



## EFFECT OF NPK FERTILIZER ON GROWTH PERFORMANCE OF *TAMARINDUS INDICA* (LINN.) SEEDLINGS IN THE SUDAN SAVANNA OF NIGERIA

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**ABSTRACT:** The study was conducted at the nursery site of the Department of Forestry and Environment, Usmanu Danfodiyo University, Sokoto to evaluate the effect of fertilizer (NPK) application on growth performance of *Tamarindus indica* seedlings. Three levels of NPK fertilizer (0, 0.5, 1.0, and 1.5 g) and no fertilizer were used. All the treatments were set in a Randomized Complete Block Design (RCBD) with three replications. Data were analysed using Analysis of Variance (ANOVA), while Duncan Multiple Range Test was used separate means among the parameters measured. The result showed no significant ( $P > 0.05$ ) difference in stem height and collar diameter, number of leaflets and biomass compared to control. Data on growth parameters was taken at 3 weeks interval. *T. indica* applied with 1.5g of NPK fertilizer had significantly higher value (53.0) than the control. The biomass was determined at 15 weeks after harvesting the seedlings. It is evident from the results of this study that, *T. indica* seedlings responded to NPK fertilizer application. It is recommended that the nurserymen should be enlighten on the accurate dose of NPK fertilizer to be used on the growth performance since it enhances the use of it to determine growth performance.

**Key:** Growth, NPK fertilizer, Tamarind, Ecological zone, Assessment

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### 1.0 INTRODUCTION

A Fertilizer, by definition, is any material used to supply one or more of the essential plant nutrient elements (Bhuiyan *et al.* 2000). Fertilization is one of the most significant cultural practices in modern plant production. Application of NPK fertilizer enhances seedlings growth (Emrah *et al.*, 2010). Fertilizer markedly increases vegetative growth of the seedlings and application of fertilizer is a silvicultural practice in the raising of multipurpose tree species in the nursery bed (Yakubu *et al.* 2013). Davidson (2004) pointed out that, fertilizer application plays an active role in increasing growth of *Parkia bicolor*, *Eucalyptus* species as well as *Tamarindus indica* at seedling stage. Inorganic fertilizer does not need to decompose over time to supply nutrients to plants. NPK fertilizers contain balanced amounts of

Nitrogen, Phosphorous and Potassium to feed plants and to foster growth and also to evaluate equal application of nutrient to tree legumes (Nader, *et al.*, 2014).

The NPK Fertilizer is the most important and costly input to enhance seedlings growth. Most savanna soils are poor in terms of fertility (Sabo, *et al.*, 2013). Multipurpose trees respond positively to fertilizer application, the dose depends on the soil type, climate and system of planting (Sabo, *et al.*, 2013). The NPK Fertilizer gave the soil equal amount of Nitrogen, Phosphorus and Potassium and this will enable us to evaluate equal application of nutrient and their functions to legume trees or shrubs (Al-Menaic, *et al.*, 2012). Deficiency of N, P and K is a major production constraint in savanna soils, which have inherent constraints like P- fixation, rapid hydraulic conductivity, faster infiltration rate, leaching of basic

cations. Thus, the crop cultivating in savanna soils requires large quantity of nutrients to support its growth and yield (Bayala, *et al.*, 2006). The major nutrients required by crops are Nitrogen (N), Phosphorus (P) and Potassium (K). Inadequate supply of any of these nutrients during crop growth is known to have negative impact on the reproductive capability, growth and yield of the plant Nafiu, *et al.* (2011).

*Tamarindus indica* belongs to the family *Fabaceae* and subfamily *Caesalpinioideae* with a common name Tamarind, in the Kingdom Plantae (Muhammad and Amusa, 2003). The seeds have a high forage value, it is a tree that provides good firewood and produces excellent charcoal (Ajiboye 2010). It is a multipurpose tree that is resistant to drought and have specific uses. It is used for medicinal, shelter, food, as well as wind break purpose. The tree is native to tropical Africa; and it grows wild throughout the Sudan and was introduced to India where it later became naturalized. The name “indica” also perpetuates the illusion of Indian origin. *Tamarindus indica* grows well over a wide range of soil and climatic conditions, occurring in low altitude woodland, savanna and bush (Baker *et al.*, 2003). According to Teklehaimanot (2004), *T. indica* prefers semi-arid areas and wooded grassland and can also be found along streams and riverbanks.

The problem of knowledge on how to use fertilizer rate must be addressed if production of these important resources is to be realized. Cultivation of trees in savanna environment is done on poor nutrient soils and the cost of reconditioning such soils cannot be afforded by poor resources farmers in the area. Taiwo *et al.* (2004) revealed that, only 4% of the nurserymen use NPK and 73% of them rely on NP fertilization.

Savanna soils are poor in terms of fertility (Bayala *et al.*, 2006). The best way of preventing soils from becoming poor is to put back into it what plants have taken out and this can be achieved by the use of inorganic fertilizer (Maharazu *et al.*, 2013). Nafiu *et al.* (2011) reported that, the major nutrients required by the seedlings are Nitrogen (N), Phosphorous (P) and Potassium (K). Inadequate supply of any of these nutrients during growth is known to have negative impact on the seedlings growth. To ensure conservation and sustainable use of these important natural resources, studies are needed on the effective and efficient regeneration methods beginning from the nursery to the field. This research examined the fertilizer rate for effective growth of *T. indica* seedlings and to undertake the required quantity of chemical fertilizer NPK 15: 15:15 that can maximize growth, biomass production and much more importantly, in north-western, Nigeria. The aim of this study is to examine the effect of NPK fertilizer on growth

performance of *Tamarindus indica* seedlings in the Sudan Savanna Environment of Nigeria, assess the growth performance of seedlings of *Tamarindus indica* as influenced by fertilizer rates and determine Biomass of the study species as influenced by NPK fertilizer.

## 2.0 MATERIALS AND METHODS

### 2.1 Experimental Site

Experiment was carried out in the central nursery of the Forestry and Environment Department main Campus of Usmanu Danfodiyo University Sokoto, Sokoto State, Nigeria. Sokoto is located in Sudan Savanna region between latitude 11° 30' to 13° – 50'N and longitude 4° to 6°E (Mamman, 1993). The weather is generally hot and dry with short rainy season between June and September. The mean annual rainfall is between 400 and 450 mm in the North and between 600 mm and 750 mm in the South. Temperature ranges between 28°C and 42°C (Bello, *et al.*, 2013). It has an average elevation of about 200-300m above sea level and its vegetation consists of shrubs, trees, forbs and grasses (Isah, 2007).

### 2.2 Seed Collection

The seeds of *Tamarindus indica* were collected from the stand of good mother tree which was close to Batsari local Government secretariat, Katsina State of Nigeria.

#### 2.2.1 Viability test

Seeds viability test was carried out by using floatation method. The seeds that floated on water were regarded as unviable, and those seeds that remained at the bottom of water for 24 hours, not all of them were viable, but those whose coat became slimy and burst on applying pressure when held between thumb and index finger were considered as unviable, but the viable seeds were pure as before pouring into the water.

#### 2.2.2 Seeds Pre – treatment

The seeds were soaked in boiled water at 100°C which was immediately removed from the heat source and left to cool gradually with the seeds for 24 hours to break their dormancy (Falemera, *et al.*, 2013; Bello and Zubairu, 2015).

### 2.3 Field Experimental Procedures

Three seedling beds sizes of seedling densities of 120, 80 and 56 (1m<sup>2</sup>) were used. The seeds were sown by direct sowing using dibbler (Dibbling). Four levels of NPK (15: 15: 15) fertilizer (0, 0.5, 1.0 and 1.5g) and no NPK were used. All treatments were set in a Randomized Complete

Block Design (RCBD) with three replications. There were 24 sample sizes. Four seedlings per bed were randomly sampled by flipping dice and average for Stem Height, Collar Diameter, Number of Leaflets and Biomass only. Fertilizer was applied by band placement when the seedlings were 6 cm in height. Collar diameter, Stem Height, Leaflets number and Biomass were obtained from four selected seedlings and average per bed. The germination beds were fully watered to maintain the moisture content of the soils to field capacity. Manual weeding was done regularly throughout the period of the research. Stem Height, Collar Diameter, and Leaflets number were taken at three weeks interval for a period of 18 weeks. At the end of 18 weeks, biomass was determined, and the experiments terminated.

### Experimental Layouts

Control (0)	NPK (0.5g)	1 NPK 2 (1.0g)	NPK 3 (1.5g)
0	NPK 1	NPK 2	NPK 3
0	NPK 1	NPK 2	NPK 3
0	NPK 1	NPK 2	NPK 3

NPK= Nitrogen, Phosphorous and Potassium, 0 = No fertilizer, g = gram

### 2.4 Data Collection

Data on the following Variables were taken after 65-95% germination and fertilizer applied, as described thus:

- i. Collar Diameter (mm) the diameter of each sampled seedling was measured at the root collar with the aid of Veneer caliper.
- ii. Stem Height (cm) the height of each seedling was measured from the surface of the soil to the tip of the leaf using meter ruler.
- iii. Number of Leaflets: Physical count.

### 2.5 Data Analysis

The data collected were subjected to ANOVA to test the significant difference of NPK fertilizer on the growth performance of *T. indica* seedlings. Means that do not carry superscript letters in the same column are not significantly different at 0.05 level using Duncan Multiple Range Tests

### 2.4 Biomass Assessment

Seedlings Biomass was determined by destructive method, all roots materials were extracted from the soil, and all soil removed from the roots and weighed with

spring scale/electrical weighing balance. The weight was taken and expressed in g/seedling for both fresh and dry. The above ground Plant tissue and below ground roots were placed in an envelope in a hot air oven set at 70 - 80°C until the whole mass attained a constant weight (SERAS, 1994; Hasanuzzaman, 2013). The tissue was dried for 24 hours and reweighed (dry weight) (SERAS, 1994).

The tissue was weighed at 4 to 8-hour intervals, replacing the material in the oven between weighed, until no more water weight was lost (i.e., to a constant weight). It is important not to allow the samples to decay before drying (SERAS, 1994; Hasanuzzaman, 2013).

### Calculation

Water Content = Fresh Weight – Dry Weight

Standing Biomass = Dry Weight (of above ground tissues) / Plot area (SERAS, 1994).

## 3.0 RESULTS AND DISCUSSION

### 3.1 Stem Height

The results in (Table 1) below found out that, there was no significant ( $p > 0.05$ ) difference at 3 WAG, but significantly ( $P < 0.05$ ) different at 6, 9, 12 and 15 WAG on NPK fertilizer on the growth performance of *T. indica* seedlings on stem height. The result of the study showed that, growth and biomass production can be enhanced by the application of fertilizer (NPK). Stem height was found to increase significantly with increasing level of NPK fertilizer (up to 1.0g per seedling) at 9 WAS. Similarly, the result of this research revealed that, NPK fertilizer at 1.0g and 1.5g, increased stem height with increment of 5 - 13cm at three weeks interval of these tree species which is close to the finding of Daldoum and Ghassan (2014) who found out that, NPK fertilizer increase shoot height growth to *Azadirachta indica*, *Albezia lebbeck* as well as *Khaya senegalensis* with increment of 8.5 cm per month. The application of NPK fertilizer to the study species provided a great enhancement and increase in stem height, this is because the fertilizer was applied by side banding placement. This concurred with the findings of Nafiu *et al.* (2011) that showed a significant enhancement in stem height with increase fertilizer application under varying level of NPK 15: 15: 15 evaluated in both pot and field trials.

Table 1: Effect of NPK Fertilizer on Stem Height (cm) of *T. indica*

Treatments	Weeks after germination				
	3	6	9	12	15
NPK (g)					
0	7.50	10.20 <sup>b</sup>	17.60 <sup>b</sup>	25.97 <sup>b</sup>	32.00 <sup>c</sup>
0.5g	8.33	10.80 <sup>b</sup>	17.60 <sup>b</sup>	28.50 <sup>b</sup>	41.33 <sup>bc</sup>
1.0g	9.30	16.33 <sup>a</sup>	24.87 <sup>a</sup>	38.00 <sup>a</sup>	49.00 <sup>ab</sup>
1.5g	8.30	14.13 <sup>a</sup>	27.20 <sup>a</sup>	40.30 <sup>a</sup>	53.80 <sup>a</sup>
SEM	0.40	0.85	1.41	1.97	2.90
Interaction	NS	NS	NS	NS	NS

Means that do not carry superscript letters in the same column are not significantly different at 0.05 level using Duncan Multiple Range Tests

SEM = Sum of error mean, NS = No significant difference, 0 = No fertilizer, g= grams

### 3.2 Collar Diameter

From The results obtained, it has showed that there is no significant difference ( $P>0.05$ ), NPK fertilizer rates were significantly ( $P<0.05$ ) different between them. It implies that the changes vary based on the treatment applied and the rate. This is in line with Zubairu (2014) who reported that, increase in stem height, Collar diameter and number of leaves of *Acacia senegal* was due to the rate of NPK fertilizer applied to the seedlings. The seedlings of *Tamarindus indica* when applied with 1.5g of NPK produced 53.80cm and collar diameter 5.33mm. This is in accordance with the findings of Ahmed *et al.* (2007) that, different levels of nitrogen were found to be highly significant in the growth of *Beta vulgaris* and the collar diameter of *A. Senegal* treated with 5g NPK was significantly higher. Healthy seedlings were observed which were grown efficiently on field to form larger one. Nader, *et al.* (2014) Observed that, fertilization in the nursery provide opportunity to produce larger seedlings that have high potential.

Table 2: Effect of NPK Fertilizer on Collar Diameter (mm) of *T. indica*

Treatments	Weeks after germination				
	3	6	9	12	15
NPK (g)					
0	1.40 <sup>b</sup>	1.90 <sup>c</sup>	2.53 <sup>c</sup>	2.80 <sup>c</sup>	3.23 <sup>c</sup>
0.5g	1.33 <sup>b</sup>	2.43 <sup>b</sup>	3.07 <sup>b</sup>	3.63 <sup>b</sup>	4.43 <sup>b</sup>
1.0g	1.93 <sup>a</sup>	2.77 <sup>ab</sup>	3.33 <sup>ab</sup>	4.00 <sup>ab</sup>	4.57 <sup>b</sup>
1.5g	2.27 <sup>a</sup>	3.13 <sup>a</sup>	3.77 <sup>a</sup>	4.40 <sup>a</sup>	5.33 <sup>a</sup>
SEM	0.13	0.15	0.14	0.19	0.24
Interaction	NS	NS	NS	NS	NS

Means that do not carry superscript letters in the same column are not significantly different at 0.05 level using Duncan Multiple Range Tests

### 3.3 Number of Leaflets

The result (Table 3) showed that, there was no significant difference ( $P>0.05$ ), NPK had no significant ( $P>0.05$ ) effect on the number of leaflets at 3 WAG. The result showed that application of 1.5g of NPK to *Tamarindus indica* gave highest number of leaflets across 15 WAG (105.33) with a lowest value of (45.00). Similarly, the rates were better than the control. From the result of the study, it implies that application of NPK fertilizer to *T. indica* seedlings makes it to grow faster, this is almost related to the finding of Hussein and Abohassan (2010) whom expressed that, NPK fertilizer increase plant height, number of leaves, diameter growth as well as number of branches. These come-across with the findings of Emrah *et al.* (2010) NPK fertilizer had a large and positive effect on stem height and the increase of leaves number.

Table 3: Effect of NPK Fertilizer on Number of Leaflets of *T. indica*

Treatments	Weeks after germination				
	3	6	9	12	15
NPK(g)					
0	3.67	12.33 <sup>b</sup>	22.00 <sup>b</sup>	31.00 <sup>b</sup>	45.00 <sup>b</sup>
0.5g	4.67	19.33 <sup>ab</sup>	35.33 <sup>ab</sup>	48.33 <sup>ab</sup>	64.67 <sup>ab</sup>
1.0g	3.67	18.67 <sup>ab</sup>	32.33 <sup>ab</sup>	50.33 <sup>ab</sup>	73.33 <sup>ab</sup>
1.5g	4.33	25.00 <sup>a</sup>	44.00 <sup>a</sup>	73.33 <sup>a</sup>	105.33 <sup>a</sup>
SEM	0.28	1.71	3.03	5.81	8.39
Interaction	NS	NS	NS	NS	NS

Means that do not carry superscript letters in the same column are not significantly different at 0.05 level using Duncan Multiple Range Tests

### 3.4 Biomass

Table 4, indicated the effect of NPK fertilizer on biomass. The results revealed that, there was no significant ( $P>0.05$ ) difference with respect to biomass. However, NPK fertilizer was significantly ( $P<0.05$ ) different among the treatments on *T. indica* seedlings. But there was significantly ( $P<0.05$ ) different on the rates of fertilizer applied. The results agreed with the findings of Upadhyaya and Thupan (2014) who showed that, NPK fertilizer application had negative response on the growth attributes and biomass production of *P. timoriana* at 1.0g, but stimulate growth and biomass of *T. indica* seedling compare to control.

Table 4: Effect of NPK Fertilizer on Biomass of *T. indica* seedlings at 15 weeks

Treatments	Biomass (WC)	Biomass (SB)
NPK (g)		
0	6.80 <sup>b</sup>	0.28
0.5g	9.73 <sup>ab</sup>	0.47
1.0g	14.20 <sup>a</sup>	0.95
1.5g	16.16 <sup>a</sup>	0.85
SEM	1.37	0.01
Interaction	NS	NS

Means that do not carry superscript letters in the same column are not significantly different at 0.05 level using Duncan Multiple Range Tests

#### 4.0 CONCLUSION

It was evident from this research that *T. indica* seedlings responded to NPK fertilizer application. 1.0g and 1.5g of NPK were found to be most effective in seedlings production. It could be recommended that the application of NPK fertilizer at 1.5g in *T. indica* per seedlings on the seedbed enhanced better performance on the seedling's height and collar diameter. It is therefore recommended that these levels should be extended to our nurserymen, farmers as well as researchers in other to minimize the persistent high mortality rate experienced over the years of seedlings on nursery beds and on the farmland in the Sudan Savanna region of Nigeria.

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