not significantly differ from the application at 5 t/ha (Table 3). Manure applied at 10 t ha^{-1} on tectona significantly increased its height at 8 to 16 WAT but this remains the same when manure was applied at 5 t ha^{-1} (Table 3).

Table 1. Some physical and chemical properties of the soil

Parameter	Values
% Sand	89.20
% Silt	5.00
%clay	5.80
Textural Class	Sandy
pH	6.52
Mn (mg kg^{-1})	42.7
Fe (mg kg^{-1})	5.40
Cu (mg kg^{-1})	0.93
Zn (mg kg^{-1})	10.6
Organic-C (%)	0.47
Total N (%)	0.04
Available P (%)	2.64
Ca (Cmol kg^{-1})	0.06
Mg (Cmol kg^{-1})	0.06
K (Cmol kg^{-1})	0.11
Na (Cmol kg^{-1})	0.26
Al + H (Cmol kg^{-1})	0.06
ECEC (Cmol kg^{-1})	7.14
% Base Saturation	99.14

3.4 Effects of Rooting Media and Poultry Manure Rates on Stem Girth of the Tree Species Seedlings

The use of soil as a rooting medium on the stem girth of gmelina seedling was significantly different from all other rooting media and this was observed from 4 to 16 WAT (Table 4). However, in the case of tectona, soil also differs significantly from other rooting media but only at 6 to 14 WAT. Poultry manure applied at 0, 5 and 10 t ha^{-1} had no significant effect on the stem girth of gmelina at 4 to 10 WAT and the same was observed for tectona at 4 to 6 WAT. Application of poultry manure at 5 t ha^{-1} had the same effect on stem girth as that applied on gmelina at a rate 10 t ha^{-1} while a significant effect was observed on tectona at an application rate of 10 t ha^{-1}.

3.5 Effects of Rooting Media and Poultry Manure Rates on Leaf Numbers of the Tree Species Seedlings

As the week progresses after transplanting, there was a significant increase in the number of leaves of gmelina (Table 5) following the use of soil as a rooting medium. Still, all the rooting media had no significant effect on the number of leaves of tectona at 12 to 16 WAT though there was a significant increase at 4 to 10 WAT with soil (Table 5).

It was observed that manure applied at 10 t ha^{-1} significantly increased the number of leaves of gmelina at 4 to 12 WAT as compared to other application rates (Table 5). Moreover, at 4, 12 and 14 WAT, there was no significant difference in the number of leaves following the use of manure (Table 5). Tectona*,* on the other hand showed a significant difference in number of leaves resulting from manure applied at 6 weeks, 8 weeks, 10 weeks, and 16 weeks in which the highest was obtained when manure was applied at 10 t ha^{-1} (Table 5).

3.6 Effects of N and P Fertilizers on Height of the Tree Species Seedlings

It was observed that N fertilization had no significant effect on the height of gmelina at 4 WAT but from 6 to 16 WAT (Table 6), N applied at 60 kg ha^{-1} had a significant effect on the height of gmelina which did not differ significantly from that obtained when 30, 90 and 120 kg ha^{-1} was applied (Table 6). As for tectona, N application at all rates showed no significant effect on its height (Table 6).

The use of P fertilizers on gmelina at 0, 45 and 90 kg ha^{-1} had no significant difference across the weeks, while tectona height differs significantly with the use of 45 kg ha^{-1} P fertilizers at 4 and 6 WAT (Table 6).

3.7 Effects of N and P Fertilizers on Stem Girth of the Tree Species Seedlings

At 4 to 6 WAT, the stem girth of the gmelina seedlings was not affected by N fertilization (Table 8). Stem girth was observed to be low under control at 8 to 16 WAT as compared to other rates (30, 60, 90 and 120 kg N ha^{-1}) which were not significantly different from each other (Table 8). At 4 WAT, the stem girth of gmelina seedlings was not affected by the P rates, while at 6 WAT, the seedlings responded more to P

application at 45 kg P ha^{-1} while 0, and 90 kg P ha^{-1} did not differ significantly.

From 4 – 12 WAT, N application had no significant effect on the stem girth of tectona, but 0 kg N/ha led to a significant increase in girth, while 30, 60, 90 and 120 kg N ha^{-1} did not differ from significantly. The use of P fertilizer does not have any significant effect on stem girth except the use of 45 kg at 6 and 14 WAT which was significantly higher than the control and 90 kg.

3.8 Effects of N and P Fertilizers on Leaf Numbers of the Tree Species Seedlings

N fertilizer applied at all rate had no significant effect on leaf number of gmelina at 4 WAT but application at 30 kg ha^{-1} resulted in a significantly higher number of leaf with no significant effect at 14 and 16 WAT (Table 8). It was observed that application of Phosphorus at a rate of 90 kg ha^{-1} led to a significant increase in the number of leaves of gmelina seedlings at 4 to 10 week after transplanting as compared to other rates (Table 8).

Application of N fertilizers at all rates had no significant effect on the leaf number of tectona seedlings from 4 to 12 WAT while at 14 to 16 WAT, N applied at 120 kg ha^{-1} led to a significant increase in leaf number compared to others which were not significantly different from each other (Table 8). Different levels of P fertilizers did not affect the number of leaves of the tectona seedlings because there were not significantly different from each other.

3.9 Effects of the Rooting Media, Poultry Manure, N and P Fertilizers Applied on pH and Electrical Conductivity of the Soil Planted to Gmelina and Tectona

Soil recorded the least significant pH value (Table 9) as compared to other rooting media. The poultry manure applied at all rate did not have any effect on the pH, while N applied at 120 kg ha^{-1} had a significant effect on pH but this did differ significantly from what was obtained at 90, 60 and 30 kg N ha^{-1}. The electrical conductivity (EC) was observed to have the least significant value when soil was used as the rooting medium whereas S: SD at 1:1 and 2:1 had the highest significant value. The use of N fertilizer at 120 kg N ha^{-1} recorded the least value but does not differ significantly as that obtained at 90 and 60 kg N ha^{-1} (Table 9).

A similar trend was observed for tectona, a significant different occurred among pH of manure applied at 0, 5 and 10 t ha^{-1} with 7.36, 7.45 and 7.47 respectively but for EC, there was no significant difference in the value recorded.

4. DISCUSSION

The high C: N ratio of sawdust was a limiting factor to seedling growth of the tree species, this supports the report of [9] that high C: N ratio slow down the decomposition rate due to low supply of N for the growth of microorganism which often leads to temporary immobilization of N by soil. The textural class of the soil used for the two experiments could also limit the seedling growth of the tree species as both species tends to thrive well in fertile and not excessively drained sandy soil. Furthermore, the soils were found to have low CEC as well as organic-C which suggest the low fertility status of the soil.

The tree species were found to vary in their response to poultry manure addition and the use of sawdust as rooting media. The results showed net increment in various growth parameters over 4 WAT which was significantly higher with combined application of poultry manure compared to control. The most economical increments in plant height, stem girth, and number of leaves were recorded with the application of 5 t ha^{-1} of poultry manure. This may be mainly attributed to the better uptake of applied nutrients compared to control and 10 t ha^{-1} applications. The increased uptake of nutrient might have caused a higher production of photosynthates and their allocation in leaves and stem leading to better increment in overall growth. These results are in conformity with findings of [3] which reported an increase in plant height and collar diameter with the application of higher levels of fertilizers. Moreover, soil mixed with sawdust at the ratio of 2:1 was significantly effective on the growth parameters but the use of soil as potting media was significantly higher when compared to others. This may also be attributed to the root of the tree seedling preferring soil with high bulk density to soil of low bulk density because the addition of sawdust to the soil will reduce the bulk density of the soil resulting in soil with a loose structure. The use of N and P fertilizers on the seedling growth was not encouraging as results obtained weeks after planting were not consistent. However, if there is a need for its use, 60 kg N ha^{-1} and 45 kg P ha^{-1} produced desirable seedling growth parameters.

Table 2. Chemical properties of sawdust and poultry manure

Sample	pH	Ca (%)	Mg (%)	Na (%)	K (%)	N (%)	Organic-C (%)	Available P (%)	Fe (mg kg^{-1})	Cu (mg kg^{-1})	Zn (mg kg^{-1})	Mn (mg kg^{-1})	C:N
Sawdust	6.52	1.19	0.09	0.46	1.12	0.21	5.14	0.05	352	14	52.5	21.5	30.2
Poultry Manure	8.35	6.49	1.15	2.43	1.18	0.91	6.62	0.09	335	48	52.5	24.8	7.54

Table 3. Rooting media and poultry manure rates effect on height of the tree species at 4, 6, 8, 10, 12, 14 and 16 weeks after treatment application

	Gmelina							Tectona						
A treatments	**4WAT**	**6WAT**	**8WAT**	**10WAT**	**12WAT**	**14WAT**	**16WAT**	**4WAT**	**6WAT**	**8WAT**	**10WAT**	**12WAT**	**14WAT**	**16WAT**
S	17.38a	32.44a	44.43a	57.12a	69.36a	74.55a	78.00a	11.88a	16.61a	21.47a	25.38a	30.68a	34.56a	38.00a
SD	11.34b	13.50c	19.57b	21.82c	26.93c	30.86d	33.83d	8.71b	9.85c	10.76c	11.65c	13.38d	15.35c	20.83c
S:SD 1:1	11.67b	18.43bc	27.00b	33.90b	44.63b	50.76bc	54.22bc	11.11ab	12.91b	14.31b	16.25b	22.48b	25.45b	29.62b
S:SD 1:2	12.25b	15.61bc	22.23b	26.18bc	32.18c	39.16cd	41.66cd	10.52ab	12.52b	13.43b	14.28b	17.20cd	21.66b	23.77c
S:SD 2:1	13.61b	19.61b	26.91b	33.37b	44.46b	56.67b	56.88b	11.02ab	12.21bc	14.43b	16.37b	19.70cb	22.94b	25.44bc
B treatments														
M 0 t/ha	12.28	16.36b	23.16b	26.64b	31.63b	38.24b	40.93b	10.95	12.44	13.62b	14.87c	17.74b	20.08b	25.67b
PM 5 t/ha	14.15	22.03a	29.50a	37.18a	49.42a	54.61a	57.50a	10.55	12.79	15.01ab	16.79b	20.93ab	23.60b	26.03b
PM 10 t/ha	13.49	21.33a	31.43a	37.82a	49.50a	56.56a	60.30a	10.55	13.45	16.10a	18.89a	23.46a	28.50a	30.89a
	ns							ns	ns					

Mean with the same alphabet in each treatment section did not differ significantly across the column at (P = .05)
S- Soil, SD- sawdust, PM- poultry manure. WAT- weeks after treatment application.
A Treatments- Treatment for rooting media B Treatments- Treatments for poultry manure

Table 4. Effects of rooting media and poultry manure rates effect on stem girth of the tree species at 4, 6, 8, 10, 12, 14 and 16 weeks after application

	Gmelina							Tectona						
A treatments	**4WAT**	**6WAT**	**8WAT**	**10WAT**	**12WAT**	**14WAT**	**16WAT**	**4WAT**	**6WAT**	**8WAT**	**10WAT**	**12WAT**	**14WAT**	**16WAT**
S	0.42 a	0.50 a	0.75 a	0.85 a	0.96 a	1.11 a	1.12 a	0.42	0.57 a	0.82 a	0.97 a	1.00 a	1.05 a	1.28
SD	0.32 b	0.37 b	0.42 b	0.47 c	0.53 c	0.60 d	0.75 c	0.37	0.40 b	0.43 b	0.48 b	0.55 b	0.68 b	0.93
S:SD 1:1	0.33 b	0.37 b	0.50 b	0.59 b	0.76 b	0.84 bc	1.05 ab	0.40	0.50 ab	0.55 b	0.59 b	0.67 b	0.74 b	0.98
S:SD 1:2	0.33 b	0.38 b	0.46 b	0.53 bc	0.57 c	0.73 c	0.84 c	0.40	0.44 b	0.56 b	0.64 b	0.72 b	0.78 ab	1.05
S:SD 2:1	0.34 b	0.37 b	0.48 b	0.56 bc	0.75 b	0.88 b	0.98 b	0.34	0.41 b	0.48 b	0.63 b	0.73 b	0.83 ab	1.94
								ns						ns
B treatments														
PM 0 t/ha	0.33	0.37	0.48	0.55	0.64 b	0.74 b	0.85 c	0.38	0.41 b	0.47 b	0.54 b	0.60 b	0.66 b	1.54
PM 5 t/ha	0.36	0.41	0.55	0.61	0.73 ab	0.84 a	0.95 b	0.38	0.46 ab	0.56 b	0.64 b	0.72 b	0.82 ab	1.50
PM 10 t/ha	0.35	0.4	0.54	0.64	0.77 a	0.92 a	1.05 a	0.39	0.53 a	0.68 a	0.82 a	0.90 a	0.99 a	1.54
	ns	ns	ns	ns				ns						ns

Mean with the same alphabet in each treatment section did not differ significantly across the column at (P = .05)
S- Soil, SD- sawdust, PM- poultry manure. WAT- weeks after treatment application.
A Treatments- Treatment for rooting media B Treatments- Treatments for poultry manure

Table 5. Effects of rooting media and poultry manure on leaf numbers of tree species at 4, 6, 8, 10, 12, 14 and 16 weeks after treatment application

	Gmelina							Tectona						
A treatments	**4WAT**	**6WAT**	**8WAT**	**10WAT**	**12WAT**	**14WAT**	**16WAT**	**4WAT**	**6WAT**	**8WAT**	**10WAT**	**12WAT**	**14WAT**	**16WAT**
S	11.88a	21.88a	23.44a	25.93 a	16 .55ab	15.44a	9.66 b	7.37a	8.66a	9.66 a	11.11 a	7.66	17.44	17.55
SD	7.77b	7.77c	8.33c	8.33b	7.88c	8.22b	7.55 b	5.75ab	5.71b	6.66 b	7.33 b	8.66	11.66	13.44
S:SD 1:1	8.25b	11.87bc	12.11bc	13.77b	14.77ab	16.11a	12.77ab	7.37a	7.50ab	9.37 ab	11.25a	10.5	13.66	14.62
S:SD 1:2	7.00b	10.33bc	11.88bc	12.11b	12.33bc	14.00ab	11.22ab	4.57b	5.25b	21.66 b	8.22 b	9.55	13.66	16.10
:SD 2:1	7.88b	14.66 b	15.33 b	20.88a	21.00a	18.77a	15.77 a	6.11ab	7.11ab	22.94 b	8.00 b	9.54	14.44	16.11
												ns	ns	ns
B treatments														
PM 0 t/ha	7.86 b	9.73 b	9.80 b	11.13 b	10.13 b	11.06	9.00	5.92	5.93 b	6.66	8.06 b	8.40	12.86	13.33 a
PM 5 t/ha	8.92 ab	14.00 a	16.06 a	17.26 a	15.33 a	16.2	12.06	6.92	7.07 ab	8.46	9.33 ab	9.40	12.93	14.73ab
PM 10 t/ha	9.07 a	16.33 a	16.8 a	19.86 a	18.06 a	16.26	13.33	6.07	7.92 a	8.64	10.07 a	9.35	16.42	18.85 a
						ns	ns	ns		ns		ns	ns	

Mean with the same alphabet in each treatment section did not differ significantly across the column at (P = .05)

S- Soil, SD- sawdust, PM- poultry manure. WAT- weeks after treatment application. A Treatments- Treatments for rooting media B Treatments- Treatments for poultry manure

Table 6. Effect of N and P fertilizers application rates on the height of Gmelina and Tectona at 4, 6, 8, 10, 12, 14 and 16 weeks after treatment application

	Gmelina							Tectona						
A treatments	**4WAT**	**6WAT**	**8WAT**	**10WAT**	**12WAT**	**14WAT**	**16WAT**	**4WAT**	**6WAT**	**8WAT**	**10WAT**	**12WAT**	**14WAT**	**16WAT**
N (kg)														
0	19.06	24.26b	35.10c	42.24b	45.77b	48.38b	48.84b	12.43	13.03	13.43	16.41	19.26	22.17	23.10
30	20.88	29.20a	43.13ab	48.10ab	50.11ab	51.98ab	52.69ab	12.07	13.34	16.04	17.98	19.85	24.88	26.63
60	19.62	28.64a	44.76a	53.02a	57.06a	63.86a	64.70a	10.43	11.52	14.06	16.02	18.06	23.30	25.20
90	18.57	26.38ab	39.56abc	47.37ab	50.40ab	55.23ab	55.83ab	11.72	13.61	16.28	18.81	20.66	26.51	27.79
120	18.81	27.48ab	37.67bc	46.83ab	50.81ab	59.37ab	60.12ab	10.69	11.72	13.44	15.83	19.00	24.62	25.91
	ns							Ns	ns	ns	ns	ns	ns	ns
B treatments														
P (kg)														
0	18.07	25.33	38.49	45.30	49.45	53.15	53.34	11.03ab	11.73b	13.59	15.86	18.15	22.71	23.98
45	19.65	28.45	40.93	50.08	53.09	59.36	60.37	12.54a	13.93a	15.78	17.66	19.79	24.82	26.53
90	20.43	27.79	40.71	47.16	49.95	54.77	55.61	10.83b	12.28ab	14.57	17.44	20.09	25.55	26.92
	ns	Ns	ns	ns	ns	Ns	Ns			ns	ns	ns	ns	ns

Mean with the same alphabet in each treatment section did not differ significantly across the column at (P = .05)

S- Soil, SD- sawdust, PM- poultry manure. WAT- weeks after treatment application. A Treatments- Treatments for N fertilizer B Treatments- Treatments for P fertilizer

Table 7. Effect of N and P fertilizers application rates on the stem girth of the tree species at 4, 6, 8, 10, 12, 14 and 16 weeks after treatments were applied

	Gmelina							Tectona						
A treatments	**4WAT**	**6WAT**	**8WAT**	**10WAT**	**12WAT**	**14WAT**	**16WAT**	**4WAT**	**6WAT**	**8WAT**	**10WAT**	**12WAT**	**14WAT**	**16WAT**
N (kg)														
0	0.40	0.52	0.56b	0.61b	0.61b	0.61b	0.70b	0.40	0.46	0.59	0.73	0.77	0.91a	0.83
30	0.40	0.58	0.73a	0.81a	0.87a	0.87a	1.01a	0.44	0.48	0.54	0.71	0.75	0.80ab	0.79
60	0.36	0.58	0.73a	0.79a	0.86a	0.89a	1.01a	0.44	0.50	0.59	0.63	0.68	0.70b	0.70
90	0.37	0.58	0.74a	0.74a	0.89a	0.92a	1.01a	0.43	0.46	0.60	0.69	0.71	0.81ab	0.81
120	0.39	0.59	0.78a	0.88a	0.90a	0.91a	1.02a	0.40	0.44	0.51	0.58	0.59	0.68b	0.66
	ns	ns						Ns	Ns	ns	ns	ns		ns
B treatments														
P (kg)														
0	0.35	0.52b	0.63b	0.70	0.76b	0.79	0.87	0.40	0.46ab	0.56	0.66	0.66	0.71b	0.69
45	0.40	0.61a	0.75a	0.80	0.83ab	0.85	0.99	0.45	0.52a	0.61	0.71	0.76	0.87a	0.82
90	0.39	0.58ab	0.75a	0.80	0.89a	0.87	0.99	0.42	0.42b	0.53	0.62	0.65	0.74ab	0.74
	ns			ns		Ns	ns	Ns		ns	ns	ns		ns

Mean with the same alphabet in each treatment section did not differ significantly across the column at (P = .05)

S- Soil, SD- sawdust, PM- poultry manure. WAT- weeks after treatment application. A Treatments- Treatments for N fertilizer B Treatments- Treatments for P fertilizer

Table 8. Effects of N and P fertilizers applied on leaf numbers of tree species at 4, 6, 8, 10, 12, 14 and 16 weeks after treatment application

	Gmelina							Tectona						
A Treatment	**4WAT**	**6WAT**	**8WAT**	**10WAT**	**12WAT**	**14WAT**	**16WAT**	**4WAT**	**6WAT**	**8WAT**	**10WAT**	**12WAT**	**14WAT**	**16WAT**
N (kg)														
0	12.56	16.89b	17.67b	18.22b	19.56b	17.33	15.67	6.00	7.00	8.56	9.43	9.86	9.29b	10.57b
30	14.67	24.11ab	24.33ab	22.56ab	22.11b	15.78	14.00	6.67	8.44	8.89	9.75	10.13	10.00ab	10.25b
60	13.78	35.11a	35.00a	31.33a	33.67a	22.78	19.33	5.44	9.67	9.11	9.11	9.89	9.33b	9.67b
90	15.00	26.67ab	27.56ab	24.00ab	23.22b	17.22	16.00	5.56	8.00	8.33	10.38	9.75	8.75b	10.13b
120	12.89	23.67b	24.33ab	24.78ab	24.44ab	19.33	17.89	6.11	9.00	9.22	10.44	10.89	11.89a	13.22a
	ns					ns	ns	Ns	Ns	ns	ns	ns		
B Treatment														
P (kg)														
0	11.27b	22.00b	21.67b	21.73b	22.20	19.13	17.67	6.33	7.87	9.00	10.07	10.36	10.57	11.00
45	14.07ab	22.60b	22.67b	21.33b	22.47	16.53	14.67	6.00	8.60	8.93	9.57	10.00	9.57	10.14
90	16.00a	31.27a	33.00a	29.47a	29.13	19.80	17.40	5.53	8.80	8.53	9.85	10.00	9.54	11.31
					Ns	ns	ns	Ns	Ns	ns	ns	ns	ns	ns

Mean with the same alphabet in each treatment section did not differ significantly across the column at (P = .05),

S- Soil, SD- sawdust, PM- poultry manure. WAT- weeks after treatment application. A Treatments- Treatments for N fertilizer B Treatments- Treatments for P fertilizer

Table 9. Effect of rooting media, poultry manure and N and P fertilizers rates applied on the soil pH and electrical conductivity (EC)

Treatment	Gmelina		Tectona	
	pH	EC (µS)	pH	EC (µS)
Soil	6.78b	0.05d	7.33c	0.70a
SD	7.27ab	0.13c	7.24c	0.14b
S:SD 1:1	7.73a	0.22a	7.46b	0.23a
S:SD 1:2	7.53a	0.18b	7.47b	0.20a
S:SD 2:1	7.67a	0.23a	7.63a	0.22a
PM 0 t/ha	7.06	0.16	7.36b	0.17
PM 5 t/ha	7.55	0.17	7.45ab	0.18
PM 10 t/ha	7.60	0.17	7.47a	0.18
	ns	ns		ns
N (kg)				
0	7.14a	0.07a	7.01a	0.04
30	7.20a	0.06b	6.99ab	0.04
60	7.03ab	0.05bc	6.97ab	0.03
90	6.99ab	0.05bc	6.81b	0.04
120	6.92b	0.04c	7.01a	0.05
P (kg)				
0	7.01	0.05	7.01	0.04
45	7.12	0.05	6.96	0.04
90	7.05	0.05	6.91	0.04
	ns	ns	Ns	ns

Mean with the same alphabet in each treatment section did not differ significantly across the column at (P = .05), S- Soil, SD- sawdust, PM- poultry manure

5. CONCLUSION

Poultry manure application at 5 t ha^{-1} enhanced the agronomic traits such as number of leaves, stem girth and plant height of gmelina and tectona. Farmers growing gmelina and tectona seedlings should apply organic manure at 5 t ha^{-1} and the use of soil is advocated for good seedlings establishment.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Agboola DA, Kadiri M. The effects of defoliation and inorganic Fertilizers on the growth of some tropical tree seedlings. Journal of Tropical Forest Science. 1999; 11(4):672–679.
2. Hoque AT, Hossain MK, Mohiuddin M, Hoque MM. Effect of Inorganic fertilizers on the initial growth performance of *Michelia champaca* Linn. Seedlings in the Nursery. 2004;4:489–497.
3. Marigoudra RM, Madiwalar SL. Effect of planting methods and fertilizers levels. Initial Growth and Foliar Nutrient Contents of Teak. 2004;17(1):72–75.
4. Husen A, Pal M. Effect of nitrogen, phosphorous and potassium Fertilizers on growth of stock plants of *Tectona* (Linn, f.) and rooting behaviour of shoot cuttings. Silvae Genetica. 2003;52(5–6):249–254.
5. Chijioke EO. Soil factors and growth of *Gmelina arborea* in Omo forest reserve. 1988;245–251.
6. Ogbonnaya CI. Effects of nitrogen sources on the wood properties of *Gmelina arborea* relevant to pulp and paper production. Forest Ecology and Management. 1993; 56(1–4):211–223.
7. Ladrach W, Associates ZF. Management of teak plantations for solid wood products. Society. Special Report. 2009;1-25.
8. Green H. WoodCraft culture.History Penguin Books. NewYork. 2006;403.
9. Moyin-Jesu EI, Adeofun CO. Comparative evaluation of different organic Fertilizers on the soil fertility, leaf mineral composition, and growth performance of mango seedlings (*Magnifera indica* L.). Emir. J. Food Agric. 2008;20(1):18–30.

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