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Effect of varying levels of fertilizer and organic manure on growth of Khaya senegalensis seedlings in Benue State, North Central Nigeria

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Abstract

African mahogany (K. senegalensis) is one of the most important timber species in the international timber market. It has diverse applications in human and livestock traditional medicine. Also because of its straight grain, high calorific value and canopy structure it is also widely used for housing construction, fuelwood and environmental protection. There is high a demand for the species in the study area and the production capacity of the species is very low. At present there is inadequate information on the right fertilizer type and the amount needed to raise the tree species. This study sets out to assess the early growth potentials of the tree species by varying the levels of fertilizer applied to Khaya senegalensis seedlings. K. senegalensis seeds were collected from three zones in Benue state, namely: zones A (Vandeikya), B (Makurdi) and C (Oju). The seeds were planted in plastic pots and given different treatments; the experiment was laid out in a 3 x 4 x 5 factorial design. Treatment A (topsoil and poultry manure), B (topsoil and cow dung), C (topsoil and NPK 15:15:15 fertilizer) and treatment D topsoil (control). Treatments were applied at five levels (5g, 10g, 15g, 20g and 25g) of fertilizer type. Each treatment consisted of 20 experimental pots replicated three times giving a total of 180 replicates. Treatments were applied after germination was assessed. Seedling parameters measured included; seedling height (cm), collar diameter (cm), leaf area (cm^2) as well as the leaf count. Data collected were subjected to descriptive statistics and two-way analysis of variance. Results on seedlings treated with poultry manure had the highest mean height of 20.76cm in zone B (Makurdi) at level four of 20g of poultry manure application per seedling. Seedlings treated with poultry manure also had the highest mean collar diameter in level four (4) at 20g poultry dung manure/seedling while the least collar diameter was recorded in level one (1) at 5g poultry manure/seedling. The highest mean number of leaves (16.56±0.95) was recorded in week 12 in zone C (Oju) in seedlings treated with poultry dropping. The result showed significant differences ($p<0.5$) in the leaf count between week 2 to week 12. Results on leaf area showed that seedlings treated with Poultry manure recorded the highest mean leaf area (68.8cm^2) in zone B. Khaya senegalensis can be best grown for successful plantation establishment with the application of poultry manure at the rate of 20g per seedling.

Keywords: *Khaya. senegalensis,* seedlings growth, organic manure and NPK fertilizer.

Introduction

In Nigeria, *Khaya senegalensis* is called *Madachi, Oganwa, Ono* and *Haa* in Hausa, Yoruba, Igbo and Tiv languages, respectively. It is an evergreen Savanna hard wood tree species, with a crown of dark shining pinnate leaves that bear round capsules[1]. The species is regenerated mainly naturally, while its plantations are a rare occurrence in savanna areas where it abundantly thrives on fertile soils with minimum competition from herbs. During early years of its growth, the seedlings tolerate light shade. Focho *et al.,* reported that if seedlings of this species are to grow efficiently and healthy, they have to be supplied with adequate and balanced nutrient stock. Enhancement of soil fertility is key to the production of high quality seedlings required for plantation establishment[2]. Different tree species vary in their requirement for particular nutrient elements for growth and completion of their reproductive cycles Nutrient requirements of tree species raised in nurseries located at different sites also vary since site chemical and physical conditions are not the same[3]. Robertson *et al.,* reported that seeds of *K. senegalensis* are often attacked by insects while they are still on the tree[4].

K. senegalensis is a forest tree species of high economic significance in Africa. It is utilized in making high quality furniture, construction, and is a preferred timber species where high surface quality is desired. The above-and below-ground parts of the plant are of immense use in human and livestock traditional medicine. There is generally little use of organic manure, especially poultry manure even though it is common nationwide owing to the growing poultry enterprise and the knowledge on their effects on plants for efficient utilization.
Adequate supply of mineral elements is of importance in the tropics where the soil is poorly formed and continuous cropping is on the increase. For any sustainable plant production, soil fertility amelioration is essential.

The high demand for this plant's products in its natural habitat has led to unrestrained exploitation; thus unsustainably depleting its population and altering its natural distribution. The natural production capacity of the species is seemingly low and therefore not likely to meet the ever growing demand for human use. This study was therefore conceived to determine the type and level of organic and inorganic fertilizer (NPK, 15:15:15) that could be a better option for the growth of *K. senegalensis* seedlings for plantation establishment.

Materials and methods

The study area: This research was undertaken at the Forestry Nursery of the Department of Forestry, Wildlife and Range Management, University of Agriculture Makurdi, Nigeria. Benue State is located between Longitude 8°21' and 9°E and Latitude 7°21' and 8°N within the Southern Guinea Savanna ecological zone. The area is characterized by a tropical sub-humid climate with high temperatures and high relative humidity. Temperatures reach a maximum of 35^0C while the minimum temperature is 23^0C[5].

The climate experiences two distinct seasons viz; wet and dry seasons with annual rainfall ranging from 1200mm-1500mm. The vegetation of the area is typically Guinea Savanna. Benue State is bordered to the south by Enugu and Cross River States, to the East by Taraba State, North by Nasarawa State and West by Kogi State. The major tribes found in Benue State are *Tiv*, *Idoma* and *Igede.* Their predominant occupations are farming, fishing, trading and hunting;

Experimental Design: The experimental design for the research was laid out in a 3 x 4 x 5 factorial design with four (4) treatments: treatment A (poultry manure), B (cow dung), C (NPK fertilizer 15:15:15) and treatment D (control)[6]. The experiment was conducted in plastic pots containing 1kg of soil each. Treatments were applied at five different levels; level 1 (5g) of either organic or inorganic fertilizer), level 2 (10g), level 3 (15g), level 4 (20g) and level 5 (25g).

Seeds used for the study were collected from three zones in Benue state namely: Zone A (Vandeikya), Zone B (Makurdi) and Zone C (Oju) from mature mother tree of superior phenotypic traits. Two seeds were sown in plastic pot and later thinned to one stand per pot after germination[7]. Between 10 to 14 days seed germination commenced and terminated. One hundred and eighty seeds (180) from each zone were sown in plastic pots perforated at the base to facilitate drainage; given a total of six hundred and thirty (630) seeds. Treatments were applied four weeks after germination was assessed. Samples without fertilization served as the control.

Top soil used for this work was obtained from the Forestry Nursery, University of Agriculture, Makurdi while cow dung and poultry manure were also collected at the Poultry and Livestock Farm, University of Agriculture Makurdi.

Data collection: Two seedlings were randomly selected from each level in each treatment Seedling height (cm), collar diameter (cm), leaf area (cm^2), and leaf count were measured. Seedling fresh and dry weights were determined at the terminal stage of the research work. Seedling height was taken from the collar region to the apical bud of the seedlings using a meter rule. Collar diameter was measured using a veneer caliper. Numbers of leaves were determined by manually counting the number of leaves on the seedlings. Leaf area was measured by tracing three (3) leaves of seedling on a graduated graph sheet. Five seedlings from each treatment were selected and leaf area assessed fortnightly[8]. The fresh and dry weights of the seedlings were assessed using an electronic weighing scale. The dry weights were taken after 48 hours of oven drying to constant weight at a temperature of 60°C as outlined by William *et al.*[9]. Three seedlings from each treatment were randomly selected and carefully removed from the growing medium to determine their mean dry weight (g)[10].

Data analysis: Data collected on seedling heights, leaf count, collar diameter, leaf area, fresh and dry weights were analysed using percentages, mean and standard deviation. Inferential statistics (two-way analysis of variance (ANOVA)) was adopted using the Minitab 17th Edition. Where significant differences occurred between the treatments means, the Fisher's least significant difference (LSD) method was used to separate the means[5,8-10].

Results and discussion

Table-1 shows the effect of varying levels of fertilizer application on *K. senegalensis seedlings.* in three (3) zones. Seedlings treated with poultry manure (TP) in level four (4) had the highest mean height at 20g/seedling in zone B while the least mean height was recorded in level four (4) with 10g (TP) in zone C. Treatment with cow dung manure (TC) in level four (4) recorded the highest mean height at 20g/seedling of cow dung manure application in zone B while the least mean height was recorded in level one (1) with 5g of cow dung application in zone C. Treatment with NPK 15:15:15 fertilizer (TF) followed the same trend with the highest mean height being recorded in level two (2) for seedling from zone B at 10g/seedling and the least seedling height was recorded in level three (3) at 15g/seedling in zone C.

The Analysis of Variance (ANOVA) on the effect of *K. senegalensis* at varying levels of fertilizer application was tested at p=0.05 to see if there were significant differences between the levels of fertilizer application. The results showed significant difference ($P < 0.04$ and $P < 0.01$) for zones A and B, respectively. However, for zone C, there were no significant differences ($P > 0.37$) within the varying levels of poultry manure fertilizer application (TP). A similar result was obtained for NPK 15:15:15 fertilizer; there were significant differences within zones A and B (at $P < 0.04$ and $P<0.04$). Zone C showed no significant differences in seedling mean height ($P >0.77$). For

cow dung (TC) there were no significant differences (P > 0.84 and P >0.12) within zone A and C respectively, but in zone B there were significant differences (P<0.04).

Table-2 shows the comparative mean height growth of *Khaya senegalensis* seedlings from three zones. In zone B (Makurdi), seedlings treated with poultry manure (TP) had the highest mean height of 20.76cm while the least mean height of 8.41cm was recorded in zone C (Oju). Seedling applied cow dung manure (TC) recorded the highest mean height of 19.09cm in zone B while the least mean height (7.44cm) was recorded in zone C. Seedlings treatment with NPK 15:15:15 fertilizer (TF) followed the same trend with the highest mean height of 15.31cm being recorded for seedlings in zone B and the least seedlings mean height (7.50cm) was recorded in zone C (Oju).

At p<0.01 level of significance differences were tested on the mean height growth of *Khaya senegalensis* seedlings in the three zone. The results indicated significant difference (P < 0.01) between zones A, B and C, respectively. Seedlings mean height growth in zone A and B had no significant differences at levels, but differed significantly from zone C.

There were significant differences in seedlings mean height growth in zone A and B. Treatment with cow dung showed no significant difference in seedling height for zone A and B at 5g and 15g level. NPK (15:15:15) fertilizer did not yield significant differences in seedlings mean height between zone A (Vandeikya) and B (Makurdi).

Table-1: Effect of Varying Levels of Fertilizer treatments on Mean Height Growth of *K. senegalensis* Seedlings by location in Benue State, Nigeria.

Treatments	Fertilizer Level or Dosage	Mean height of seedlings by treatment, and zone (cm)		
		Zone A	Zone B	Zone C
Control	0g	13.07±0.63^{a}	15.25±0.67^{c}	14.05±0.60^{b}
Poultry manure (TP)	L 1 = 5g	14.43±0.82^{ab}	15.92±0.99^{bc}	9.41±0.81^{a}
	L 2 = 10g	14.16±0.94^{ab}	17.06±0.99^{b}	8.41±0.75^{a}
	L 3 = 15g	16.14±0.81^{a}	15.05±0.87^{c}	9.16±0.66^{a}
	L 4 = 20g	14.79±0.81^{ab}	20.76±1.09^{a}	10.52±0.81^{a}
	L5 = 25g	13.10±0.74^{b}	18.39±1.16^{ab}	10.00±0.83^{a}
	P-Value	*0.04*	*0.01*	*0.37^{ns}*
Cow dung (TC)	L 1 = 5g	15.01±0.79	17.72±1.01^{ab}	7.44±0.61^{a}
	L 2 = 10g	13.59±1.05	15.84±0.80^{b}	9.58±0.57^{a}
	L 3 = 15g	14.42±0.71	16.43±1.14^{ab}	9.58±0.63^{a}
	L 4 = 20g	14.55±0.73	19.09±1.30^{a}	8.69±0.73^{a}
	L 5 = 25g	14.45±0.93	18.34±1.14^{ab}	8.63±0.68^{a}
	P-Value	*0.83^{ns}*	*0.04*	*0.12^{ns}*
NPK Fertilizer 15:15:15 (TF)	L 1 = 5g	12.52±0..69^{ab}	14.25±1.03^{a}	7.63±0.50^{a}
	L 2 = 10g	13.41±0.72^{a}	15.31±1.21^{a}	7.91±0.65^{a}
	L3 = 15g	13.12±0.91^{a}	13.65±0.88^{ab}	7.50±0.59^{a}
	L 4 = 20g	10.12±0.98^{b}	14.81±0.89^{a}	8.80±0.96^{a}
	L 5 = 25g	12.00±1.07^{ab}	10.45±0.75^{b}	8.11±0.80^{a}
	P-Value	*0.04*	*0.04*	*0.77^{ns}*

Means on the same Column (within zone) with different superscript are significantly different (p<0.05), ns = not significant. Where: TP= Poultry manure; TC= Cow dung and TF= NPK fertilizer (15:15:15).

Table-2: Comparative Mean Height Growth of *Khaya. senegalensis* Seedlings by treatment and location in Benue State, Nigeria.

Treatments	Fertilizer Level or Dosage	Mean height of seedlings by treatment, dosage and zone (cm)			P-value
		Zone A	Zone B	Zone C	
Control	0.00g	13.07±0.63^{a}	15.25±0.67^{b}	14.05±0.60^{ab}	*<0.01*
Poultry manure (TP)	L 1 = 5g	14.43±0.82^{a}	15.92±0.99^{a}	9.41±0.81^{b}	*<0.01*
	L 2 =10g	14.16±0.94^{b}	17.06±0.99^{a}	8.41±0.75^{c}	*<0.01*
	L 3 =15g	16.14±0.81^{a}	15.05±0.87^{a}	9.16±0.66^{b}	*<0.01*
	L 4= 20g	14.79±0.81^{b}	20.76±1.09^{a}	10.52±0.81^{c}	*<0.01*
	L 5 = 25g	13.10±0.74^{b}	18.39±1.16^{a}	10.00±0.83^{c}	*<0.01*
Cow dung (TC)	L 1 = 5g	15.01±0.79^{b}	17.72±1.01^{a}	7.44±0.61^{c}	*<0.01*
	L 2 = 10g	13.59±1.05^{a}	15.84±0.80^{a}	9.58±0.57^{b}	*<0.01*
	L 3 = 15g	14.42±0.71^{a}	16.43±1.14^{a}	9.58±0.63^{b}	*<0.01*
	L 4 = 20g	14.55±0.73^{b}	19.09±1.30^{a}	8.69±0.73^{c}	*<0.01*
	L 5 = 25g	14.45±0.93^{b}	18.34±1.14^{a}	8.63±0.68^{c}	*<0.01*
NPK fertilizer 15:15:15(TF)	L 1= 5g	12.52±0..69^{a}	14.25±1.03^{a}	7.63±0.50^{b}	*<0.01*
	L 2 = 10g	13.41±0.72^{a}	15.31±1.21^{a}	7.91±0.65^{b}	*<0.01*
	L 3 = 15g	13.12±0.91^{a}	13.65±0.88^{a}	7.50±0.59^{b}	*<0.01*
	L 4 = 20g	10.12±0.98^{b}	14.81±0.89^{a}	8.80±0.96^{b}	*<0.01*
	L 5 = 25g	12.00±1.07^{a}	10.45±0.75^{ab}	8.11±0.80^{b}	*0.01*

Means on the same row (across zones) with different superscript are significantly different ($p<0.05$), ns = not significant.

Table-3 shows the mean collar diameter (mm) of *Khaya senegalensis* at varying levels of fertilizer application from the three (3) zones. Seedling treated with poultry manure had the highest mean collar diameter in level four (4) at 20g poultry manure/seedling while the least collar diameter was recorded in level one (1) at 5g poultry manure/seedling. Cow dung manure also gave the highest mean collar diameter in level three (3) at 15g cow dung/seedling while the least mean collar diameter was recorded in level two (2) at 10g cow dung/seedling. NPK (15:15:15) fertilizer followed the same trend with the highest mean collar diameter recorded in level two (2) at 10g NKP 15:15:15 fertilizer/seedling and the least mean collar diameter was recorded in level four (4) at 20g NPK 15:15:15 fertilizer/seedling.

The Analysis of Variance on the collar diameter of *Khaya senegalensis* at varying levels of fertilizer application was tested at $p<0.05$ to see if there were significant differences between the dosage or levels of fertilizer application. The test results showed no significant difference ($P > 0.05$) on collar diameter within all the varying dosage or levels in each zone.

Table-4 shows the comparative mean collar diameter (mm) of *Khaya senegalensis* seedlings from the three (3) zones. Zone B (Makurdi), seedlings treated with poultry manure had the highest mean collar diameter (4.12 mm). The least mean collar diameter (3.30 mm) was observed in zone A (Vandeikya). Cow dung manure yielded the highest mean collar diameter of (4.85 mm) in zone C (Oju) while the least mean collar diameter (3.20 mm) was recorded in zone A (Vandeikya). NPK (15:15:15) fertilizer followed the same trend with the highest mean collar diameter of (3.77mm) recorded in zone C (Oju) and the least mean collar diameter (2.67mm) was observed in zone A (Vandeikya). In zone B (Makurdi), control had the highest mean collar diameter of 4.80 mm while the least mean collar diameter (3.27mm) was observed in zone C (Oju).

At 0.05 significant differences were tested among the zones based on varying levels of fertilizer application. There was no significant difference (P >0.05) in the collar diameter for all the zones (A, B and C) respectively; except for the treatment with 10g cow dung/seedlings which indicated that cow dung and NPK (15:15:15) fertilizer showed significant difference in collar diameter (P <0.05) among the zones.

Table-5 shows the effect of fertilizer type on the mean number of leaves of *Khaya senegalensis* seedlings over a growing time limit of 2 to 12 weeks. The result revealed that there were significant differences (p<0.05) in keaf count between weeks 2 to week 12.

In weeks 4 and 8, there were no significant differences in control in zone B (Makurdi). The highest mean number of leaves (16.56±0.95) was recorded in week 12 in zone C (Oju) in seedlings treated with poultry dropping while the least mean number of leaves (3.76±0.34) was recorded in week 2 in zone A (Vandiekya) in seedlings treated with NPK 15:15:15 fertilizer.

Table-3: Effects of varying level of Fertilization on Collar Diameter of *K. senegalensis* Seedlings.

Treatments	Fertilizer Level or Dosage	Collar Diameter by fertilizer level by zone (mm)		
		Zone A (Vandeikya)	Zone B (Makurdi)	Zone C (Oju)
Control	0.00g	3.43±0.18	4.80±0.15	3.27±0.14
Poultry manure (TP)	L 1 = 5g	3.30±0.22^{a}	3.42±0.21^{a}	3.88±0.24^{a}
	L 2 = 10g	3.47±0.24^{a}	3.46±0.22^{a}	3.62±0.23^{a}
	L 3 = 15g	3.66±0.23^{a}	3.64±0.20^{a}	4.00±0.17^{a}
	L 4 = 20g	3.59±0.22^{a}	4.12±0.24^{a}	4.04±0.23^{a}
	L 5 = 25g	3.31±0.23^{a}	3.80±0.22^{a}	3.70±0.23^{a}
	P-Value	*0.75^{ns}*	*0.15^{ns3}*	*0.61^{ns}*
Cow dung (TC)	L 1 = 5g	3.52±0.22^{a}	3.76±0.17^{a}	3.46±0.18^{a}
	L 2 = 10g	3.20±0.23^{a}	3.82±0.23^{a}	3.96±0.21^{a}
	L 3 = 15g	3.40±0.22^{a}	3.66±0.24^{a}	4.85±0.14^{a}
	L 4 = 20g	3.58±0.23^{a}	3.89±0.26^{a}	3.77±0.25^{a}
	L 5 = 25g	3.43±0.23^{a}	3.97±0.26^{a}	4.01±0.28^{a}
	P-Value	*0.81^{ns}*	*0.90^{ns}*	*0.49^{ns}*
NPK fertilizer 15:15:15 (TF)	L 1 = 5g	3.17±0.19^{a}	3.28±0.18^{a}	3.45±0.22^{a}
	L 2 = 10g	3.08±0.18^{a}	3.40±0.22^{a}	3.77±0.25^{a}
	L 3 = 15g	3.16±0.19^{a}	3.23±0.20^{a}	3.48±0.21^{a}
	L 4 = 20g	2.67±0.23^{a}	3.35±0.19^{a}	3.55±0.20^{a}
	L 5 = 25g	3.08±0.25^{a}	2.92±0.24^{a}	3.09±0.23^{a}
	P-Value	*0.50^{ns}*	*0.68^{ns}*	*0.43^{ns}*

Means in the same Column (within zone) with different superscript are significantly different (p<0.05), ns = not significant.

Table-4: Comparative Mean Collar Diameter of *Khaya senegalensis* Seedlings from the three Zones.

Treatments	Fertilizer Level or Dosage	Collar Diameter in zones by fertilizer Level (mm)			P-value
		Zone A (Vandeikya)	Zone B (Makurdi)	Zone C (Oju)	
Control	-	3.43±0.18 [a]	4.80±0.15 [a]	3.27±0.14 [a]	
Poultry manure (TP)	L 1 = 5g	3.30±0.22 [a]	3.42±0.21 [a]	3.88±0.24 [a]	*0.16*^{ns}
	L 2 = 10g	3.47±0.24 [a]	3.46±0.22 [a]	3.62±0.23 [a]	*0.85*^{ns}
	L 3 = 15g	3.66±0.23 [a]	3.64±0.20 [a]	4.00±0.17 [a]	*0.39*^{ns}
	L 4 = 20g	3.59±0.22 [a]	4.12±0.24 [a]	4.04±0.23 [a]	*0.22*^{ns}
	L 5 = 25g	3.31±0.23 [a]	3.80±0.22 [a]	3.70±0.23 [a]	*0.27*^{ns}
Cow dung (TC)	L 1 = 5g	3.52±0.22 [a]	3.76±0.17 [a]	3.46±0.18 [a]	*0.53*^{ns}
	L 2 = 10g	3.20±0.23[b]	3.82±0.23[ab]	3.96±0.21[a]	*0.04*
	L 3 = 15g	3.40±0.22 [a]	3.66±0.24 [a]	4.85±0.14 [a]	*0.28*^{ns}
	L 4 = 20g	3.58±0.23 [a]	3.89±0.26 [a]	3.77±0.25 [a]	*0.14*^{ns}
	L 5 = 25g	3.43±0.23 [a]	3.97±0.26 [a]	4.01±0.28 [a]	*0.21*^{ns}
NPK fertilizer 15:15:15 (TF)	L 1 = 5g	3.17±0.19 [a]	3.28±0.18 [a]	3.45±0.22 [a]	*0.63*^{ns}
	L 2 = 10g	3.08±0.18[b]	3.40±0.22[ab]	3.77±0.25[a]	*0.04*
	L 3 = 15g	3.16±0.19 [a]	3.23±0.20 [a]	3.48±0.21 [a]	*0.51*^{ns}
	L 4 = 20g	2.67±0.23[b]	3.35±0.19[ab]	3.55±0.20[a]	*0.04*
	L 5 = 25g	3.08±0.25 [a]	2.92±0.24 [a]	3.09±0.23 [a]	*0.87*^{ns}

Means on the same row (across zones) with different superscript are statistically significant ($p<0.05$), ns = not significant.

Table-6 shows the effect of organic and inorganic fertilizer on the leaf area of *Khaya senegalensis* seedlings in the three studied zones. The result revealed that poultry manure (TP), NPK 15:15:15 fertilizer (TF) and Control had no significant effect on the leaf area of *Khya senegalensis* seedlings while cow dung (TC) had significant ($p=0.04$) effect on the leaf area of *K. senegalensis* seedling among the seed sources. Zone B (Makurdi) had the highest mean leaf area (50.48±4.32cm^2) due to application of cow dung followed by poultry manure which had a mean leaf area of 48.22±5.51cm^2 in zone C. NPK 15:15:15 fertilizer recorded a leaf area of 40.55±6.80cm^2. The least mean leaf area (25.32±5.17cm^2) was recorded in Control from zone A (Vandiekya).

Discussion: *K. senegalensis* seedlings grown on organic and inorganic fertilizer responded differently with regards to plant height ($p<0.05$). This result showed that the application of nutrients at different levels had significant effects (Table-1) on the seedlings height if seeds are sourced from zones A (Vandeikya) and B (Makurdi) (Table-2). This may be as a result of geographical location (provenance) that influenced the differences between the zones. NPK fertilizer application in the three zones (Table-2) recorded poor growth in seedlings height. This may be as a result of high doses of Phosphorus (P) application, since excess absorption of P can affect regular functioning of body organs. This showed that NPK had little or no positive effect on the mean height growth of *K. senegalensis* seedlings.

Seedlings treated with organic fertilizer had faster growth rate than plants treated with NPK fertilizer. This study agrees with the report of Seyedbagheri who recorded positive effect on vegetative growth of plant due to application of organic fertilizer[11]. Ajari *et al* asserted that poultry manure positively increase plant height more relative to other sources of manure[12]. Comparatively higher nitrogen concentration in poultry manure more significantly enhances the vegetative growth of plants. The results also revealed that there was probably some toxic effect on growing seedlings especially at higher concentrations of inorganic NPK 15:15:15 fertilizer application (at higher levels or dosage).

The higher the level of NPK 15:15:15 fertilizer application (20g and 25g) the higher the toxicity rate which resulted in the death of some seedlings. This result contradicted Focho *et al.* who recorded no toxic effect during their assessment[2].

Table-5: Effects of fertilizer type on the mean number of leaves of *Khaya senegalensis* seedlings over a period of 2-12 weeks.

Age of Seedling	Treatment	Leaf count by treatment by zone		
		Zone A (Vandeikya)	Zone B (Makurdi)	Zone C (Oju)
Week 2	Control	5.20±0.22^{a}	5.90±0.38^{a}	6.13±0.31^{a}
	TC	4.96±0.23^{a}	5.26±0.18^{ab}	4.96±0.21^{b}
	TF	3.76±0.34^{b}	4.30±0.32^{c}	3.10±0.32^{c}
	TP	5.00±0.19^{a}	4.93±0.18^{bc}	5.23±0.27^{b}
	P-Value	*<0.01*	*<0.01*	*<0.01*
Week 4	Control	8.13±0.49^{a}	10.63±0.61^{a}	10.06±0.46^{a}
	TC	5.93±0.26^{b}	6.46±0.15^{b}	6.13±0.23^{b}
	TF	4.76±0.47^{c}	5.33±0.44^{c}	4.73±0.47^{c}
	TP	6.70±0.19^{b}	6.20±0.22^{bc}	6.83±0.25^{b}
	P-Value	*<0.01*	*<0.01*	*<0.01*
Week 6	Control	5.20±0.22^{b}	5.90±0.38^{b}	6.13±0.31^{b}
	TC	7.46±0.26^{a}	7.50±0.26^{a}	7.56±0.30^{a}
	TF	5.53±0.55^{b}	6.16±0.51^{b}	5.46±0.58^{b}
	TP	7.70±0.14^{a}	7.23±0.27^{a}	7.83±0.31^{a}
	P-Value	*<0.01*	*<0.01*	*<0.01*
Week 8	Control	8.13±0.49^{ab}	10.63±0.61^{a}	10.06±0.46^{a}
	TC	8.43±0.31^{a}	9.23±0.41^{ab}	9.36±0.42^{a}
	TF	6.86±0.64^{b}	7.93±0.62^{b}	6.70±0.67^{b}
	TP	8.83±0.25^{a}	8.96±0.33^{b}	9.26±0.46^{a}
	P-Value	*0.01*	*<0.01*	*<0.01*
Week 10	Control	5.20±0.22^{c}	5.90±0.38^{c}	6.13±0.31^{c}
	TC	10.80±0.46^{a}	11.56±0.51^{ab}	10.50±0.40^{a}
	TF	8.00±0.74^{b}	9.40±0.73^{b}	8.85±0.71^{b}
	TP	10.63±0.32^{a}	10.56±0.39^{a}	11.30±0.56^{a}
	P-Value	*<0.01*	*<0.01*	*<0.01*
Week 12	Control	8.13±0.49^{b}	10.63±0.61^{c}	10.06±0.46^{c}
	TC	13.56±0.56^{a}	16.00±0.79^{a}	14.20±0.84^{b}
	TF	9.43±0.91^{b}	11.73±1.03^{bc}	11.57±0.98^{c}
	TP	12.40±0.40^{a}	13.50±0.43^{b}	16.56±0.95^{a}
	P-Value	*<0.01*	*<0.01*	*<0.01*

Means on the same Column with different superscript are significant different ($p<0.05$), ns = not significant.

Table-6: Effect of Organic and Inorganic Fertilizer on Leaf Area of K. *senegalensis* Seedling from three Provenances (cm^2).

Treatments	Leaf Area in zones by fertilizer treatment by zone (cm^2)			P-Value
	Zone A (Vandeikyya)	Zone B (Makurdi)	Zone C (Oju)	
TP	38.73±6.12 ^{b}	41.17±6.68 ^{ab}	48.22±5.51 ^{a}	0.53^{ns}
TF	31.77±6.24 ^{b}	38.95±6.35 ^{ab}	40.55±6.80 ^{a}	0.60^{ns}
TC	32.10±5.85^{b}	50.48±4.32^{a}	39.97±5.44^{ab}	0.04*
Control	25.32±5.17 ^{b}	32.83±4.46 ^{a}	30.92±4.09 ^{ab}	0.50^{ns}

Means on the same row with different superscript are significantly significant ($p<0.05$); ns = not significant *Significant

Application of organic and inorganic NPK 15.15.15 fertilizer responded differently ($p<0.05$) with regard to collar diameter of *K. senegalensis* seedlings among the three zone (Table-3 and 4). Results show that varying levels of fertilizer by type did not significantly increase collar diameter of *K. senegalensis* seedlings (Table-3 and 4). This implies that there could be no need for varying levels of fertilizer when raising *K. senegalensis* seedlings in zone B (Makurdi). With higher level of fertilizer application during this experiment, it was observed that some seedlings were dying due to higher fertilizer dosage or toxicity. The result on the number of leaves agrees with the study of Roger who reported that organic fertilizer more gradually released available nutrients over a longer time unlike inorganic fertilizer which releases nutrients within a shorter period to seedlings[13]. The result on poultry manure which showed the highest mean number of leaves (Table-5) in Zone C (Oju) may be attributed to higher concentration of nitrogen in poultry droppings than in cow dung and inorganic manure. Cow dung manure may be inferior in terms of total nutrients content as compared to the poultry manure and this may probably be due to the differences in feed quality between the local cattle and intensively raised fowls, in addition to the differences in the nature of their metabolic characteristics[14]. Based on the treatments variation in leaf area of *K. senegalensis* seedlings, cow dung had the best mean leaf area ($p<0.05$) among the three zones (Table-6). The highest mean leaf area was recorded in seedlings treated with organic fertilizers. This could be inferred that organic manures further enhanced growth performance of the seedlings compared to the inorganic fertilizer (NPK 15:15:15). This research result agrees with the work of Ogunwale *et al* who asserted that the addition of organic matter content to the growth media resulting from organic manure application improved nutrient availability to the tree seedlings, especially in tropical soils that are generally low in soil organic matter[15]. Due to fast organic matter decomposition rates resulting from generally higher tropical temperatures.

Conclusion

This study revealed that all treatments applied were valuable sources of fertilizer for the growth of *K. senegalensis;* they had greatly improved growth performance of treated plants over the controls. Poultry manure demonstrated better growth attributes such as greater height and collar diameter than other source of manure. These results also attest that *K. senegalensis* can be best grown for successful plantation establishment with the application of poultry manure at the rate of twenty gram (20g) per seedling.

Recommendations: i. When raising *K. senegalensis* seedlings for plantation establishment, seed source should be considered as an important factor. Affecting germination and growth of seedlings. ii. Puultry dung is recommended as a rich source of nutrients for growing seedlings. iii. For successful *K. senegalensis* seedlings production, further research should be undertaken with lower rates of NPK 15:15:15 fertilizer application to minimize its toxic effects.

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