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EARLY GROWTH RESPONSE OF *Kigelia africana.* Lam SEEDLINGS AS INFLUENCED BY NUTRIENT ELEMENT COMBINATIONS

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ABSTRACT

Nutrient deficiency may adversely affect the growth and quality of plants and this will also affect seedlings in forest nurseries. The objective of this study was to determine the effects of Nutrient element deficiencies on the early growth of *Kigelia africana* seedlings raised under a screen house condition. Pre-germinated *K. africana* seedlings were transplanted into 2kg polythene pots filled with washed river sand after which nutrient elements combinations were applied and data collected over a period of 16 weeks are plant Height (cm), Diameter (mm) and number of leaves. The study was set up in a completely randomized design (CRD) with 16 treatments consisting of -N,- P, -K, -Mg, -Ca, -Fe and -S in deficient dosage, +N,+ P, +K, +Mg, +Ca, +Fe, and +S in excess dosage with control and complete nutrient. Each plant with nutrient combinations were replicated four times. The seedlings' agronomic data were recorded at two weeks interval for 16 weeks. At 8 weeks after transplanting (WAT) it was observed that the absence of Nitrogen(-N) in the nutrient element combinations inhibits plant growth in terms of height (cm) with a figure of 11.5cm while a double dose of Nitrogen increased the plant height significantly to 15.75cm more than all other nutrient combinations in the study. Also, the lack of phosphorus in the nutrient element combination also affected the growth of *Kigelia africana* in terms of stem diameter with a value of 7.25cm when deficient and 10.11cm when in double dosage. The number of leaves produced over the period of the study was also significantly different with the absence and presence of phosphorous with values 7.5 and 11.5 respectively. Therefore, higher rate of Nitrogen and adequate supply of Phosphorus are recommended when formulating fertilizer rate for *Kigelia africana*

Keywords: *Kigelia africana*, Nutrient element, Minus One Element Technique, Seedlings

Introduction

Soil is essential medium for plant growth and for support in the environment. It is a major source of nutrients needed by plants for growth. Soil nutrient status or soil fertility are affected by soil use and management practices (Kyuma, 1996). Nutrients required to grow plants is only one aspect of successful crop production. Unfortunately, many soils do not have adequate nutrients for plant uptakes at their early growth stage. Early growth and development of some forest trees such *Vitex doniana, Diospyros mespiliformes, Adansonia digitata, Balanites aegyptiaca* and *Parkia biglobosa* has been reported to be affected by the condition of the growth media and climatic condition (Mukhtar, 2016). Bolanle – Ojo *et al.* (2014), also reported early growth performance of *K. africana* was significantly affected by different light intensities, while there is also limited information about their nutrient uptake, most especially for *Kigelia africana.K. africana* is a semi-evergreen plant, the tree size is normally between 10 – 12 m tall, occasionally up to 25 m, with a low – branching trunk up to 80 cm in diameter and rounded crown (Bolanle-Ojo *et al*, 2014). The tree flower at the end of the dry season, this occurs from November to December in West Africa. *K. africana* is widespread across Africa and is found in most wet savannah and riverine areas. The fruit is eaten by several species of mammals, including baboons, bush pigs, savannah elephants, giraffes, hippopotami, monkeys and porcupines (Oyeku *et al*, 2011). In most parts of Africa the Kigelia fruit has a long history of both consumption and tropical application (Descalsota*et al* 2003). It is valued as an aphrodisiac, a disinfectant and a cure for dermal complaints. Scientific literature confirms the validity of many of the uses due to the presence of numerous secondary metabolites.

These compounds include iridoids, flavonoids, fatty acids, sterols, glycosides and naphthoquinones (Olatunji *et al.* (2009) and Burkill, (1985) reported that *K. africana* is broadly used traditionally in South west Nigeria as herbal medicine for various ailments such as antioxidant, anticancer, antiulcer, anti-malarial and anti-aging. It is also useful in the treatment of tumours, gynecological disorders, fainting, epilepsy, eczema, depression, respiratory ailment, body weakness, leprosy, worm infestation, sickle-cell anaemia, and so on.

Regardless of the presence of secondary metabolites and its high medicinal uses*K.africana* only exist as a protected and semi domesticated specie.Lack of adequatesoil nutrient have put a lot of pressure on the growth of forest thereby affecting it's productivity. Therefore, to prevent a total loss or extinction of important forest food trees, there is need for check of the nutrient required.Actual Soil fertility limitations can be evaluated by soil analysis, field experiments, plant tissue analysis, observations on the incidences of deficiency or toxicity symptoms, and biological test. Recently a biological method known as minus-one element technique (MOET) was developed by PhilRice (Silva and Uchida2000). MOET is based on the principle that plant growth responds to the most limiting nutrients. Results of past studies showed that MOET was able to identify deficiencies, which could not be checked by soil analysis. *K. africana* suffers poor germination rate so the study was conducted to determine nutrient requirement and record the effect of mineral deficiencies and the effect of a super abundance of a particular nutrient under nursery conditions.

Materials and Methods

The study was carried out in a screen house at the Soil and Tree Nutrition Department of Forestry Research Institute of Nigeria, (FRIN) located on the longitude 07 ^{o} 23'18"N to 07 ^{o} 23'43"N and latitude 03 ^{o} 51'20"E to 03 ^{o} 23'43"43E (FRIN, 2015). The river sand was collected and thoroughly washed with water before being sterilized for an hour and then allowed to cool down before being filled into polythene pots of 13cm X 23cm capacity. Pre-germinated seedlings in top soil were then transplanted at 4 leaves stage into the pre-filled poly pots and were watered with nutrients solution.

The nutrients solutions were formulated using Minus-one technique (MOET). The nutrients used were Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Sulphur and Iron. Stock solutions of each nutrient were prepared and nutrients solution used was then prepared using 1ml of the prepared stock (Table 1). The experiment was laid out in a completely randomized design with sixteen (16) treatments replicated four (4) times. The growth variables: plant height, stem diameter and number of leaves were assessed at two weeks intervals starting from two weeks after transplanting. Data collected were subjected to Analysis of Variance and Means was separated using DMRT at 5% level of probability.

Results and Discussion

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The effect of the nutrient treatments on the stem diameter (mm) of *kigelia africana*is shown on Table 1. There was no significant variation observed at the start of the experiment and at 4 weeks after transplanting (WAT)but at 2 WAT, control had the least stem diameter value followed by double dosage of calcium. Every other treatmentwas not significantly different from one another. At 6 WAT, double dosage of sulphur had the highest stem diameter at 7.68mm though not significantly different from the addition of potassium and phosphorous; the least value was observed in the deficiency of phosphorous. Addition of potassium had the

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Trt	Composition	KNO_3	KH_2P0_4	Ca(NO3)2	$MgS0_4$	KCL	$Cacl_2$	Na_2S0_4	NaH2PO4	$NaNO_3$	$Mg(NO_3)_2$	$Mgcl_2$	Trace element	Iron solution
1	Control	-	-	-	-	-	-	-	-	-	-	-	-	-
2	Complete	+	+	+	+	-	-	-	-	+	-	-	+	+
3	-K	-	-	+	+	-	-	-	+	-	-	-	+	+
4	-Ca	+	+	-	-	-	-	-	-	-	+	-	+	+
5	-Mg	+	+	+	-	-	-	-	-	-	-	-	+	+
6	-N	-	+	-	+	+	+	+	-	-	-	-	+	+
7	-P	+	-	+	+	+	-	-	-	-	-	-	+	+
8	-S	+	+	+	-	-	-	-	-	-	-	+	+	+
9	-Fe	+	+	+	+	-	-	-	-	-	-	-	+	-
10	+K	+	+	+	+	+	-	-	-	+	-	-	+	+
11	+Ca	+	+	+	+	-	+	-	-	+	-	-	+	+
12	+Mg	+	+	+	+	-	-	-	-	+	-	+	+	+
13	+N	+	+	+	+	-	-	-	-	++	-	-	+	+
14	+P	+	+	+	+	-	-	-	+	+	-	-	+	+
15	+S	+	+	+	+	-	-	+	-	+	-	-	+	+
16	+Fe	+	+	+	+	-	-	-	-	+	-	-	+	++

Table 1: Treatments summary of nutrient solution composition

highest stem diameter value followed by complete nutrient and double dosage of magnesium, sulphur and iron. At 10 WAT, complete nutrient and calcium deficiency had significantly higher values (8.92 and 8.93mm) followed by the deficiency of potassium (8.69 mm).The least value was observed control and phosphorous deficiency at (3.87mm and 5.4 mm) respectively. At 14 WAT, complete nutrient, magnesium deficiency, double dosage of both sulphur and iron (10.49 mm, 10.11 mm, 9.62 mm, and 10.30mm) had the higher stem diameter values which were not different from each other. At 16 WAT, control and phosphorous deficiency had the least values while double dosage of sulphur had the highest stem diameter value but not significantly different from complete nutrient, deficiency of potassium, calcium and magnesium (Table 2). Calcium and phosphorus deficiency in treatment 4 and 7 respectively were observed to significantly influence the stem growth of *K. africana* at 10WAT which is contrary to the report of (Abiodun, 2018) where potassium deficiency in the nutrient element combination significantly increased the stem diameter of *Azadirachta indica* under similar condition. This could be as a result of a positive interaction of other nutrient element in the absence of calcium.

As shown on Table 3, the effect of nutrient element treatment on the number of leaves of *K.* a*fricana* whichcontrol gave the least value (6.50) while double dosage of potassium and sulphur gave the highest number of leaves (10.25). At 4 WAT, control gave the least value while the highest value was observed for calcium deficiency then double dosage of magnesium, phosphorous, sulphur and iron which were not significantly different from the values of the treatments for deficiency of potassium, calcium and magnesium. At 8 WAT, treatments with potassium and calcium deficiency then double dosage of calcium and magnesium had the highest mean value for the number of leaves compared to control and phosphorous deficiency which had the least value (7.62). At 10 WAT, control h ad the least number of leaves while potassium and iron deficiency had the highest values at 17.25 and 16.75 respectively. Complete nutrient at 14 WAT was not significantly from double dosage of phosphorous, sulphur and iron which were higher in numbers of leaves compared to the control (Table 3). This clearly shown that plant nutrient application significantly influenced leaves production in this study and this is also similar to the work of (Ihediuche *et al.*, 2019) which reported an increase in leaves production with nutrient element application.

The effect of Nutrient combinations on *Kigelia africana* plant height (cm) is shown on Table 4.Double dosage of potassium had the highest value at 2-4 WAT while the least value was observed in control. At 16 WAT, double dosage of nitrogen was not significantly different

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Trt	NUTRIENT	0WAT	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT	14WAT	16WAT
1	**Control**	2.542	2.69c	3.130	3.42	3.75d	3.87e	4.36e	4.55	4.95
2	**Complete moet**	2.423	3.88bcd	6.11a	7.58ab	8.69a	8.92a	9.49a	10.49a	10.88a
3	**-K**	2.362	4.17ab	5.82a	7.04abc	7.95ab	8.69a	9.28a	9.62ab	10.06ab
4	**-Ca**	2.828	4.10ab	6.17a	6.97abc	7.42ab	8.93a	9.40a	9.74ab	10.03ab
5	**-Mg**	2.594	3.70bcd	5.69a	6.85abc	7.53ab	8.46ab	9.35a	10.11a	10.52ab
6	**-N**	2.942	4.02abc	4.78a	5.81cd	6.40bc	6.57bcd	7.31abcd	7.89bc	8.40bc
7	**-P**	2.714	3.93bcd	4.77a	4.89d	5.28cd	5.40de	5.76bde	6.33c	7.25c
8	**-S**	2.998	3.79bcd	6.18a	6.96abc	7.86ab	8.55ab	8.742a	8.87ab	9.26abc
9	**-Fe**	2.625	3.39bcd	4.91a	6.01bcd	7.33ab	7.81abc	8.43a	8.93ab	9.21abc
10	**+K**	3.472	5.20a	7.78	7.44abc	9.02a	8.25ab	9.18a	10.18a	10.04ab
11	**+Ca**	3.245	4.32ab	6.13a	7.22abc	7.95ab	7.45abc	8.64a	9.07ab	9.91ab
12	**+Mg**	3.085	2.83cd	5.34a	7.08abc	8.42a	6.27cd	7.78ab	8.80ab	9.42ab
13	**+N**	2.777	3.53bcd	6.19a	6.43abc	8.24ab	7.16abcd	7.77abc	9.62ab	9.59ab
14	**+P**	2.828	3.44bcd	5.80a	6.59abc	8.47a	7.19abcd	9.15a	9.57ab	10.11ab
15	**+S**	3.268	3.98bc	6.22a	7.68a	8.96a	8.32ab	7.99a	9.62ab	10.77a
16	**+Fe**	2.772	3.78bcd	5.50a	7.11abc	8.61a	7.74abc	7.88a	10.30a	9.64ab

Table 2; Effect of Nutrient element combinations on K*igelia africana* Stem diameter (mm)

Means followed by the same letter in each column are not significantly different (P=0.05)

WAT = weeks after transplanting

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Table 3; Effect of Nutrient element combinations on K*igelia africana* number of leaves

Trt	NUTRIENT	0WAT	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT	14WAT
1	Control	6.50c	6.00d	5.25e	4.25d	3.25d	2.00	2.88c	3.50cd
2	Complete MOET	8.33abc	12.33ab	13.00abc	12.33abc	15.33ab	16.33ab	12.33ab	15.00ab
3	-K	9.50ab	13.50ab	14.75ab	13.25abc	17.00a	17.25a	6.25bc	9.25bcd
4	-Ca	9.50ab	13.25ab	16.00a	14.50a	17.00a	12.25bcde	10.50abc	7.00cd
5	-Mg	9.63ab	13.25ab	14.62ab	13.00abc	10.88bc	11.00cdef	12.12abc	10.88abc
6	-N	7.25bc	10.00bc	9.50cd	9.75bc	11.50bc	9.75def	9.00bc	8.25cd
7	-P	8.75abc	8.50cd	7.88de	5.25d	7.62cd	7.25f	6.62bc	7.50cd
8	-S	9.50ab	12.50ab	11.75bc	11.00abc	15.25ab	15.00abc	12.25ab	12.50abc
9	-Fe	9.75ab	10.25bc	12.00abc	11.75abc	15.75ab	16.75a	18.00a	12.50abc
10	+K	10.25a	14.50a	15.00ab	14.25a	15.50ab	13.75abcde	13.00ab	9.25bcd
11	+Ca	8.75abc	12.50ab	13.00abc	13.25abc	17.00a	14.00abcd	8.25bc	7.00cd
12	+Mg	8.25abc	13.00ab	16.00a	14.25a	17.00a	15.25ab	11.25abc	8.00cd
13	+N	8.50abc	13.75ab	15.50ab	14.00a	15.75ab	9.75fg	5.75bc	8.75bcd
14	+P	9.00abc	12.50ab	14.50ab	13.75ab	17.25a	15.25abc	6.25bc	11.50abc
15	+S	10.25a	13.25ab	13.25abc	13.00abc	15.25ab	14.50abc	13.75ab	15.00ab
16	+Fe	9.75ab	13.00ab	12.00abc	9.50c	12.25abc	13.62abcde	13.94ab	16.25a

Means followed by the same letter in each column are not significantly different (P=0.05)

WAT = weeks after transplanting

Trt	NUTRIENT	0WAT	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT	14WAT	16WAT
1	**Control**	6.25bc	6.38f	6.88g	7.12i	8.00h	8.38f	8.43	8.45	8.50
2	**Complete moet**	7.667abc	10.33abcd	12.83cde	13.33ef	16.33def	17.33cd	21.83abcde	24.33ab	24.33ab
3	**-K**	8.450ab	10.43abcd	13.55cd	14.50de	16.62def	18.50bcd	19.62bcde	19.62ab	20.25bcde
4	**-Ca**	7.50abc	9.75bcdef	17.25a	18.38ab	19.75abcd	21.75ab	22.88abc	23.30ab	23.52ab
5	**-Mg**	5.875c	10.19abcde	16.75ab	17.31abcd	23.00a	20.62abc	20.88abcde	23.50ab	22.75ab
6	**-N**	5.625c	7.125def	8.12fg	9.12ghi	10.00h	10.88f	12.38f	13.05c	14.50f
7	**-P**	6.45abc	6.56ef	7.56fg	8.75hi	10.50gh	12.88ef	13.47f	13.95c	14.81cef
8	**-S**	6.00c	9.13bcdef	10.25ef	10.88fgh	14.75ef	16.50de	19.12cde	19.58b	19.62bcdef
9	**-Fe**	6.75abc	9.18bcdef	12.25cde	14.62bcd	16.43def	19.25bcd	23.07abc	23.88ab	24.50ab
10	**+K**	8.67a	13.55a	17.38a	19.50ab	21.38ab	23.75a	23.62ab	25.32ab	25.62ab
11	**+Ca**	7.22abc	12.00abc	14.12bcd	16.82bcd	18.50bcd	20.75abc	22.70abcd	22.72ab	22.75ab
12	**+Mg**	6.50abc	8.88cdef	12.80cde	15.00abcd	17.25cde	19.50bcd	20.38abcde	20.48b	20.62bc
13	**+N**	7.30abc	12.75ab	16.88ab	20.25a	22.25a	24.00a	24.00a	28.62a	28.75a
14	**+P**	6.80abc	9.88abcdef	15.25abc	17.75abc	20.50abc	21.85ab	20.75abcde	21.00b	24.00ab
15	**+S**	5.850c	11.00abc	11.88de	12.20efg	14.00ef	16.00de	18.48de	21.30b	21.38b
16	**+Fe**	5.63c	9.75bcdef	11.20de	12.00efg	13.38fg	15.88de	18.12e	20.50b	20.60bcd

Table 4; Effect of Nutrient combinations on K*igelia africana* height (cm)

Means followed by the same letter in each column are not significantly different (P=0.05)

WAT = weeks after transplanting

from double dosage of phosphorous same with sulphur and iron. The plant height obtained from the plant supplied with +N nutrient combination recorded the highest plant height (28.75 cm) compared with others while the least height (14.5 cm) was observed from –N nutrient solution (Table 4). This showed that, the concentration of each nutrients in the plant system were adequate except for nitrogen which is required in large quantity for rapid growth (Bloom, 2015). This was revealed by the result obtained from the –N solution. Similarly, (Abiodun *et al.*, 2018) and (Ihediuche *et al.*, 2019) also reported stunted growths when nitrogen was eliminated from the nutrient element combinations in their studies.

Increasing the concentration of all the nutrient elements in the combinations negatively influence the leaves, stem and root dry matter yield (DMY) of *Kigelia africana* which suggest that increasing the concentration of any of the nutrient elements has no positive agronomic effect on the plant's dry matter yield (Table 5). The best result on the plant's DMY was obtained from complete nutrient (4.42, 4.31 and 5.99 g) for leaves, stem and root respectively which have the complete nutrient formulation and this shows that the right amount of each of the nutrient elements were available for the plant. This result was closely followed by that of magnesium deficiency with a lowered DMY (3.14, 3.72 and 4.49 g) which shows the essentiality of magnesium to the plant. According to (Uchida 2000) magnesium is the central core of chlorophyll molecule in plant tissue, thus if Mg is deficient, the shortage of chlorophyll results in poor and stunted plant growth. Likewise, phosphorus is a yield limiting factor in crops (Fageria 1997), which also reflected in the poor stem dry matter yield of the plant (0.54 g) when compared with the Complete MOET (4.31 g) (Table 5).

Table 5; Effect of Nutrient combinations on K*igelia africana* dry matter yield (g)

SN	TREATMENT	LEAVES	STEM	ROOT
1	**Control**	0.10kl	0.37k	0.30e
2	**Complete moet**	4.42a	4.31a	5.99a
3	**-K**	2.18c	2.30f	2.50cd
4	**-Ca**	0.47h	2.66e	2.38cd
5	**-Mg**	3.14b	3.72b	4.49b
6	**-N**	1.63d	1.77g	2.50cd
7	**-P**	0.30i	0.54j	0.32e
8	**-S**	0.22j	1.49h	1.33de
9	**-Fe**	0.25j	1.45h	1.43de
10	**+K**	0.23j	3.17c	3.06c
11	**+Ca**	1.25f	2.38f	2.74c
12	**+Mg**	0.13k	1.19i	0.82e
13	**+N**	0.82g	2.29f	2.26cd
14	**+P**	1.31e	2.840d	2.42cd
15	**+S**	0.11kl	1.580h	2.09cd
16	**+Fe**	0.09l	1.167i	1.42de

Means followed by the same letter in each column are not significantly different (P=0.05)

WAT = weeks after transplanting

Conclusion

As shown in this study, the absence of Nitrogen in the nutrient element combination solution inhibits plant growth in terms of height (cm) while a double dose of Nitrogen also increased the plant height significantly more than all other nutrient combinations in the study. Likewise, the absence of phosphorus in the nutrient combination solution also inhibit the growth of *Kigelia africana*in terms of stem diameter and the number of leaves produced over the period of investigation. Therefore, in other to promote early growth of *Kigelia africana* with efficient use of fertilizer application, higher rate of Nitrogen and adequate supply of Phosphorus are recommended when formulating fertilizer rate for the plant

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