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Early Growth Responses of *Tamarindus indica* L to Different Manure Sources

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ABSTRACT

Inadequacy of quantified information on the early growth responses of *T. indica* seedlings to different manure sources has limited its propagation as well as its biodiversity conservation. In an attempt to enhance the slow growth of *T. indica*, investigation was conducted to assess its growth responses to different manure sources. The experimental design adopted was a Completely Randomised Design with six treatments replicated five times. The treatment consisted of 10g of each manure (cowdung, goat droppings, rabbit droppings, poultry droppings, pig droppings and control) assessed on the early growth of *T. indica* seedlings. A total of thirty (30) seedlings were involved in the experiment. Six months old *T. indica* seedlings were transplanted into pots with and without manure and subjected to 200ml of water daily. Growth parameters evaluated were height, girth, number of leaflets and fresh and dry biomass. Data collected were subjected to one way Analysis of Variance (ANOVA) at 5% level of significance. Manure sources significantly ($P<0.05$) enhanced the growth of *T. indica*. Highest height (26.40cm), total fresh weight (5.24g) and total dry weight (2.44g) were recorded from seedlings planted in the soil amended with cowdung respectively at 12 WAT. Highest number of leaflet (57.20) and girth (0.30cm) were recorded from seedlings planted in the soil influenced with goat droppings and rabbit droppings respectively. Cowdung enhances growth of *T. indica* seedlings

Keywords: Growth, Manure sources, Response, Amendment, Indigenous fruit trees

Introduction

Trees play an important role in the functioning of the savanna ecosystems (Sankaran *et al.,* 2008) by maintaining soil chemical properties and nutrient cycling and providing direct or indirect human nutrition for developing countries particularly (Vinceti *et al.,* 2008; Arnold *et al.*,2011).Forests and trees face increasing and competing demands for land, wood, food, feed, energy and ecosystem services. Agriculture expansion is often at the expense of forests (Gibbs *et al.,* 2010) and is considered the largest cause of deforestation, responsible for approximately 80% of forest loss (Kissinger *et al.,* 2012). Deforestation, desertification and erosion are the most challenging and obvious factors responsible for biodiversity loss as well as soil degradation in the savanna regions (Oyebamiji *et al.,* 2019). These limiting factors can be addressed and ultimately minimized through afforestation and re-afforestation or regeneration programmes.

An increase in production and availability of this wild indigenous species will only be possible when suitable production practices of its potentials are obtained through domestication (Fariyike *et al.,* 2013), propagation and regeneration programmes. Nevertheless, to realize these regeneration and domestication programmes, seed germination and seedling growth factors must be taken into consideration especially for indigenous economic species. *Tamarindus indica* is an indigenous economic tree species. *Tamarindus indica* is widely distributed in Sudan and other Afro-Asian countries (Warda *et al.*,2007). The species is indigenous to tropical Africa, particularly in the Sudan (Morton, 1987). Adeolaand Aworh (2010) stated that *Tamarindus indica* grows wild in Africa in locales as diverse as Sudan, Cameroon, Nigeria, Zambia and Tanzania.

In Arabia, it is found growing wild in Oman, especially Dhofa, where it grows on the sea-facing slopes of mountains. Lewis *et al.*(2005) stated that *Tamarindus indica* is a member of the family Fabaceae, sub-family Caesalpinioideae which is the third largest family of flowering plants with a total of 727 genera and 19, 327 species. The tree is commonly known as “tsamiya” in Hausa, “IchekuOyibo” in Igbo, Ajagbon” in Yoruba, and “Tamarind” in English languages. Samina*et al.*(2008) reported that its young seedlings, leaves and flowers of mature trees are eaten as vegetable and in curies, salads and soup. Its sour pods are cooked as seasoning with rice, fish and meats. Its fruit pulp is used for the preparations of beverages in different regions (Samina *et al.*,2008).

The species is valuable and more of it needs to be propagated. The slow growth characteristics of *T .indica* have been limited its propagation. Bello and Zubairu (2015) stated that the *T. indica* is a slow-growing one. The slow growth of seedlings of *T. indica* is a threat to population demand and biodiversity conservation. Successful seed germination and seedling development are crucial steps in the growth of a new plant(Wolny*et al.,* 2018).Seedling stage is the most sensitive stage in the life cycle of a plant and hence it is susceptible to physical and chemical adversities (Vaithiyanathan and Sundaramoorthy, 2016) and affected by soil fertility as well assoil properties. Soil properties, one of the important factors affecting distribution and growth of plants, play an important role in the ecology of vegetation (Sambou *et al.,* 2017).

With time, deep soil tillage, application of high amounts of inorganic fertilizers and herbicides, burning of crop residues and continuous cropping, result in a progressive deterioration of soil fertility, degradation of soil aggregate stability, increased soil compaction, nitrate losses and gravitational water pollution, and thus have negative consequences not only on the soil properties, but also on the environmental quality (Yerima *et al.*, 2015).As such, it is necessary to use sustainable agricultural practices (Maiorana*et al.*,2004) and forestry practices to address soil degradation as well as soil deterioration. Erosion, salinization, compaction and loss of organic matter are the main forms of soil deterioration. Addition of organic matter could be a way to improve soil structure and aeration, creating a better environment for plant growth (Yerima *et al.,* 2015). Manure comprises of organic matter and other nutrients. The use of organic fertilizer, manure in the nursery portends advantages such as soil replenishment, increased soil friability, improved beneficial soil life, increased growth and yield, prevention of hardpans, recycling and reduction of waste, minimized greenhouse gas emissions, and plant protection against diseases (Aderounmu and Olajuyigbe, 2019).

Manure possesses enormous potentials which eventually lead to enhancement of soil fertility for luxuriant plant growth. Enhancement of soil fertility is the key to the production of high quality seedlings required for plantation establishment (Afa *et al.*,2011). Different tree species vary in their requirement for particular nutrient elements for growth and completion of their reproductive cycles (Agera *et al.,* 2019). Nutrient requirements of tree species raised in nurseries located at different sites also vary since site chemical and physical conditions are not the same (Pinkard *et al.,* 2006).Plant species nutrient requirement and management as well as site environment are important for successful seedling growth. Seedling growth is directly proportional to the nutrition. In forestry, tree seedling growth is vital since it influences the gestation period of tree and amount of wood to harvest. In order to ensure adequate plant nutrition without jeopardising the environment, investigation was carried out on the early growth responses of *T. indica* to different manure sources. This investigation was carried out with a view to enhance its seedling production as well as to increase its biodiversity conservation in Nigeria.

Materials and method

The research was conducted in the screen house of Federal College of Forestry Mechanization, Afaka, Kaduna State during dry season of 2015. The College is located in the Northern Guinea Savannah ecological zones of Nigeria. It is situated in Igabi Local Government Area of Kaduna State, Nigeria. It lies between Latitude 10^o 35$'$ and 10^o 34$'$ and Longitude 7^o 21$'$ and 7^o 20$'$ (Adelani, 2015). The mean annual rainfall is approximately 1000mm. The vegetation is open woodland with tall broad leave trees (Otegbeye*et al.,* 2001).

Experimental Procedure

The seeds were sourced from Afaka Forest, Kaduna State. The seeds were extracted from fruits and air dried for thirty minutes. Three hundred seeds were extracted from fruits. The viability of the randomly selected seed samples were assessed using cutting method (Schmidt, 2000). The sowing media (river sand), which was collected from the floor of College dam was made to pass through 2mm sieve and then sterilized at 160^{o}C for 24hours. The polythene pots used was 20x10x10cm^3 in dimension and filled with the sterilized river sand and arranged in the screen house.

Chemical analysis of manure applied

The samples of manure cured and dried for two weeks were analysed chemically for nitrogen, phosphorus and potassium (NPK)content at Federal University of Agriculture Abeokuta, Ogun State, Nigeria laboratory. Determination of total nitrogen was done by MacroKjeldahi method. Available phosphorus (P) was extracted by Bray-1 method and determined colourimetrically. Extracts from the digestion of manure were used to determine potassium by flame photometry.

Early growth responses of *Tamarindus indica* to different manure sources

The experimental design adopted for the early growth responses of *Tamarindus indica* to different manure sources was a Completely Randomised Design with six treatments replicated five times. The treatment consisted of 10g of each manure (Cowdung, goat droppings, rabbit droppings, poultry droppings, pig droppings and control) applied on the *T. indica* seedling growth. The experiment involved a total of thirty seedlings. Six month old seedlings were transplanted into potting mixture with or without manure and subjected to 200ml of distilled water daily. Seedlings planted in sand without mixture of manure served as control. The sand without the addition of leaf litters was analysed for nutrient content of soil under control treatment. Growth parameters assessed every three weeks included; Seedling height (using meter rule); girth (using venier caliper); the number of leaflets were counted manually. The fresh and dry weight were determined by the use of Mettler Top Loading Weighing Balance, but dry weight was taken after oven dried the seedlings at 70°C for 72hours (Umar and Gwaram, 2006).

Data analysis

The data on the early growth responses of *T. indica* to different manure sources were subjected to one way analysis of variance (ANOVA) using SAS (2003). Comparison of significant means was accomplished using Fishers Least Significant Difference (LSD) at 5% level of significance

Result

Early growth responses of *T. indica* height to different manure sources

Highest height of 26.40cm was recorded from seedlings planted in the soil amended with cowdung, while the least of height (11.76cm) was obtained from seedlings without organic fertilizer at 12 and 3 WAT respectively (Table 1).

Table 1: Early growth responses of *T.indica* height (cm) to different manure sources

Manure	Weeks	After	Transplanting	
	3	6	9	12
Cowdung	24.34[a]	24.60[a]	25.12[a]	26.40[a]
Goat droppings	22.28[a]	22.64[a]	23.18[ab]	23.96[ab]
Rabbit droppings	22.48[a]	22.96[a]	23.64[ab]	24.10[ab]
Poultry droppings	21.54[a]	22.52[a]	22.78[ab]	23.22[ab]
Pig droppings	19.34[ab]	20.14[ab]	20.48[ab]	21.42[ab]
Control	11.76[b]	12.75[b]	13.18[b]	13.86[b]
SE±	3.59	3.61	4.35	4.35

*Means on the same column having different superscripts are significantly different (P<0.05)

Key: WAT= Weeks After Transplanting

Early growth responses of *T. indica* number of leaflets to different manure sources

Highest number of leaflets (57.20) was recorded from seedlings planted in the soil influenced with goat droppings, while the least value of number of leaflets (13.20) was recorded from untreated seedlings (control) at 12 and 3 WAT respectively.

Table 2: Early growth responses of *T. indica* number of leaflets to different manure sources

Manure	Weeks	After	Transplanting	
	3	6	9	12
Cowdung	19.00[a]	29.00[a]	33.60[a]	40.60[ab]
Goat droppings	23.00[a]	34.80[a]	41.60[a]	57.20[a]
Rabbit droppings	22.20[a]	26.60[a]	27.00[a]	53.80[ab]
Poultry droppings	21.00[a]	21.80[a]	24.20[a]	46.80[ab]
Pig droppings	14.60[a]	19.60[a]	31.00[a]	32.20[ab]
Control	13.20[a]	14.60[a]	18.80[a]	19.40[b]
SE±	9.79	9.30	10.78	15.08

*Means on the same column having different superscripts are significantly different (P<0.05)

Key: WAT= Weeks After Transplanting

Early growth responses of *T. indica* girth to different manure sources

Highest girth of 0.30cm was recorded from seedlings planted in the soil enhanced with rabbit droppings at 12 WAT. The least value of 0.16cm was recorded from untreated seedlings (control) at 3WAT.

Table 3: Early growth responses of *T. indica* girth(cm) to different manure sources

Manure	Weeks	After	Transplanting	
	3	6	9	12
Cowdung	0.24^{a}	0.26^{a}	0.26^{a}	0.29^{a}
Goat droppings	0.21^{a}	0.26^{a}	0.27^{a}	0.27^{a}
Rabbit droppings	0.22^{a}	0.23^{a}	0.24^{a}	0.30^{a}
Poultry droppings	0.20^{a}	0.23^{a}	0.24^{a}	0.24^{a}
Pig droppings	0.25^{a}	0.25^{a}	0.25^{a}	0.26^{a}
Control	0.16^{a}	0.19^{a}	0.20^{a}	0.20^{a}
SE±	0.52	0.49	0.43	0.50

*Means on the same column having different superscripts are significantly different (P<0.05)

Key: WAT= Weeks After Transplanting

Early growth responses of *T. indica* fresh and dry weight (g) to different manure sources

Highest leaf (2.60g), shoot(1.02g) and root fresh weight (1.62g) were recorded from seedlings planted in the soil influenced with cowdung respectively. Highest leaf(1.02g) shoot (0.81g) and root dry weight (0.61g) were recorded from seedlings planted in the soil enhanced with cowdung respectively. Highest total fresh weight(5.24g) and total dry weight (2.44g) were recorded from seedlings planted in the soil amended with cowdung respectively.

Table 4: Early growth responses of *T. indica* fresh and dry weight (g) to different manure sources

Manure	FW			TFW	DW			TDW
	L	S	R		L	S	R	
Cowdung	2.60^{a}	1.02^{a}	1.62^{a}	5.24^{a}	1.02^{a}	0.81^{a}	0.61^{a}	2.44^{a}
Goat droppings	2.40^{ab}	0.92^{ab}	1.47^{ab}	4.79^{ab}	0.92^{ab}	0.74^{ab}	0.55^{ab}	2.21^{ab}
Rabbit droppings	2.41^{ab}	0.93^{ab}	1.48^{ab}	4.82^{ab}	0.93^{ab}	0.74^{ab}	0.56^{ab}	2.23^{ab}
Poultry droppings	2.30^{ab}	0.89^{ab}	1.43^{ab}	4.62^{ab}	0.89^{ab}	0.71^{ab}	0.54^{ab}	2.14^{ab}
Pig droppings	2.10^{ab}	0.82^{ab}	1.32^{ab}	4.24^{ab}	0.82^{ab}	0.66^{ab}	0.49^{ab}	1.97^{ab}
Control	1.40^{b}	0.53b	0.85^{b}	2.78b	0.53^{b}	0.43^{b}	0.32^{b}	1.28^{b}
SE±	0.43	0.17	0.27	0.87	0.17	0.13	0.10	0.40

*Means on the same column having different superscripts are significantly different (P<0.05)

Nutrient composition of manure sources applied

Highest percentage nitrogen (0.27%), phosphorus (4.15mg/kg) and potassium (9.96%) were recorded from pig droppings, pig droppings and goat droppings respectively. The least values of 0.04%, 0.07mg/kg and 0.17% were recorded for nitrogen, phosphorus and potassium content of soil without manure.

Table 5: Nutrient composition of manure sources applied

Manures	N%	Pmg/kg	K%
Cowdung	0.19	0.51	1.08
Goat droppings	0.04	0.57	9.96
Rabbit droppings	0.13	0.34	2.91
Poultry droppings	0.07	1.82	6.29
Pig droppings	0.27	4.15	1.16
Control	0.04	0.07	0.17

Discussion

A significant growth parameters were recorded from seedlings planted in the soil improved with cowdung. Similar observation has been made by Dachung and Kalu, (2019) who stated that organic manure (cow dung) should be utilized to make nutrient available for optimal growth of *Tamarindus indica* seedlings. Sale *et al.*(2018) also observed that ginger growth was influenced by cow dung. The *Entandrophragma angolense* seedlings treated with 10g of cowdung+2kg of topsoil (T6) performed best in all parameters assessed compared to others (Agbo-Adediran and Oso, 2014).Abubakar and Rabo (2019) stated that better number of leaves and leaf area were recorded from *Khaya senegalensis* seedlings planted in the soil added with cow dung manure. Nidhi *et al.*(2016) also stated that cow dung is high in organic materials and enrich in nutrients such as nitrogen.

Contrary to the result of this experiment, Thomas and Aluko (2016) recommended that poultry manure application at 1.5 kg/ha and 2 kg/ha could be used to enhance the soil nutrient status and vegetative growth of *Treculia africana* seedlings at the nursery stage respectively. The finding on the use of poultry manure also agrees with the work of Ugese (2010) who obtained higher results in organic manure (poultry droppings) application with *Tamarindus indica* as compared with rice hull and sawdust. *Khaya senegalensis* can be best grown for successful plantation establishment with the application of poultry manure at the rate of 20g per seedling (Agera *et al.*, 2019).Olajiire-Ajayi *et al.* (2018) recommended that 30g of poultry manure can be used if desired attribute of *Mansonia altissima* are growth parameters. The organic manure that best suit the growth of *Kigelia africana* was poultry manure (Rafiu *et al.*, 2018).

Similar observation has been reported by Rotowa *et al.* (2020) who stated that the sapling of *Eucalyptus torelliana* treated with poultry droppings recorded the highest mean value of the growth in most of the accessed parameters including plant height and plant girth. This could be attributed to the fact that nutrient availability in the soil enriches and improves plant growth (Rotowa *et al.*,2020). This is in accordance with the study of Egbewole (2017) who assessed the early growth of *Araucaria heterophylla* seedlings and recorded highest mean value in soil treated with poultry droppings. The variation in response of seedlings to various manure sources aside cowdung is also supported by the reports of Bali *et al.* (2013)who observed that survival percent under field conditions was higher in *Terminaliabellirica* seedlings raised in Farm Yard Manure and Celrich (bio-organic soil enricher) compared to other treatments (goat and poultry manures).In the same trend, Patel *et al.*(2020) also reported that Farm

Yard Manure generally facilitated *Pterocarpussantalinus* rooting; improve water retention capacity and results in the even distribution of nutrients in soil profile.

The *T. indica* seedlings treated with manure significant performed better than untreated ones.

Similar observation has been made by Rotowa *et al.* (2020) also stated that plant growth is directly related to the availability of nutrient in the soil as the *Eucalyptus torelliana* planted in treated soil sample performed better than those in the untreated soil. Manure used in the amendment of soil released nutrients which influenced the growth of the *T. indica*. Manure is added to the soil for several reasons, with ultimate aim of improving soil nutrients. Various researchers who worked on the effect of organic manures on the growth of some tropical trees species gave similar results to that of the present study {(Mbakwe and Nzekwe (2005); Baiyeri (2002)}. The result also agreed with the findings of Mbakwe and Nzekwe (2005) who observed that organic manures had effect on the growth of the seedlings of *Irvingia wombulu* (Vermeosen). Mukhtar (2016) also recorded high performance in organic application with *Adansonia digitata*.The result is in line with assertions of Mader and Andreas (2012) who stated that organic nutrients increase the abundance of soil organism by providing organic matter and micronutrients for organisms which aid plants in absorbing nutrients. This indicates that addition of organic matter to poor or sandy soils would improve not only good seedling emergence, but also optimum plant growth at later stages (Yerima *et al.,* 2015).

Chemical analysis revealed that highest nitrogen and phosphorus present in pig droppings, while highest potassium present in goat droppings. However, highest seedling growth parameters were recorded from soil mixed with cowdung. The superior performance of seedlings planted in the soil improved with cowdung inspite of contradictory result of chemical analysis, could be that cowdung was able to release its nutrient better during dry season compared to other manure sources.

Conclusion

One of the vital ways of overcoming challenges of genetic erosion of our indigenous, economic and endangered trees as *T. indica* is to predispose the seedlings to appropriate sources of manure, which is economical, adoptable and environmentally friendly. Appropriate manure application to *T. indica* seedlings improves its growth to meet population demand as well as to increase its biodiversity conservation for various purposes. Investigation conducted into early seedling growth responses of *T. indica* to different manure sources revealed that cowdung enhances its growth.

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