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INFLUENCE OF NPK FERTILIZER ON GROWTH AND NUTRIENT UPTAKE OF KENAF (*HIBISCUSS CANNABINUS* L.) IN SOUTH WESTERN NIGERIA

[1*]Olanipekun, S.O., [2]Togun, A.O. and [1]Adebayo, A.K.
[1]Institute of Agricultural Research and Training (IAR&T), Obafemi Awolowo University, Moor Plantation, Ibadan, Nigeria
[2]Department of Crop Protection and Environmental Biology, University of Ibadan, Nigeria
[*]Corresponding author**:** **Olanipekunsam@yahoo.com**

ABSTRACT: *A pot experiment and field trial was conducted in 2013 and 2014 respectively at Ibadan (07038'N, 03084'E 182m) Nigeria to determine the influence of NPK fertilizer applied at five different rates (0, 70, 100, 130, 160 kg/ha) on the growth and yield of kenaf in a randomized complete block design with three replications. Our data showed that highest plant height, fibre and seed yields, and macro and micro nutrient uptakes were obtained in pots and plots fertilized with 130 kg/ha but not significantly different from those with 100 kg/ha. Hence, 100 kg/ha is recommended for kenaf cultivation in Southwest Nigeria.*

KEYWORDS: kenaf, N rates, fibre, seed yield.

INTRODUCTION

In spite of its industrial uses, kenaf cultivation in Africa has been constrained to small area of production with attendant low yield per unit land area, hence yield as low as 0.04% of the global production is being recorded in Africa (FAO, 2016). This might be associated with the fact that tropical soils are inadequate in soil minerals therefore calls for addition of mineral elements rich in soil nutrient to improve kenaf production. The poor fertility status due to continuous land cultivation which is a regular practice in most African countries. This practice limit nitrogen phosphorus and potassium which are important element in the soil for plant growth.

Increase in human population is responsible for high demand on infrastructure and farming lands (Agbaje *et al*., 2005). The available lands are therefore under pressure to meet basic needs for the sustenance of man and animals especially in the developing countries of Asia and Africa (Raji, 2007). This leads to soil fertility reduction and unsustainable crop yield over time. Hence the objective of this work is to ascertain the required quantity of NPK fertilizer that optimizes the potential yield of kenaf in south western Nigeria.

MATERIALS AND METHODS

Pot Trial

Four seeds of Ifeken 400 variety of kenaf were sown directly into each pot of 10 kg soil at 0.5 cm depth on the 23 October 2013. The seedlings were reduced to two plants per pot at 2 weeks after sowing (WAS). The trial was laid down in a completely randomized design (CRD) with four replicates. Fertilizer (NPK 20:10:10) was applied at: 0.00, 1.75, 2.50, 3.25 and 4.00 g/pot expected to release 0, 70, 100, 130, 160; 0, 35, 50, 65, 80; 0, 35, 50, 65 and 80 kg /ha of N: P: K respectively. Plants were watered regularly and weeds were removed by hand picking whenever they emerged. Laraforce (Lambda – cyhalothrin 2.5% E.C) insecticide was sprayed at the rate of 1L ha^{-1} with dilution factor of 2.5 ml/litre to control insect pests. The insecticide was sprayed at 4 and 8 WAS before the maturation of the plant. Data were collected at 4, 8 and 12 WAS on some growth parameters from four plants per treatment. Plant height was measured from the soil surface to the tip of the stem using a meter rule graduated in centimeter. Stem diameter was measured using vernier caliper at the base of each plant, 10 cm above the soil surface. Number of leaves per plant were counted

Kenaf (*Hibiscus cannabinus* L.) is cultivated for its soft bast fibre. Its cultivation has been increased around the world due to its high biomass yield and the raised fibre content (Hossain *et al*., 2011). All the components of kenaf plant: leaves, seed, bast and core are of industrial importance (Agbaje *et al*., 2011). Kenaf fibres have three major chemical constitutions, which are the cellulose (58-63%), hemicelluloses (21-24 %) and lignin (12-14 %). The difference in kenaf fibre morphology and quality are caused by genetic inheritance, environmental influence, management practices and other inputs (Hazandy *et al*., 2009; Hossain *et al*., 2011) while leaf area was measured using SHY- 150 leaf area meter with accuracy of ± 2% at 4, 8 and 12 WAS. At 20 WAS, harvesting was done by cutting the dried plant at 1 m above the soil surface. Capsules were separated and threshed; seed yield per plant was determined by weighing.

Field Trial

A field trial was conducted at the experimental farm of the Institute of Agricultural Research and Training, located in Ibadan, Nigeria (07038'N, 03084'E 182m above sea level). The location is within rainforest savanna transition zone of Nigeria. Field was ploughed and harrowed, then marked out into 3 m x 4 m plot with 1 m between two plots. The trial was laid down in a randomized complete block design (RCBD) with three replicates. Four seeds of Ifeken 400 variety of Kenaf were planted at 0 - 0.5 cm depth with spacing of 0.2 m intra rows and 0.5 m inter rows on the 24 May, 2014. Plants were reduced to two plants per stand at 2 WAS, resulting to a plant density of 240,000 plant ha^{-1}. Fertilizer (NPK 20-10-10) was applied at: 0, 0.42, 0.60, 0.78 and 0.96 kg per plot to give the same rate as in pot trial. Weeding was done at 3 and 6 WAS, while insect pest was controlled at 4 and 8 WAS using Laraforce (Lambda- cyhalothrin 2.5% E.C) insecticide.

Data collection from the field trial

Ten plants were randomly selected from the middle of each plot and these were tagged for data collection on crop performance. Data were collected on growth parameter as described in pot experiment at 4, 6, 8, 10 and 12 WAS. For dry matter determination, two plants per replicate were uprooted at 4, 6, 8 and 10 WAS and washed in water to remove soil from their roots. Each sample was divided into components (leaves stem and roots) and oven dried at 70^{o}C till constant weight was attained. Dry matter yield of the plant components were determined by weighing using Mettler PM 4000 weighing balance to get root dry weight, stem dry weight and leaves dry weight. Total above ground dry weight was determined by adding the values of dry leaves with dry stem. Percentage shoot weight was also calculated by dividing the total above dry weight by the sum total of the whole plant multiplied by 100. Relative growth rate (RGR) was also calculated as done by Hazandy et al. (2009).

$$\text{RGR (g.day}^{-1}\text{)} = \frac{log_e W_2 - log_e W_1}{(t_2 - t_1)}$$

Where: RGR : Relative growth rate

log_e : Natural log
W_1 : Biomass at first reading
W_2 : Biomass at second reading
T_1 : Time of first biomass reading
T_2 : Time of second biomass reading

Fibre yield determination

At 10 WAS, plants were cut from plant base within the inner row of each plot in each replicate to avoid border effect. The leaves were removed and whole stems were subjected to water retting. The plants were submerged in water for 14 days. After the 14th day, the plants were removed from water and the bast was separated from the core. The bast and core were thereafter washed with clean water and sun dried. Dried bast and core yields were determined by weighing.

Determination of seed yield and yield components

At 20 WAS (when more than 80% of the capsules were already dried but before the seed started to shatter), the plants were cut at about 1 m above ground level and packed based on treatments and stored under the shed for further processes. Five plants were selected from each plot to determine: number of capsule per plant and number of seed per capsule through visual counting. Weight of 100 seed and the total seed weight per plot were also recorded.

Determination of nutrient content in kenaf plant tissue

Five plants were randomly selected per plot at 10 WAS and cut at 10 cm above soil surface. The plants were rinsed in clean water to remove soil and any other dirt particles on it before separated into shoot and root. The shoots were oven dried at 70 °C till constant weight. These dried plant materials were ground into powder using a Glen Creston mill equipped with stainless steel grinding chamber with knives and sieve (0.5 mm operations) and stainless cup. After grinding, the plant materials were ashed, digested and analyzed for N, P, K, Ca and Mg concentration according to procedures described in the IITA manual for soil and plant nutrient analysis (IITA, 1984). To determine total nitrogen in the samples, the milled samples were subjected to Kjedahl digestion using concentrated sulphuric acid with selenium and sodium sulphate as catalyst. Total nitrogen inform of NH_4-N released from the digest by steam distillation with excess NaOH was trapped in boric acid. The nitrogen was then determined by titration with 0.1 N HCl. The P, K, Ca and Mg were determined by ashing 0.2 g plant samples in a crucible and placed in muffle furnace for 2 hours at 600 °C. The ash was cooled and dissolved in 1N HCl and solution passed through filter paper into 50 ml volumetric flask and made up to the mark with distilled water. Phosphorus

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concentration was determined by the vanado molybdate yellow colorimetric method using spectrophotometer. The K, Ca and Mg in the digest were read with the atomic absorption spectrophotometer (Model Buck Scientific 210 VGP). Nutrient uptake was then calculated using the following formula as used by Adekunle *et al*. (2014)
Nutrient uptake = Y× NC
Where Y = dry matter (g)
NC = Nutrient concentration (%)

Statistical analysis
All data collected were subjected to analysis of variance (ANOVA) and means were separated using Duncan's multiple range test (DMRT) at $p \leq 0.05$. The analysis was done using statistical analysis system (SAS).

RESULTS

The physio-chemical properties of the soils used for both pot and field experiments before cropping as shown in Table 1 indicated that pH (7.37) of the soil in the pot was considered slightly alkaline while (6.24) in soil from the experimental field was neutral. Organic carbon (7.70 and 9.10 gkg^{-1}) in pot and field respectively were reported to be moderate. Total nitrogen (0.77 and 0.90 g/kg) in pot and field were reported to be low according to soil fertility maps of Nigeria. The available P (6.00 mg/kg) for potted (3.25 mg /kg) field soils were also low. The exchangeable Ca ranged between 1.2 mg/kg to 2.21 mg/kg in the pot and field soil respectively. Exchangeable K was between 0.1 cmol/kg to 0.22 cmol/kg while the effective cation exchange capacity were 2.3 cmol/kg (pot) and 3.86 cmol/kg (field). The soil textures is sandy and loamy sand for pot and field respectively.

Vegetative growth and seed yield of kenaf grown in the pot
Kenaf plant height responded differently to NPK fertilizer application rates (Table 2). The plant height increased with rate of fertilizer applied. At 4 WAS, plant height (60.09 cm) obtained in plot treated with 100 kg/ha was greater than plant height (59.63, 56.20, 46.86 cm) obtained in plots treated with 130,160 and 70 kg/ha respectively while the least plant height (38.32 cm) was in pot without fertilizer application. Rates 160, 130 and 100 kg/ha were not significantly different in their effects on plant height (83.81, 86.75 and 83.13 cm) respectively at 8 WAS. At 12 WAS, plant height (187.38 cm) was highest in pot treated with 130 kg/ha but not significantly different from plant height (183.63 cm) obtained in pot with 100 kg/ha, both were however higher than plant height (165.13 cm) obtained in pot with 160 kg/ha. Plant height (145.31 cm) was least in pot without fertilizer.

The stem diameter (0.53, 0.53 and 0.54 cm) obtained in pots treated with 70, 100 and 160 kg/ha respectively were not significantly different as showed in Table 3. They were however lower than stem diameter (0.69 cm) obtained in pot with 130 kg N/ha at 4 WAS. At 12 WAS, the stem diameter (1.33 and 1.36 cm) obtained in pot with 70 and160 kg/ha were not significantly different from each other. The stem diameter (1.60 cm) was highest in pot treated with 130 kg/ha but not

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significantly different from stem diameter (1.58 cm) obtained from pot treated with 100 kg/ha while it was least (1.16 cm) in pot without fertilizer.

The highest number of leaves (12.56) was obtained in pots treated with 100 kg/ha at 4 WAS (Table 4). At 8 WAS, number of leaves (33.38 and 34.31) were obtained in pots treated with 70 and 100 kg/ha respectively were not significantly different. They were both significantly higher than number of leaves (28.38 and 27.93) obtained from pots with 130 and 160 kg/ha while the least number of leave (25.00) was from pots without fertilizer treated. Number of leaves (66.50) was highest under 130 kg/ha at 12 WAS. Number of leaves (55.31 and 53.38) obtained from pots with 160 and 70 kg/ha respectively were not significantly different from each other but they were lower than number of leave (61.63) obtained in pots with 100 kg/ha while the lowest number of leaves (41.63) was in pot without fertilizer at 12 WAS.

Seed yield (15.44 g/pot) was highest in pots treated with 100 kg/ha, while Seed yield (14.45 g/pot) in 130 kg/ha was not significantly different from seed yield (13.53 g/pot) obtained from pots treated with 160 kg/ha. Seed yield (9.58 g/pot) obtained from pots treated with 70 kg/ha was not significantly different from seed yield (9.33 g/pot) obtained from plots without fertilizer application. They were however lower than seed yield obtained from other rates (Figure 1).

Table 1: Physical and chemical properties of the soils of both pot and field trials in 2013 and 2014

Parameter	**Results**	
	Pot	**Field**
pH (H_2O)	7.37	6.24
Organic Carbon (g kg^{-1})	7.70	9.10
Total Nitrogen ((g kg^{-1})	0.77	0.90
Avail.P (mg kg^{-1})	6.00	3.25
Ca^{++}	1.2	2.21
Mg^{++}	0.8	0.90
K^{+}	0.1	0.22
Na^{+}	0.2	0.41
Exchangeable acidity (cmol kg^{-1})	ND	0.12
ECEC	2.3	3.86
Sand	892	864
Silt	68	68
Clay	40	68
Textural Class (USDA)	Sand	Loamy sand

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Table 2: Effects of NPK fertilizer on the plant height of pot grown kenaf in 2013

NPK 20:10:10 (kg/ha)	**Weeks After Sowing**		
	4	**8**	**12**
0	38.32 ^{d}	74.63 ^{b}	145.31 ^{d}
70	46.86 ^{c}	74.25 ^{b}	155.50 ^{c}
100	60.09 ^{a}	83.13 ^{a}	183.63 ^{ab}
130	59.63 ^{a}	86.75 ^{a}	187.38 ^{a}
160	56.20 ^{b}	83.81 ^{a}	165.13 ^{b}

Means with same letter within the column are not significantly different at $p \leq 0.5$.

Table 3: Effect of NPK fertilizer on stem diameter of pot grown kenaf in 2013

NPK 20:10:10 (kg/ha)	**Weeks After Sowing**		
	4	**8**	**12**
0	0.40 ^{c}	0.66 ^{d}	1.16 ^{c}
70	0.53 ^{b}	0.78 ^{b}	1.33 ^{b}
100	0.53 ^{b}	0.79 ^{b}	1.58 ^{a}
130	0.69 ^{a}	0.89 ^{a}	1.60 ^{a}
160	0.54 ^{b}	0.72 ^{c}	1.36 ^{b}

Means with same letter within the column are not significantly different at $p \leq 0.5$.

Table 4: Effect of NPK fertilizer number of leaves of kenaf grown in the pot in 2013

NPK 20:10:10 (kg/ha)	**Weeks After Sowing**		
	4	**8**	**12**
0	7.69 ^{e}	25.00 ^{c}	41.63 ^{d}
70	8.75 ^{d}	33.38 ^{a}	53.38 ^{c}
100	12.56 ^{a}	34.31 ^{a}	61.63 ^{b}
130	10.75 ^{b}	28.38 ^{b}	66.50 ^{a}
160	9.63 ^{c}	27.93 ^{b}	55.31 ^{c}

Means with same letter within the column are not significantly different at $p \leq 0.5$.

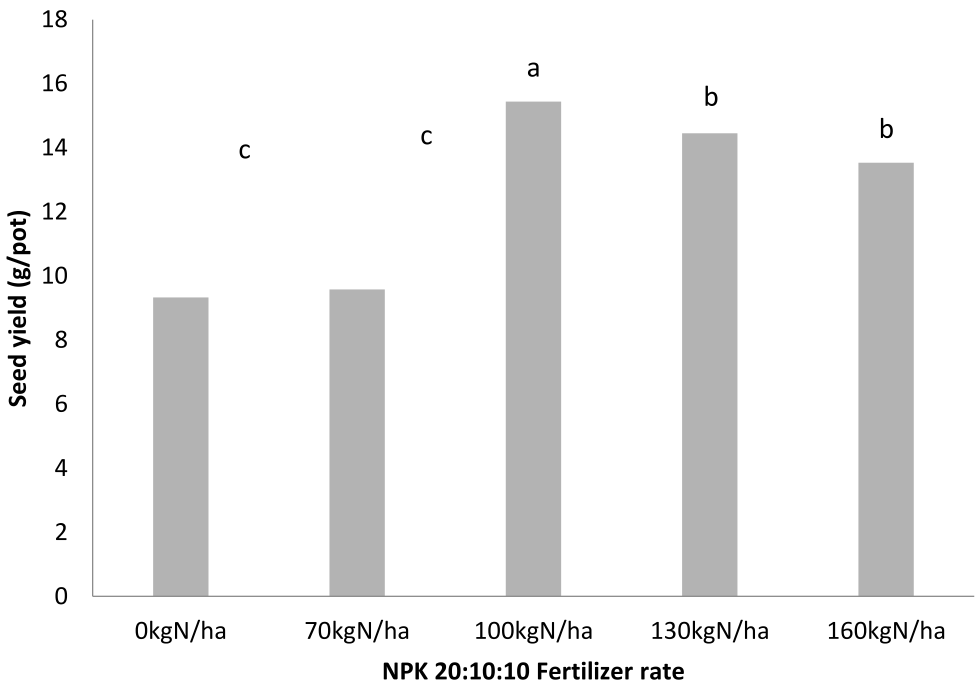

Figure 1: Effect of NPK fertilizer on kenaf seed yield grown in pot in 2013

Effects of NPK fertilizer on the vegetative growth of field grown kenaf in 2014.

Plant height ranged from 69.7 cm to 77.9 cm in plot treated with fertilizer while plot without fertilizer application had the least plant height (42.9 cm) at 4 WAS as showed in Table 5. Plant height (93.7 cm) was taller in 100 kg/ha at 6 WAS. Rates 130 and 100 kg/ha had plant height (136.4 cm and 134.8 cm) which were not significantly different at 8 WAS but were significantly taller than (126.2 cm) obtained from plots with application of 70 and 160 kg/ha. At 10 WAS, plant height (164.73 cm) was highest in plots treated with 100 kg/ha. Plant height (157.2 cm and 157.8 cm) obtained from 70 and 160 kg/ha were not significantly different, they were however lower than plant height (162.4 cm) obtained from 130 kg/ha while the least plant height was in plots without fertilizer application. At 12 WAS, the highest plant height (191.9 cm) was in plots with 100 kg/ha and least (143.3 cm) in plots without fertilizer.

Stem diameter (0.91, 0.89 and 0.87 cm) obtained from plots treated with 100, 130 and 160 kg/ha, respectively were not significantly different from one another but they were all higher than stem diameter (0.82 cm) obtained in plots with 70 kg/ha. However, plot without fertilizer had the least stem diameter (0.56 cm) at 4 WAS (Table 6). Stem diameter in plots with 100 and 130 kg/ha were not significantly different at 6, 8 and 10 WAS while it was highest (2.26 cm) in 130 kg/ha at 12 WAS, the least stem diameter was in plots without fertilizer.

Leaf area obtained at 4 WAS were not significantly different for all the rates. However, leaf area at 4 WAS was higher than leave area obtained in plots without treatment (Table 7). Although the highest leaf area (3386 cm^2) was obtained in plots with 160 kg N/ha, it was not significantly different from leaf area (3175, 2960 and 3029 cm^2) obtained from plots with 130, 100 and 70 kg/ha, respectively at 4 WAS. Highest leaf area (4057, 5733, 6516 and 6620 cm^2) were obtained from plots with 130 kg/ha. These were significantly higher than leaf area obtained from other rates while the least leaf area (2346, 2781, 3744 and 3881 cm^2) were from plots without fertilizer at 6, 8, 10 and 12 WAS, respectively.

Effect of NPK fertilizer on Relative Growth Rate (RGR) of field grown kenaf in 2014

The RGR (2.50 g/plant) was highest in plots with 130 kg/ha. It was however not significantly different from (2.5 g/plant) obtained in plots with 160 kg/ha and (2.45 g/plant) obtained in plots with100 kg/ha at 4-6 WAS (Table 8). At 10-12 WAS, RGR (2.4 and 2.2 g/plant) from plot with 70 kg/ha and plots without fertilizer respectively were significantly not different. Although, the highest RGR (4.5 g/plant) was obtained from 100 kg/ha at 10-12 WAS.

Effects of NPK fertilizer on the fibre and seed yield of kenaf evaluated in 2014

Core and bast yields (2.0 and 1.2 t/ha) were highest in plots treated with 130 kg/ha, and least (0.5 and 0.4 t/ha) in plots without fertilizer (Table 9). Number of capsule (41.6) was highest in plot with 100 kg/ha, Capsule (38.7 and 36.5) obtained from plots with 130 and 160 kg/ha) respectively were not significantly different from each other but were both higher than capsule per plant (21.5) obtained from plot without fertilizer. Seed yield (1.8 t/ha) was highest in plot with 100 kg/ha. Seed yield (1.6 t/ha) obtained from plot with 130 kg/ha was significantly higher than seed yield (1.3 and 1.2 t/ha) obtained from plot with 160 kg/ha and 70 kg/ha respectively while the lowest seed yield (1.1 t/ha) was from plot without fertilizer

Effects of NPK fertilizer on nutrient uptake (mg/plant) of kenaf grown in 2014

Rate influences nutrient uptake differently as shown in Table 10. Nitrogen concentration in plant tissue were higher in plant from plot treated with NPK at rates of 160 and 130 kg/ha while P (32.6 mg/plant) was higher in plot with 100 kg/ha. Phosphorus concentration was higher (22.2 mg/plant) in plot with 70 kg/ha and least (8.9 mg/plant) in plot without fertilizer. Potassium, sodium, Calcium and Magnesium concentration were higher in plant with fertilizer application and least in control.

Table 5: Effect of NPK fertilizer on plant height (cm) of field grown kenaf in 2014

NPK 20:10:10	**Weeks After Sowing**				
(kg/ha)	**4**	**6**	**8**	**10**	**12**
0	42.95 ^{c}	65.85 ^{e}	102.14 ^{c}	116.47 ^{d}	143.25 ^{e}
70	69.70 ^{b}	89.25 ^{d}	125.23 ^{b}	157.15 ^{c}	165.69 ^{d}
100	77.88 ^{a}	93.65 ^{a}	134.80 ^{a}	164.73 ^{a}	191.99 ^{a}
130	76.83 ^{a}	91.70 ^{b}	136.40 ^{a}	162.40 ^{b}	180.71 ^{b}
160	76.13 ^{a}	90.25 ^{c}	126.20 ^{b}	157.80 ^{c}	171.18 ^{c}

Means with same letter within the column are not significantly different at $p \leq 0.5$

Table 6: Effect of NPK fertilizer on stem diameter (cm) of field grown kenaf in 2014

NPK 20:10:10	**Weeks After Sowing**				
(kg/ha)	**4**	**6**	**8**	**10**	**12**
0	0.56 ^{c}	1.01 ^{c}	1.22 ^{d}	1.38 ^{d}	1.49 ^{e}
70	0.82 ^{b}	1.27 ^{b}	1.39 ^{c}	1.73 ^{c}	1.92 ^{d}
100	0.89 ^{a}	1.38 ^{a}	1.66 ^{a}	1.99 ^{a}	2.14 ^{c}
130	0.91 ^{a}	1.39 ^{a}	1.65 ^{a}	1.95 ^{a}	2.26 ^{a}
160	0.87 ^{a}	1.36 ^{a}	1.54 ^{b}	1.88 ^{b}	2.19 ^{b}

Means with same letter within the column are not significantly different at $p \leq 0.5$

Table 7: Effect of NPK fertilizer on leaf area (cm^2) of field grown kenaf in 2014

NPK 20:10:10	**Weeks After Sowing**				
(kg/ha)	**4**	**6**	**8**	**10**	**12**
0	2097.71 ^{b}	2346.00 ^{c}	2781.00 ^{c}	3744.00 ^{c}	3881.00 ^{c}
70	3029.64 ^{a}	3431.40 ^{b}	4162.00 ^{b}	5370.00 ^{b}	5605.00 ^{b}
100	2960.34 ^{a}	3228.60 ^{b}	4619.00 ^{ab}	5567.00 ^{b}	6404.00 ^{a}
130	3175.61 ^{a}	4057.00 ^{a}	5733.00 ^{a}	6516.00 ^{a}	6620.00 ^{a}
160	3386.06 ^{a}	3472.90 ^{b}	4853.00 ^{ab}	5387.00 ^{b}	5568.00 ^{b}

Means with same letter within the column are not significantly different at $p \leq 0.5$

Table 8: Effect of NPK fertilizer on RGR (g/plant) of kenaf evaluated in 2014

NPK 20:10:10 (kg/ha)	**Weeks After Sowing**			
	4-6	**6-8**	**8-10**	**10-12**
0	1.97^{b}	1.98^{b}	2.32^{e}	2.23^{c}
70	2.30^{b}	2.37^{b}	3.40^{c}	2.42^{c}
100	2.44^{a}	4.38^{a}	5.47^{a}	4.48^{a}
130	2.50^{a}	4.52^{a}	4.57^{b}	3.51^{b}
160	2.48^{a}	4.45^{a}	4.52^{b}	3.50^{b}

Means with same letter within the column are not significantly different at $p \leq 0.5$

Table 9: Effect of NPK fertilizer on fibre and seed yield (t/ha) of kenaf evaluated in 2014

NPK 20:10:10 (kg/ha)	**Yield (t/ha)**				**Seed yield (t/ha)**
	Core	**Bast**	**Capsule/plant**	**Seed/capsule**	
0	0.54^{c}	0.35^{c}	21.50^{d}	13.04^{c}	1.07^{d}
70	1.65^{b}	0.96^{b}	34.86^{c}	20.28^{a}	1.23^{c}
100	1.68^{b}	0.99^{b}	41.60^{a}	21.34^{a}	1.77^{a}
130	1.96^{a}	1.21^{a}	38.73^{b}	20.78^{ab}	1.55^{b}
160	1.68^{b}	1.03^{b}	36.48^{bc}	20.39^{ab}	1.28^{c}

Means with same letter within the column are not significantly different at $p \leq 0.5$

Table 10: Effect of NPK fertilizer on the nutrient concentration (mg/plant) of kenaf evaluated in 2014

NPK 20:10:10 (kg/ha)	Nitrogen	Phosphorus	Potassium	Sodium	Calcium	Magnesium
	(mg/plant)					
0	163.76^{d}	8.88^{d}	132.27^{c}	118.37^{c}	460.83^{d}	48.79^{d}
70	257.14^{c}	22.23^{c}	221.48^{b}	199.59^{b}	725.87^{c}	67.29^{c}
100	324.24^{b}	32.56^{a}	255.02^{a}	232.65^{a}	900.78^{b}	93.04^{a}
130	333.52^{a}	29.24^{b}	253.76^{a}	233.26^{a}	906.27^{b}	89.46^{a}
160	335.21^{a}	28.07^{b}	254.62^{a}	233.61^{a}	935.10^{a}	84.90^{b}

Means with same letter within the column are not significantly different at $p \leq 0.5$

DISCUSSION

Increase in kenaf growth and yield are accounted for by differences in environmental factors and influence of fertilizer application (Hazandy *et al*., 2009). Response of kenaf in this study to different NPK rates showed that the crop can perform optimally if grown with appropriate fertilizer rates. From the result, rate above 130 kg/ha fertilizer had a decreasing effect on the plant height and stem diameter of kenaf. The result is in agreement with Zhang, (2003) who reported that applying more fertilizer than required could lead to leaching, hence reduce its efficiency on the plant.

Dry matter production of kenaf increased with increase in fertilizer rate. However, biomass accumulation of kenaf grown with NPK fertilizer rate of 100, 130 or 160 kg/ha differed not significantly. Growth rates decrease in kenaf grown with fertilizer above 130 kg/ha. This was similar to the report of Danalatos and Archontoulis (2004; 2010) who reported that kenaf does not require higher dose of fertilizer. The consistent low yield of kenaf under fertilizer rate higher than 130 kg /ha as reflected in this study may be attributed to the nature of the soil used. Hamzah *et al* (2009), Saga *et al* (2010), Zaidey *et al* (2010) reported that application of mineral fertilizer to the tropical soil, which is poor in water holding capacity, low in cation exchange capacity (CEC) and nutrient availability could result to leaching of applied nutrient and mineralization due to high temperature and erratic rainfall, hence the low performance of kenaf with the application of inorganic fertilizer.

Number of capsule per plant increased with increase in the rate of NPK fertilizer applied while there was a decrease in the number of capsule per plant at rate above 130 kg/ha. Number of seeds per capsule were not affected by the rate of NPK fertilizer applied. Kabura (2002) stated that availability of soil nutrient improved photosynthesis and translocation from source to sink resulting in increased capsule and seed yield of okra. The percentage crude protein, crude fibre and ash content of the plant increased with increase in the rate of NPK fertilizer. The crude protein of 14.83 % to 15.90 % confirmed the claim of Webber *et al.* (2002) who reported that crude protein in kenaf leaves ranged from 14 % to 34 %. It was noted that the percentage crude fibre and total ash were higher in plant tissue grown with NPK fertilizer application. Moisture content increased with increase in the rate up to 130 kg/ha before it declined. Dry matter and nitrogen free extract decreased with increase in NPK fertilizer at a rate higher than 130 kg/ha.

CONCLUSION

Kenaf growth and yield was enhanced with the application of NPK fertilizer as indicated in this study. However, rate above 130 kg/ha had a diminishing effect on the parameters assessed. Hence, 130 kg /ha is recommended for kenaf cultivation in Southwestern Nigeria.

REFERENCES

Adekunle, A.F., Olanipekun, S.O., Kayode, C.O. and Ogunleti, D.O. 2014. Evaluation of time of compost application on the growth, nutrient uptake and seed yield of kenaf. *Greener Journal of Soil Science and Plant Nutrition,* 1.1: 007-015.

Agbaje G.O, Ogunsumi L.O, Oluokun J.A, and Akinlosotu, T. A. 2005. Survey of yam production system and the impact of government policies in south-western Nigeria. *Journal of Food Agriculture and Environment*, 3.2:222-229.

Agbaje, G.O, Aluko O.A and Olasoji. J.O. 2011. Effect of plant spacing on seed yield and yield components in kenaf (*Hibiscus cannabinus*) variety, Ifeken 400. *African Journal of plant Science,* 5. 12: 718-721.

Danalatos, N.G., and Archontoulis, S.V. 2004. Potential growth and biomass productivity of kenaf (*Hibiscus cannabinus* L.) under central Greek conditions: The influence of fertilization and irrigation. 2nd World Conference on Biomass for energy, industry and Climate protection: 323-326.

Danalatos, N.G., and Archontoulis, S.V. 2010. Growth and biomass productivity of kenaf (*Hibiscus cannabinus* L.) under different agricultural input and management practices in central Greece: *Industrial Crops Products*, 32: 231-240.

FAO.2016. Jute, Kenaf, Sisal, abaca, coir and allied fibres. Food and Agriculture Organization. Statistical Bulletin. 2016. 40p. www.fao.org/3/a-i7162e.

Hamzah, M. Z., Arifin, A., Zaidey, A. K., Azirim, A. N. and Zahari, I. 2009. Characterizing soil nutrient status and growth performance of planted dipterocap and non dipterocap species on degraded forest land peninsular Malaysia. *Journal of Applied Science*, 9: 4215-4223.

Hazandy, A. H., Mohad, H. Y., Nor-Aini, A., Bahrom, Z. and H. M. Mohamed. 2009. Effects of different fertilizerapplication level on growth and physiology of *Hibiscus cannabinus* L. planted on BRIS Soil. *Journal of Agricultural science*.1.1: 121 – 131.

Hossain, M.D.,Hanafi,H.J., and A.H. Hazandy. 2011. Growth, yield and fibre morphology of kenaf (Hibiscus cannabinus L.) grown on sandy soil as influenced by different levels of carbon. *African Journal of Biotechnology*, 10.50:10087-10094.

IITA. 1984. *Selected methods for Soil and Plant analysis* manual IITA Ibadan Nigeria.

Okafor, L.J. 1998. A preliminary study of the nitrogen response and yield potential of twenty barly varieties in Lake Chard basin. *Nigeria Journal of Agricultural Technology*, 1: 20-25.

Raji. J.A. 2007 Intercropping kenaf and cowpea. *African Journal of Biotechnology* 6.24: 2807-2809.

Saga, B. T., Ahmed, O. H., Jamaluddin, A. S., Abdul-Hamid, H. and Jusop, S. 2010. Selected soil morphological, mineralogical and sesquioxide properties rehabilitated and secondry forest. *American Journal of environmental Scienc*e. 6: 389-394.

Webber III, C.L., Bhardwaj, H.L. and Bledsoe, V.K. 2002. Kenaf production: Fibre, Feed and Seed. In: Janick J., Whipkey A. (eds): Trends in New Crops and New Uses, 327-339. ASHS Press, Alexandria, VA, USA.

Zaidey, A. K., Arifin, A., Zahari, I., Hazandy, A. H. and Zaki, M. H. 2010. Characterizing soil properties of lowland and hill dipterocap forest at peninsular Malaysia. *International Journal of Soil Science*, 5: 112-130.

Zhang, T. 2003. Improvement of kenaf yarn for apparel application. M.sc Thesis, Louisiana State University