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Response of oil palm (*Elaesis guineensis* Jacq.) nursery seedling to NPK and Urea based gel liquid fertilizers in oil palm belt in Nigeria

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ABSTRACT

Raising vigorous oil palm nursery seedlings for field planting is contingent upon good fertility management. Following this, two separate experiments which consisted of liquid NPK gel fertilizer and Urea based gel liquid fertilizer were conducted in a randomized complete block design in four replicates to determine the response of nursery seedlings to gel liquid fertilizers. The experiments consisted of five treatments each namely (a) zero application (control), (b) 0.2L ha^{-1} (c) 0.5L ha^{-1} (d) 1.0 L ha^{-1} and (e) 1.5 $Lha^{-1}$of the products. Treatments were applied bimonthly after transplanting until the seedlings were 8 months old. Basal application of NPKMg fertilizer was done at 3, and 5 months after transplanting. Observation on seedling growth was taken 9 months after transplanting of pre-nursery seedlings. Data were analyzed using analysis of variance and means compared using Duncan Multiple Range Test (DMRT) at 5% level of probability. The results showed that palm height (79cm), girth (18cm), leaf number (12.57) and leaf area (0.64 m^2) respectively were highest at 1.5 L ha^{-1} of NPK gel fertilizer. Consequently, in Urea based gel liquid fertilizer palm height (74.2cm), girth (18.20cm), leaf number (12.33), and leaf area (0.673m^2) respectively were also highest in plot treated with 1.5 L ha^{-1}. Leaf nutrient of nitrogen, and phosphorus were adequate for seedlings productivity only in NPK gel fertilizer and leaf nutrient content of Nitrogen, phosphorus and magnesium were sufficient for seedlings productivity in Urea liquid-based fertilizer. This result concluded that both fertilizers produced good seedlings at 1.5 L $ha^{-1.}$

Keywords: Circumference; Height; Leaf; Transplanting; Treatment
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Introduction

Farmers in Nigeria are mostly faced with the problem of low crop yield occasioned by low inherent soil fertility that is limited by high Fe and Al contents, low activity clay and low organic matter content (Olusola, 2009). Therefore, these soils do not produce optimally when cultivated because available nutrients are low. Improving the soil fertility has consistently been considered to be one of the most critical factors in the bid to promote the sustainability of agriculture in Nigeria (Ikuenobe *et al*., 2010). This is achieved by the use of fertilizer which could be organic or inorganic (Zia *et al*., 1991). Oil palm seedlings the nursery stage places a high demand on soil nutrients to attain adequate growth and vigor necessary for optimum field establishment (Fairhurst & Hardter, 2003). Consequently, the reserve of nutrient in the soil are inadequate to compensate for the high level of removal through the requirement for growth, thus, nutrient deficiency frequently occur and the drain of nutrients need replenishment for growth to be sustained (Hartley, 1988).

However, in order to meet the demand for nutrients in oil palm nursery seedlings in Nigeria, standard compound fertilizer NPKMg 12:12:17:2 has been recommended at the rates of 2 g seedling^{-1} and it usually applied at 14 g per seedling at 3,5 and 8 months after transplanting of pre-nursed seedlings (Ugbah & Utulu, 2005). Presently, the use of the inorganic granular fertilizer NPKMg 12:12:17:2 has been prone to high leaching and volatilization resulting from high Rainfall and sunshine which condition the soil resulting in low fertility in the area (Ikuenobe *et al*., 2010). In oil palm nursery production, nutrient management is the key to success. The use of the inorganic fertilizer NPKMg 12:12:17:2 has been limited by scarcity, rising cost, low quality and unavailability at the period of peak demand. Other limitations of the use of inorganic fertilizers is their cause of decline in soil organic matter content, soil acidification as a result of the residual effects, as well as degradation of certain soil physical properties with resultant increased incidence of soil erosion (Goh & Hardter, 2003). In order to mitigate farmers' dependency on this inorganic fertilizer (NPKMg 12:12:17:2) alone, minimize nutrient loss due to leaching, and prevent soil degradation and acidification, it is paramount to explore potential alternative sources. Among these alternative sources are foliar liquid NPK fertilizers.

More importantly, foliar fertilization does not totally replace soil applied fertilizer but it does increase the uptake and hence the efficiency of the nutrients applied to the soil. The increased efficiency in foliar use fertilizer reduces the need for soil applied fertilizer, reduces leaching and run-off of nutrients, reducing the impact on the environment of fertilizer salts (Ludders & Simon, 1980). These fertilizers when used could adequately enhance the vegetative growth of oil palm seedlings. The use of these fertilizers could provide adequate supplementary nutrition input to the oil palm seedlings fertility management in the nursery, thereby producing vigorous seedlings for field establishment by the Nigerian farmers and eventually increase income. Thus, this study investigates the effect of liquid NPK and Urea base gel liquid fertilizers on vegetative growth of oil palm seedling. This is with a view to improving on the existing granular fertilizer currently used in fertility management in the oil palm nursery in NIFOR.

Materials and Methods

The experiment was conducted at the main nursery of the Nigeria Institute for Oil Palm Research (NIFOR) in the 2019 cropping season. Liquid NPK gel fertilizer and Urea based liquid gel fertilizer were used at various rates. The liquid fertilizers were supplied by AMSAJ IND. CO LTD ABUJA. Two separate experiments consisted of five treatments namely (a) zero application (control) (b) 0.2L/ha (c) 0.5L ha^{-1} (d) 1.0 L ha^{-1} (e) 1.5L ha^{-1}for liquid NPK gel fertilizer and Urea based liquid gel fertilizers. Soil applied granular fertilizer (NPKMg 12:12:17:2) was used at 14 g per seedling as basal dressing at three months and five months after transplanting. The experiments were laid down as Randomized Complete Block Design (RCBD) replicated four times. Each treatment consists of 15 seedlings per plot and each plot and block was separated by guard row seedlings of 1 m apart.

Oil palm seedlings were raised following the method described by (Rankine & Fairhurst, 1998). The polybag (30 cm × 40 cm) containing 10 kg of soil and 0.4 kg of shredded empty bunch refuse as mulch were used. Treatments were applied bimonthly after transplanting seedlings from the pre-nursery at three months until the seedlings was eight months. Watering and weeding were done as and when necessary, using manual method. Phytosanitary measure was carried out bimonthly to prevent pests and diseases by using Cypermenthrine at 6 mls L^{-1} to spray the seedlings. Data were collected on palm height (cm), girth (cm), number of leaves and leaf area (m^2). Palm height was measured with a graded meters ruler, from the palm base to the top of the drawn-up leaf, while girth was the circumference of palm base which was measured using a thread and then placed on a graded metric ruler for reading and recording.

Leaf number was done by counting, while the leaf area was estimated by the methods (Fairhust & Hãrdter, 2003; Corley & Tinker, 2016; Ovie *et al.,* 2022). Data collected were subjected to analysis of variance (ANOVA) using Genstat version 12.1, 2009) and means were separated by the DUNCAN'S TEST in order to reduce experimental wise error rate. Critical nutrient level as described by (Fairhurst & Hãrdter, 2003) was used in determining nutrient sufficiency level. Climatic data of the area is shown in table 1. The chemical composition of the liquid fertilizers used in this study containing both macro and micro nutrients require for plant growth is showed in tables 2 & 3. The initial soil analysis used in this study showing acidic and sandy nature of the soil with low base saturation is as detailed in table 4.

TABLE 1

Climatic data of the experimental area

Month	**Relative humidity (%)**	**Temperature °C**		**Sunshine (hour)**	**Rainfall (mm)**
		Min.	**Max.**		
January	71	23.0	33.0	4.9	0.0
February	70	26-0	35.0	2.3	0.0
March	76	23.0	33.0	5.4	90.0
April	78.6	23.8	33.1	5.9	107.0
May	78.05	24.1	33.1	5.4	56.6
June	83.85	22.0	31.4	3.6	381.4
July	84.75	23.2	29.5	2.3	281.0
August	89.95	23.5	30.2	2.9	427.0
September	87.2	23.4	31.3	3.9	442.9
October	70.95	23.6	31.9	3.2	385.4
November	73.75	23.5	33.2	6.3	140.8
December	65.75	21.5	33.0	8.0	0.0
Mean	78.4	23.4	32.3	4.4	192.7

TABLE 2

Chemical composition of Liquid NPK gel fertilizer

Nutrient elements	% nutrient elements
Total nitrogen	28.0
Ammoniac nitrogen	3.8
Ureic nitrogen	24.2
Phosphorous pentoxide (p2o5) water soluble	11.0
Potassium oxide (k2o) water soluble	14.0
Boron (B) water soluble	0.03
Iron (Fe) EDTA Chelated	0.04
Copper (Cu) EDTA Chelated	0.03
Manganese (Mn) EDTA Chelated	0.03
Zinc (Zn) EDTA Chelated	0.01
Molybdenum (Mo) water soluble	0.03

TABLE 3

Chemical composition of urea base gel liquid fertilizer

Nutrient elements	% nutrient elements (w/v)
Total Nitrogen (N)	15
Nitric Nitrogen (N)	12.3
Ammoniac Nitrogen (N)	0.9
Ureic Nitrogen (N)	1.8
Calcium oxide (CaO) water-soluble	22.5
Magnesium Oxide (MgO) water-soluble	2.0
Boron (B) water-soluble	0.03
Copper (Cu) EDTA chelated	0.03
Iron (Fe) EDTA chelated	0.05
Manganese (Mn) EDTA chelated	0.03
Molybdenum (Mo) water-soluble	0.003
Zinc (Zn) EDTA chelated	0.02

TABLE 4

Physical and chemical properties of the soil used for the nursery experiment

Soil parameters	NPK Gel liquid fertilizer	Urea based Gel liquid fertilizer
pH	5.96	5.78
EC (µS)	378	287.8
C (%)	1.12	0.13
N (%)	0.24	0.31
P (mg/kg)	24.07	13.65
Ca (cmol / kg)	13.04	22.2
Mg (cmol / kg)	1.16	1.12
Na (cmol / kg)	0.67	0.64
K (cmol / kg)	0.21	0.22
H^+ (cmol / kg)	1.2	1.0
Al^{3+} (cmol / kg)	-	-
Clay (%)	3.6	4.6
Silt (%)	4.3	3.8
Sand (%)	92.1	91.6

Results and Discussion

The results from study showed that seedlings height, base circumference, number of leaves and leaf area were significantly affected by application of liquid NPK gel fertilizer. However, seedlings height, base circumference, number of leaves and leaf area were highest when liquid NPK gel fertilizer was applied at 1.5 L ha^{-1} and their corresponding values were 79 cm, 18.63 cm, 12.57 and 0.69 m^2 respectively. The lowest values in seedlings height, base circumference, and leaf area were achieved with the application of 0.0 L $ha^{-1}$of liquid NPK gel fertilizer (control plot) and their corresponding values were 60.3 cm, 13 cm, 12.55 and 0.13 m^2 respectively (Table 5). Only in the application of 1.0 L $ha^{-1}$of liquid NPK gel fertilizer and 1.5 L $ha^{-1}$of liquid

NPK gel fertilizer was the seedling leaf area significantly similar. Consequently, seedling base circumference was significantly similar in all the treatments except the control treatment. However, number of leaves was lowest with the application of 0.2 L $ha^{-1}$of liquid NPK gel fertilizer.

Similarly, application of Urea based liquid gel fertilizer significantly affected the seedling height, base circumference, number of leaves and leaf area. In effect, the highest nursery seedling height, base circumference, number of leaves and leaf area with corresponding values of 74.2 cm, 18.20 cm, 12.33 and 0.67 m^2 were obtained with 1.5 L $ha^{-1}$of Urea based gel liquid fertilizer. Conversely, 0.0 L ha^{-1} of urea based liquid gel fertilizer gave the least nursery seedling height (56.3 cm), base circumference (12.91 cm), number of leaves (8.83 cm), and leaf area (0.23 m^2) respectively (Table 6). The leaf nutrient content of potassium was below economic productivity range of 0.9% to 1.3% in the two trials, but only higher with NPK gel liquid fertilizer. Leaf nutrient of Nitrogen was above the critical level of 2.3% in oil palm in all the treatment except in the control plot and leaf nutrient of phosphorus was greater than deficiency range of 0. 13%. In effect, leaf nutrient of magnesium was within the sufficiency range of 0, 3% to 0.40% only in experiment with Urea base liquid fertilizer (Tables 7 & 8).

Moreover, leaf nutrient of nitrogen, phosphorus, potassium and magnesium do not show a particular trend along with the increase in foliar fertilizer application but were observed to be generally lower in the control treatments in the two experiments probably indicated that nutrient uptake could be enhanced by fertilizer application (Table 7 & 8).

TABLE 5

Effect of NPK gel liquid fertilizer on oil palm seedlings

12 months after planting				
Treatment (l ha^{-1})	Height(cm)	Base circumference(cm)	Number of leaves	Leaf area(cm)
0.2	68.35b	17.68b	10.55a	0.21b
0.5	70.4b	17.95b	11.90abc	0.32c
1.0	74.0c	16.83b	11.55ab	0.64d
1.5	79.0d	18.63b	12.57c	0.69d
0.0	60.22a	13.00a	12.55bc	0.13a
S:E	1.148	0.544	0.77	0.022

TABLE 6

Effect of Urea based gel liquid fertilizer on oil palm seedlings

12 months after planting				
Treatment (l ha^1)	Height(cm)	Girth(cm)	Number of leaves	Leaf area(m^2)
0.2	63.8b	16.72a	10.83c	0.562d
0.5	60.32b	13.95b	9.58b	0.495b
1.0	71.22c	16.71b	11.41c	0.529c
1.5	74.2c	18.20b	12.33d	0.673e
0.0	56.3a	12.66a	8.83a	0.227a
S:E	1.78	0.51	0.22	0.0026

TABLE 7

Effect of NPK Gel liquid fertilizer on nutrient uptake of oil palm seedlings

Treatment	N %	P %	K %	Mg
0.2	2.35	0.23	0.49	0.23
0.5	2.31	0.21	0.49	0.24
1.0	2.42	0.26	0.51	0.21
1.5	2.43	0.24	0.63	0.21
0.0	1.98	0.16	0.38	0.22

TABLE 8

Effect of Urea based gel liquid fertilizer on nutrient uptake of oil palm seedlings

Treatment	N %	P %	K %	Mg
0.2	2.58	0.16	0.31	0.41
0.5	2.61	0.18	0.33	0.44
1.0	2.61	0.16	0.30	0.46
1.5	2. 59	0.14	0.33	0.46
0.0	2.10	0.14	0.30	0.32

Increase in leaf nutrient content due to inorganic fertilizer application had been previously reported (Ekhator *et al.,* 2019). Importantly, in the experiment with NPK gel liquid fertilizer leaf nutrient content of Nitrogen and Phosphorus was adequate for seedling productivity. While in urea based liquid fertilizer leaf nutrient content of Nitrogen, Phosphorus and magnesium were adequate for seedling productivity. This leaf nutrient content result suggests that oil palm seedlings could require high potassium and probably magnesium supplementation for maximum growth. Moreover, in these experiments we have reduced the application of inorganic fertilizer NPKMg (12: 12: 17:2) by 33%. This reduction could have mitigated farmers' dependency on inorganic fertilizer alone and enhance supplementary nutritional input with the complementation of NPK or Urea gel foliar fertilizer thereby and probably minimizing nutrient loss due to leaching. Critical level of nutrients has been commonly used for assessing the sufficiency of nutrient in oil palm leaf (Fairhust & Hãrdter, 2003).

Although increase in plant vegetative growth due liquid fertilizer application was significantly different; but increase in plant height, base circumference, number of leaves and leaf area was better achieved at 1.5 L of the products ha^{-1} indicating that this rate of liquid fertilizer could be needed to maintain good vigor of oil palm seedling. Response of oil palm seedlings to inorganic fertilizer has been reported to increase oil palm vegetation parameters (Satriawan *et al*., 2019; Sudradjat *et al.,* 2015; Sukmawan & Riniart, 2022). The increase in vegetative growth of oil palm seedlings due to the effectiveness of NPK fertilizer had been previously reported in literature (Tarmizi & Tayeb, 2006). The increase in oil palm seedlings growth resulting from applied liquid and inorganic fertilizer had previously been reported in literature (Imogie *et al*., 2020).

The increase in oil palm seedling vegetative growth due to applied liquid fertilizers (NPK and urea-based gel fertilizer) and inorganic granular fertilizer might have reduced the heavy dependence on conventional soil applied liquid fertilizer because only 67% of conventional fertilizer was applied as basal dressing. The leaf nutrient content due to NPK fertilizer application has also been reported to be optimum for oil palm seedlings (Charis Saliun, 2019). Foliar fertilizers have been reported not to replace soil applied fertilizer but to complement increase uptake and hence the effectiveness of the nutrients applied to the soil (Ludders & Simon, 1980). The low level of potassium in plant leaf could be due to the high leaching of reserved potassium in tropical soil and this could indicate the need to further increase and complement this nutrient fertilizer. Similarly, the low level of magnesium in the NPK gel liquid fertilizer could have been due to the lack of magnesium element in the foliar fertilizer and magnesium element needs to be complemented where NPK gel liquid fertilizer is used.

Furthermore, the increase in oil palm growth parameters over the control plots could have indicated the effectiveness of the foliar compound fertilization when used in combination with inorganic fertilizer in growing oil palm seedlings. The type and dosage of liquid fertilizers as provided in this study will no doubt be beneficial in increasing the efficiency and effectiveness of fertilizing oil palm seedlings and increasing it growth in Nigeria. Consequently, the fear of high nutrient demand by oil palm seedlings due torrential rainfall which subjects the soil to high leaching of nutrients could have been allayed from the result of this study.

Conclusion and Recommendation

The results of these studies suggest that the conventional soil applied NPKMg fertilizers could be sufficiently complemented with foliar applied liquid NPK gel or Urea based liquid gel fertilizer at 1.5 l ha^{-1} for enhanced seedlings vegetative growth provided potassium and probably magnesium is adequately supplemented.

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