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EFFECT OF ORGANIC AND INORGANIC FERTILIZERS ON THE EARLY GROWTH OF *Tamarindus indica* L. IN MAKURDI, NIGERIA

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ABSTRACT

Tamarindus indica, commonly known as Tamarind is one of the important multipurpose tropical fruit tree species in the tropical region. To effectively harness the potentials of this species, emphasis must be made for improving their demand as plantation trees, and also their early growth, and speed up their full development rate. The study was conducted to determine the effect of organic and inorganic fertilizers on the early growth of Tamarindus indica in the Forestry Nursery of Federal University of Agriculture Makurdi. Seeds were procured, pre-treated with 50 % sulphuric acid for 60 minutes to break seed dormancy and sown in the poly pots filled with top soil. Two weeks after germination, 10 potted seedlings each were divided into 4 groups of 3 different levels of inorganic and organic fertilizer applications in a Completely Randomized Design (CRD) experiment. Fertilizers were applied using ring method. Data collected for early growth parameters were seedling height, collar diameter and number of leaves produced. The growth parameters were measured at two weeks interval for six weeks. The results showed that application of ~~organic~~ manure at various doses yielded better growth and seedlings quality of Tamarindus indica as compared to NPK (15:15:15) and Urea fertilizer. Urea treatment was toxic to the seedlings at all levels of applications which led to the death of the seedlings. NPK applied at 6 grams and 9 grams were also toxic to the seedlings which also led to high mortality rate after application. From the results obtained in this experiment it was that organic manure (cow dung) should be utilized to make nutrient available for optimal growth of Tamarindus indica seedlings and the application of fertilizers (NPK and Urea) above 3 grams on Tamarindus indica seedlings should be discouraged.

Keywords: *Tamarindus indica*, Cowdung, NPK, Urea, early growth

INTRODUCTION

Tamarindus indica L., commonly known as Tamarind is one of the most important multipurpose fruit tree species in the tropical region. It is a large evergreen tree up to 30 m tall, bole usually 1-2 m, up to 2 m diameter, crown is dense, widely spreading, rounded; bark rough, fissured, grayish-brown (Bhadoriya *et al.* 2011). *Tamarindus indica* has a hard and heavy wood for general carpentry, boat building, firewood, and charcoal production; it is used as shade, amenity, bee forage and windbreak. Pods contain 1-10 seeds, which are irregularly shaped, flattened or rhomboid. Seeds are very hard, shiny, reddish, or purplish brown. They are embedded in the pulp, lined with a tough parchment resembling a membrane, and joined to each other with tough fibres (Kumar and Bhattacharya, 2008).

Tamarindus indica belongs to the family *Fabaceae* and subfamily C*aesalpinioideae*. It is an important source of food in the tropics. It is a multipurpose tree of which almost every part finds at least some use as either nutritional or medicinal (Kumar and Bhattacharya, 2008). Tamarind is indigenous to tropical Africa but it has been introduced and naturalized worldwide in over 50 countries. The major production areas are in the Asian countries, India and Thailand, but also in Bangladesh, Sri Lanka, and Indonesia, while America, Mexico and Costa Rica are the biggest producers. Africa on the whole does not produce tamarind on a commercial scale, though it is widely used by the local people. Minor producing countries in Africa are Senegal, Gambia, Kenya, Tanzania and Zambia (El-Siddig *et al.*, 2006).

Tamarind is valued highly for its fruits, especially the pulp which is used for a wide variety of domestic and industrial purposes (El-Siddig *et al*., 2006), especially for food and beverages (Kotecha and Kadam, 2003). The pulp constitutes 30-50% of the ripe fruit, the shell and fibre account for 11-30% and the seed about 25-40% (El-Siddig *et al.*, 2006).

Tamarind fruit pulp is used for seasoning as a food component, to flavour confections, curries and sauces, and is a main component in juices and certain beverages. Tamarind fruit pulp is eaten fresh and often made into a juice, infusion or brine (El-Siddig *et al*., 1999; El-Siddig *et al*., 2006), and can also be processed into jam and sweets. The refreshing drinks are popular in many countries around the world, though there are many different recipes. In some African countries, the juice obtained from the fruit pulp is mixed with wood ash to neutralize the sour taste of the tartaric acid. However, the most common method is to add sugar to make a pleasantly acid drink. Sometimes pulp is fermented into an alcoholic beverage (El-Siddig *et al*., 2006). There are great differences and variations in fruit size and flavour (Kumar and Bhattacharya, 2008).

Tamarind seed is a by-product of the tamarind pulp industry. The presence of tannins and other dyeing matter in the testa make the whole seed unsuitable for direct consumption. The major industrial product of tamarind seed is the tamarind kernel powder (TKP) which is an important sizing material used in the textile, paper, and jute industries (Kumar and Bhattacharya, 2008). Tamarind seed is also the raw material used in the manufacture of polysaccharide (jellose), adhesive and tannin. In 1942, two Indian scientists observed that decorticated kernels contained 46-48% of a gel-forming substance. This polysaccharide (pectin) with carbohydrate character and gelly forming properties, named 'jellose' (El-Siddig *et al*., 2006), has been recommended for use as a stabiliser in ice cream, mayonnaise and cheese, and as an ingredient or agent in a number of pharmaceutical products (Morton, 1987; El-Siddig *et al*., 2006). Flour from the seed may be made into cake and bread. Roasted seeds are claimed to be superior to groundnuts in flavour (ICRAF, 2007). In view of the overall nutrient and chemical composition, tamarind seeds may be adopted as an inexpensive alternative protein source to alleviate protein malnutrition among traditional people living in developing countries (Siddhuraju *et al.*, 1995).

Tamarind leaves and flowers can be eaten as vegetables and are prepared in a variety of dishes (ICRAF, 2007). They are used to make curries, salads, stews and soups in many countries, especially in times of scarcity (El-Siddig *et al*., 2006).

Tamarind barks and leaves contain tannins. The bark is rich in tannins reaching up to 70%, and as such has found a place for use in the tanning industry. The bark is used for tanning hides and in dyeing (Morton, 1987; El-Siddig *et al*., 2006). In Zambia, bark tannins are used in the preparation of ink and for fixing dyes. The bark is also burnt to make ink in many other African countries. Tamarind twigs are sometimes used as chewing sticks whereas the bark is used as a masticatory, alone or as a substitute of lime in betel nut. The bark yields the alkaloid hordenine (Morton, 1987; El-Siddig *et al*., 2006).

To effectively harness the potentials of this species, emphasis must be made for improving their demand as plantation trees. In this regard, the use of organic and inorganic manure applications becomes essential in forest soil management practice.

In order to regenerate a forest and maintain it, the soil has to be enriched with nutrients. This enrichment could be in form of fertilizer application, which may be organic or inorganic forms, all of which furnish plants with nutrients necessary for their growth (Offiong *et al*., 2010).

Siddhuraju (2007) reported that during the early stages of growth, trees are very well dependent on soil nutrient supply. Failure to manage nursery soil adequately can result in depletion of site quality and a reduction of seedling growth (Hoque *et al.*, 2004). The dilemma for the foresters is how to increase the yield and quality of products for rapidly expanding wood based industries and for use by a rapidly expanding human population and simultaneously maintaining the environmental diversity. However, it is well understood that the loss of diversity may be minimized in a sustainable manner through increasing the number of species used in production forestry through domestication of indigenous timber species (Rafiqul *et al.*, 2004). In view of this multipurpose function and utility of *Tamarindus indica*, it is favoured for plantation programs.

This study was aimed at evaluating the effect of organic and inorganic manure applications on *Tamarindus indica* at early growth stage to ascertain the best means of improving faster seedling growth of the species.

MATERIALS AND METHODS

Study Area

The experiment was conducted at the Forestry Nursery of Federal University of Agriculture Makurdi. The Forestry nursery is located beside the University Teaching and Research Farm (7^o 41' N 8^o 37 ' E) Benue state is located in the southern guinea savanna ecological zone of Nigeria with a tropical sub-humid climate. It has two distinct seasons called the dry and wet seasons. The wet season starts from April to October while dry season is from November to March (Odekunle, 2004).

The soils are mainly oxisols and ultisols (tropical ferruginous) which vary over space with respect to texture, drainage, and gravel content. The soil is significantly agronomical because of its ability to produce a perched water table which is an important source of capillary water, which keeps the surface moist long after the end of the rainy season (Fagbami and Akamigbo, 1986).

Seeds Collection and Treatment

The pods of *Tamarindus indica* seeds were purchased from the Railway Market in Makurdi, Benue State and the seeds were extracted from the pods by splitting the pods carefully using mechanical means. Seed dormancy was broken by soaking the seeds in 50 % concentration of H_2SO_4 acid for 60 minutes to rupture the hard coat and to enhance the germination of seeds according to Abubakar and Muhammed (2013).

Experimental Design

The experiment was laid out in a Completely Randomised Design with three treatments (NPK, Cowdung and Urea) replicated four times and a control.

Seeds Sowing

Treated seeds were sown directly into poly pots filled with sterilized river sand. Two seeds were sown per poly pot, approximately 2cm deep into the pots. The seeds were lightly covered with sand and watering was done until germination of the seeds. The seedlings were allowed for two weeks growth before fertilizer application. Tamarind seedlings were transplanted into poly pots filled with a mixture of top soil and river sand in ratio of 4:1 before the fertilizer application. Both organic (cow dung) and inorganic (NPK 15:15:15 and Urea) fertilizers were applied when the seedlings were two weeks old using ring method. Varying levels of 3 g, 6 g and 9 g were administered into the poly pots.

Data collection Procedure

Data were collected for the following early growth parameters: seedling height, collar diameter and number of leaves produced. The growth parameters were measured at two (2) weeks interval for eight (8) weeks. The height of seedling in each poly pot was measured using a graduated meter rule. Vernier caliper was used to measure the collar diameter of seedling. The production of new leaves recorded by visually counting the number of leaves produced. These parameters were measured fortnightly. Data collected were subjected to Analysis of Variance (ANOVA).

RESULTS

Effect of the varying levels of inorganic and organic manure applications on the mean height of *Tamarindus indica* seedlings is shown on Table 1. Highest mean height of 22.73±2.73 cm was observed in the 6 grams dosage of organic manure treatment in the 8th week after application, followed by the NPK treatment with mean height of 19.28±3.49 cm recorded in the 8th week after application. The lowest mean value of 0.00 was observed at all levels of application in Urea treatment.

Table 1: Effect of Varying Levels Organic and Inorganic Fertilizers on the Mean Height (cm) of *Tamarindus indica* Seedlings.

Treatment	Duration in weeks	Levels of Fertilizers		
		3 g	**6 g**	**9 g**
		Height (cm)	**Height (cm)**	**Height (cm)**
Control	-	12.87±1.50 [b]	8.32±0.02 [a]	8.20±1.14 [a]
NPK	2nd BFA	10.60±2.00 [a]	9.26±1.49 [a]	9.54±1.06 [b]
	4th AFA	11.95±2.08 [a]	10.65±0.21 [b]	8.50±2.12 [a]
	6th AFA	15.08±2.66 [c]	0.00	0.00
	8th AFA	19.28±3.49	0.00	0.00
	***P*-value**	**<0.001**	**<0.001**	**<0.001**
Organic	2nd BFA	9.74±1.37[a]	9.56±0.96 [a]	10.50±1.01 [a]
	4th AFA	10.91±1.58 [a]	11.71±1.44 [a]	11.71±1.44 [a]
	6th AFA	17.05±2.59 [b]	18.91±2.36 [b]	17.63±2.13 [b]
	8th AFA	20.88±3.40 [c]	22.73±2.73 [c]	21.41±2.08. [c]
	***P*-value**	**<0.001**	**<0.001**	**<0.001**
Urea	2nd BFA	9.03±1.38	9.39	9.09
	4th AFA	0.00	0.00	0.00
	6th AFA	0.00	0.00	0.00
	8th AFA	0.00	0.00	0.00
	***P*-value**	**<0.001**	**<0.001**	**<0.001**

Means on the same column with different superscripts are statistically significant (p<0.05)
Key: BFA: Before Fertilizer Application; AFA: After Fertilizer Application

Effect of the varying levels of organic and inorganic fertilizers on number of leaves of *Tamarindus indica* seedlings is shown in Table 2. Highest mean number of 19.30±4.03 was observed with 6 grams dosage of organic manure treatment in the 6th week after application, followed by the NPK treatment with mean number of leaves of 14.00±3.68 recorded in the 6th week after application. The least mean value of zero was observed at all levels of application in Urea treatment. Results indicated significant difference in height parameter which showed increase through the study period, with the 6 g level having the highest value. Effect of the varying levels of organic and inorganic fertilizers on the mean girth of *Tamarindus indica* seedlings is shown in Table 3. Highest mean girth of 0.37±0.03cm was observed with 9 g dosage of organic manure treatment in the 6th week after application, followed by the NPK treatment with mean girth of 0.35±0.05cm in 3 g dosage recorded in the 6th week after application. The least mean value of 0.00 was observed at all levels of application in Urea treatment.

Table 2. Effect of Varying Levels Organic and Inorganic fertilizers on the Mean Number of Leaves of *Tamarindus indica* Seedlings.

Treatment	Duration in weeks	Levels of Fertilizers		
		3 g	**6 g**	**9 g**
Control	-	8.20±1.14	8.20±1.14	8.20±1.14
NPK	2^{nd} BFA	5.20±2.20	3.40±0.52	3.80±0.63
	4^{th} AFA	7.30±2.26	6.00±0.00	5.50±0.71
	6^{th} AFA	12.40±2.72	0.00	0.00
	8^{th} AFA	14.00±3.68	0.00	0.00
	***P*-value**	**<0.001**	**<0.001**	**<0.001**
Organic	2^{nd} BFA	3.90±0.32	3.50±0.53	3.70±0.48
	4^{th} AFA	8.00±1.16	7.80±0.92	7.10±1.45
	6^{th} AFA	12.10±2.13	11.50±2.07	11.80±1.40
	8^{th} WAFA	19.30±4.03	19.20±4.49	16.80±4.29
	***P*-value**	**<0.001**	**<0.001**	**<0.001**
Urea	2^{nd} BFA	3.30±0.48	3.20±042	3.50±0.53
	4^{th} AFA	0.00	0.00	0.00
	6^{th} AFA	0.00	0.00	0.00
	8^{th} AFA	0.00	0.00	0.00
	***P*-value**	**<0.001**	**<0.001**	**<0.001**

Means on the same column with different superscripts are statistically significant (p<0.05)

Table 3: Effect of Varying Levels of Organic and Inorganic Fertilizers on the Mean Girth (cm) of *Tamarindus indica* Seedlings.

Treatment	Duration in weeks	Levels of Fertilizers		
		3 g	**6 g**	**9 g**
		Girth (cm)	**Girth (cm)**	**Girth (cm)**
Control	-	0.32±0.03 ^{a}	0.32±0.03 ^{a}	0.32±0.03 ^{b}
NPK	2^{nd} BFA	0.32±0.03 ^{a}	0.30±0.02 ^{a}	0.33±0.03 ^{b}
	4^{th} AFA	0.32±0.03 ^{a}	1.67±1.89 ^{b}	0.29±0.01 ^{a}
	6^{th} AFA	0.34±0.04 ^{a}	0.00	0.00
	8^{th} AFA	0.35±0.05 ^{a}	0.00	0.00
	***P*-value**	**0.086**	**<0.001**	**<0.001**
Organic	2^{nd} BFA	0.31±0.03 ^{a}	0.31±0.03 ^{a}	0.32±0.02 ^{a}
	4^{th} AFA	0.32±0.02 ^{a}	0.31±0.01 ^{a}	0.32±003 ^{a}
	6^{th} AFA	0.36±0.03 ^{a}	0.34±0.03 ^{a}	0.37±0.03 ^{a}
	8^{th} AFA	0.36±0.03 ^{a}	0.36±0.03 ^{a}	0.37±0.03 ^{a}
	***P*-value**	**0.999**	**0.990**	**0.099**
Urea	2^{nd} BFA	0.31±0.31 ^{a}	±0.34 ^{a}	±0.31 ^{a}
	4^{th} AFA	0.00	0.00	0.00
	6^{th} AFA	0.00	0.00	0.00
	8^{th} AFA	0.00	0.00	0.00
	***P*-value**	**<0.001**	**<0.001**	**<0.001**

Means on the same column with different superscripts are statistically significant (p<0.05

DISCUSSION

There were negative responses from Urea treatments and NPK doses on survival of *Tamarindus indica* seedlings Increase in fertilizer dose caused decrease in survival percentage *Tamarindus indica* seedlings. At Urea treatments, there was significantly lower survival rate (higher mortality rate) than NPK, while organic treatment had no significant effect on survival of *Tamarindus indica* seedlings

The greater height at 2 weeks was recorded in the organic fertilizer, followed by NPK fertilizer though not significantly different. However, after 6 weeks of application the response of organic manure was positive and Urea was negative. There was no significant difference ($p>0.05$) between heights. The performance of organic manure treatment was better than other treatments. When individual dose was examined, responses of organic manure (1:2:3 saw dust, poultry droppings and river sand) were found to be superior in comparison to other doses where various ratios of rice hull and saw dust were combined though the difference was not statistically significant (Ugese, 2010).

The seedlings in this experiment were not significantly different in their initial diameter (at the time of fertilizer application). NPK fertilizer have significant effect on diameter increment of *Tamarindus indica* seedlings and that after 6 weeks of application, there were no significant difference ($p<0.1$) on diameter growth among the doses.

There was significant difference ($p<0.1$) for leaf area among different treatments. The highest mean leaf number was found with organic manure while the lowest were found with Urea. There were no significant differences in the leaf number between the various doses.
The results of this study show that the application of organic fertilizers yielded better growth and seedlings quality. This is also in agreement with earlier reports of Rafiqul (2004) who recorded high performance in fertilizer application with *Anthocephalus chinensis.* The finding 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. Mukhtar (2016) also recorded high performance in organic application with *A. digitata*. Positive effect of fertilization were also reported by Offiong *et al*, (2010) who recorded high performance in both NPK and organic manure with *Tetrapleura tetraptera*. The application of little doses of fertilizer stimulates cell differentiation and multiplication leading to height increments (Afa *et al.,* 2011). Similar results have been reported for *Michelia champaca* L seedlings in which minimal doses of Phosphorus yielded positive effects on height increments (Hoque *et al*., 2004). High doses of phosphorus application may become toxic to seedlings since absorption of this element may affect regular metabolic processes.

CONCLUSION

Application of organic manure at various doses yielded better growth at the early stage of *Tamarindus indica* as compared to NPK and Urea fertilizers. Treatment with urea was toxic to the seedlings at the 3 g, 6 g and 9 g, levels of applications which led to the death of the seedlings. NPK applied at 6 g and 9 g were also toxic to the seedlings which also led to the high mortality rate in the treatment after application.

Recommendation

From the results obtained, it is therefore recommended that:

i. Organic manure (cow-dung) should be utilized for better plant nutrition and faster growth of *Tamarindus indica* seedlings.
ii. The application of inorganic fertilizers (NPK and Urea) above 3 g, can affect the growth of *Tamarindus indica* seedlings negatively hence proper application guidelines should be adhered to.

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