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Impact of newly introduced liquid fertilizer as fertilizer for raising oil palm seedlings

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ABSTRACT: Impact of newly introduced liquid fertilizers on growth and development on oil palm seedlings was investigated at the Nigerian Institute for Oil Palm Research Main Nursery, Benin City for two cropping seasons 2013 and 2014 respectively. The fertilizers investigated are Operon 22:0:0, Advantage 20:20:10, Boost Xtra 20:20:20 and conventional fertilizer NPKMg 12:12:17:2. The trial consists of 9 treatments laid down in Randomized Complete Blocks Design (RCBD) in three replicates at zero application (control), 28 g, and 56g per seedling respectively. Treatments were applied at 3, 5 and 8 months after planting and data were collected on seedling height, girth, number of frond production, dry matter yield and percentage of transplantable seedlings at 3, 6 and 12 months after planting. Data collected were analysed using analysis of variance (ANOVA) and their mean compared with Turkey's Honest Significance Difference (THSD) at 5% level of probability. At 3 and 6 months after planting, seedlings treatments had no significant effects on palm height, girth and number of frond production. However, at 9 and 12 months after planting, applied treatments had significant effects on palm height, girth, dry matter yield and the number of transplantable seedlings. The highest palm height (138.5 cm), girth (23.5cm), number of frond production (12), transplantable percentage (97.7%) and dry matter yield (198.5.7 g) were obtained in seedlings that received application of 28 g NPKMg 12:12:17:2, while the least palm height (75.5 cm), number of frond production (11), transplantable percentage (68%) and dry matter yield (105.8 g) was obtained from the control. The performance of seedlings that received fertilizers were all significantly different from the control, this is an indication that the liquid fertilizers Operon 22:0:0, Advantage 20:20:10 and Boost Xtra 20:20:20 could be used as an alternate fertilizer for raising oil palm seedlings when the conventional NPKMg is not readily available.

Keywords: Development, fertilizer, growth, liquid, seedling.

INTRODUCTION

One of the major problems encountered by small and medium scale farmers in oil palm production in Nigeria is low yield due to low inherent soil fertility. Improving soil fertility has consistently been shown as one of the most critical factors to promote the sustainability of agriculture in Nigeria (NIFOR, 2005). Oil palm seedlings at the nursery stage place a high demand on soil nutrients to attain optimum growth, development and seedlings vigour, this makes it necessary for optimum field establishment. To meet this demand for nutrients, compound fertilizer NPKMg 12:12:17:2 is applied at the recommended rates of 28 g to 42 g/seedling (Ugbah and Utulu, 2005; NIFOR, 2021). The use of this inorganic fertilizer NPKMg 12:12:17:2 has been limited by scarcity, rising cost, low quality and unavailability during the period of peak demand (Ugbah, 2008). Other limitations of the use of inorganic fertilizers are the declined 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 and Hardter, 2003).

The alternative to depending on these inorganic fertilizers (NPKMG 12:12:17:2) is to explore other potential sources (Fairhurst and Hardter, 2005). Newly introduced liquid fertilizers such as Operon 22: 0: 0, Advantage 20:20:10, and Boost Xtra 20:20:20 have been found to

increase the yield of arable crops like rice, maize, millet and sorghum and also fruit crops such as tomatoes, oranges, apples and pineapples (Highdawm, 2007). It was further reported that Operon and Advantage 20:20:10 enhanced crop growth and also help the crop to develop resistance to some fungal diseases. Liquid fertilizers are readily available, cheap and environmentally friendly (Aziz and El-Ashry, 2009). However, their use in perennial crops such as oil palm, coconut palm, raphia palm, date palm and shea tree which are mandate crops of NIFOR has not been reported. Thus, this study investigates the impact of newly introduced liquid fertilizer on the growth and development of oil palm seedlings along with the recommended oil palm fertilizer as an alternative source of fertilizers for raising oil palm seedlings in the nursery.

MATERIALS AND METHODS

Location

The experiment was conducted at the Main Nursery of the Nigerian Institute for Oil Palm Research (NIFOR) in the 2013 cropping season and was repeated in the 2014 cropping season respectively. The Nigerian Institute for Oil palm Research (NIFOR) is located at KM 17, Benin - Akure Road in Ovia North East Local Government Area of Edo State. It lies within latitudes 6º 33" and 7º 25" north of the Equator and longitudes 5º 15" and 5º 37" east of the Greenwich Meridian.

Treatment

Three liquid fertilizers Operon 22: 0: 0, Advantage 20:20:10 and Boost Xtra 20:20:20 were tested along with the conventional inorganic fertilizer NPKMg 12:12:17:2. The liquid fertilizers were supplied by Highdawn Nigeria Limited; Lagos. The experiments consist of nine (9) treatments namely:

1. 0 g (control)
2. 28 g NPKMg 12: 12: 17: 2
3. 56 g NPKMg 12: 12: 17: 2
4. 28 g Operon 22: 0: 0
5. 56 g Operon 22: 0: 0
6. 28 g Advantage 20: 20: 10
7. 56 g Advantage 20: 20: 10
8. 28 g Boost Xtra 20: 20: 20
9. 56 g Boost Xtra 20: 20: 20

Experimental design

The trial was laid down in a Randomized Complete Block Design (RCBD) replicate three times. Each block and plot were separated with a 2 m alley path. Each plot contained sixteen oil palm seedlings spaced at 45 cm x 45 cm. Fertilizer treatments were applied three times a year, at 3, 5 and 8 months after planting through foliar application. The solid NPKMg was spread evenly in a circle hoe of 2 mm deep dug around the seedling at a distance of 5cm away from the palm base and covered evenly with soil. Watering and weeding were carried out as when due. Prior to treatment the chemical composition of the liquid fertilizers were determined (Table 1). Also, the soil used for the nursery experiment was analysed to determine the soil's physical and chemical properties as described by Juo (1981).

Data collection

Data were collected on palm height, base circumference (girth), number of frond production, dry matter yield (fresh and dry) and percentage of transplantable seedlings. Palm height, number of frond production and girth were measured at 3, 6, 9 and 12 months after planting, while dry matter yield and percentage transplantable seedlings were measured at 12 months after planting. The palm height was measured from the palm base to the top of the drawn-up leaf with a graded long metric ruler, while the girth was the circumference of palm the base which was measured using a thread and was then placed on a graded metric ruler to read. The number of frond production was done by counting and dry matter yield was estimated using 12 months old seedlings. Destructive sampling was carried out by carefully removing the seedlings from the polythene bags without damage to the seedlings, the ball of the earth was carefully loosed off the seedlings and the root was washed in water to remove the soil completely. The harvested seedlings were weighed to obtain fresh weight and were then taken to the laboratory for oven drying in order to obtain the dry matter yield. The dry matter yield was obtained by oven drying the seedlings at 85ºC for 48 to 72 hours until a constant weight was obtained. Transplantable seedlings were healthy plants without any growth abnormalities with at least 10 to 12 green leaves and with a minimal girth of 15 cm and above (Ugbah, 2008).

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) using SAS user guide version SAS Institute (1987). When F calculated was found to be significant their means were separated by the Turkey's Honest Significance Difference (THSD) at 5% level of probability.

RESULT AND DISCUSSION

Chemical properties of liquid fertilizer

The chemical composition of the liquid fertilizer, Operon 20 – 0 -0, Advantage 20:20:10, Boost Xtra 20:20:20 and NPKMg is present in Table 1. The results of the chemical

Table 1. Chemical composition of Liquid fertilizer

Element	Advantage20:20:10(%)	Boost Xtra (%)	Operon 22:0:0 (%)
N	20	20	22
P	20	20	-
K	10	20	-
Mg	-	1.5	-
Mn	-	0.15	-
Fe	-	0.075	-
Cu	-	0.075	-
Zn		0.075	
B	-	0.0315	-
Co	-	0.0012	-
Mo	-	0.0012	-

Highdawn bulletin 2007.

analysis show that Operon contained only nitrogen (20%), Boost Xtra 20:20:20 contained nitrogen, phosphorous and potassium at equal ratio of 20% while Advantage 20:20:10 contained nitrogen, phosphorus and potassium with less percentage of potassium. The NIFOR recommended fertilizer NPKMg contained nitrogen, phosphorous, potassium and magnesium with high percentage of potassium 17% compared to the liquid fertilizers. The tested fertilizers contained three essential nutrients required for growth, development and yield except Operon 20 – 0 – 0 which contains only nitrogen which is essential for growth. Oil palm requires high amount of nitrogen greater than potassium greater than phosphorus greater than magnesium (N > K > P > Mg) in this order and in the bearing years, potassium and nitrogen become more important (NIFOR, 2005). The liquid fertilizers all contained high percentage of nitrogen, an essential nutrient for oil palm seedlings in nurseries at the early stages of growth is an indication that they can be used as fertilizer for raising oil palm seedlings.

Table 2. Soil physical and chemical properties of the experimental site.

Properties	Initial	Post
pH	5.1	5.2
N gkg-	0.10	0.09
C g kg-	0.02	0.048
P mg kg-	19.95	16.00
Exchangeable cation(cmol/kg)		
K	8.10	6.48
Ca	2.34	1.26
Mg	1.02	2.08
Na	0.30	0.20
Particle sizes		
Sand (%)	85.3	86.3
Silt (%)	2.9	1.9
Clay (%)	11.8	11.8
Texture	Sandy Loam	Sandy Loam

Physical and chemical properties of experimental soil

Results of the laboratory analysis of the soil used for raising oil palm seedlings are presented in Table 2. Results obtained show that the physical and chemical properties of the soils are slightly acidic, with low total nitrogen, organic carbon and exchangeable cation. The soil available phosphorus was moderate while the soil texture was sandy loam. A similar result was obtained by Imogie *et al.* (2020) in their trial to investigate the efficacy of Vimpel on the growth and development of oil palm seedlings. According to NIFOR (2005), soil native nutrients status is generally low and thus requires external application of fertilizers either organic or inorganic before transplanting seedlings for optimum growth, development and dry matter yield. Application of fertilizers will therefore improve the soil nutrient compositions and in turn enhance optimum oil palm seedlings' performance. Post soil analysis shows that soil nutrients were not depleted compared to the control, especially K and Mg. The significant performance of seedlings that received fertilizer over the control is an indication that the applied fertilizer enhanced the soil nutrient composition which in turn affected the seedlings' responses.

Effect of applied treatment on palm height, number of frond production and palm girth

Oil palm seedlings treated with fertilizers either liquid or solid fertilizers performances were significantly better than oil palm seedlings that received no fertilizers. At 6 months after planting, striking differences were observed, but these differences were not statistically significant (Table 3). The significant difference became visible at 9 and 12 months after planting where the palm height, girth and leaf numbers of the oil palm seedlings were significantly

Table 3. Mean height of oil palm seedling at 3, 6, 9 and 12 months after planting as affected by treatments.

Treatment	3	6	9	12
Control	25	49.3	75.5[c]	94.3[c]
28 g NPKMg 12 : 12 : 17 : 2	30	59.6	97.4[a]	138.5[a]
56 g NPKMg 12 : 12 : 17 : 2	32	59.5	96.4[a]	120.7[a]
28 g Advantage 20 : 20 : 10	30.2	56.4	89.3[b]	118.5[b]
56 g Advantage 20 : 20 : 10	28.0	57.4	93.5[a]	117.5[b]
28 g Boost xtra 20 : 20 : 20	29.5	58.7	90.9[b]	119.2[b]
56 g Advantage 20 : 20 : 20	30.5	58.7	94.5[a]	130.5[a]
28 g Operon 20 : 0 : 0	29.6	55.8	86.8[b]	109.4[b]
56 g Operon 20 : 0 : 0	29.5	56.7	90.5[b]	115.8[b]

Mean with the same alphabet are not significantly different from each other at 5% level of probability by Turkey's Honest significance difference.

Table 4. Mean number of frond production of oil palm seedlings at 3, 6, 9 and 12 months after planting.

Treatment	3	6	9	12
Control	5	8	10	10
28 g NPKMg 12 : 12 : 17 : 2	6	9	11	12
56 g NPKMg 12 : 12 : 17 : 2	5	9	11	12
28 g Advantage 20 : 20 : 10	6	8	11	11
56 g Advantage 20 : 20 : 10	6	9	11	12
28 g Boost xtra 20 : 20 : 20	5	9	11	12
56 g Advantage 20 : 20 : 20	6	8	10	12
28 g Operon 20 : 0 : 0	6	8	10	11
56 g Operon 20 : 0 : 0	5	8	11	11

affected by applied treatments. This significant difference observed at 9 and 12 months of planting was attributed to the applied fertilizers. This finding is in line with Ogeh *et al*. (2014), who investigated the response of Raphia palm (*Raphia hookeri*) seedlings to fertilizer application. The none significant effect of applied fertilizer treatments on the seedling heights at 3 and 6 months after planting may be attributed to the fact that the first treatment application was done a week when the seedlings were transplanted from pre nursery at 3 months to the main nursery. The highest palm height (138.5 cm) was obtained when NPKMg 12:12:17:2 was applied at 28 g per seedling, this was followed when Advantage 20:20:10 was applied at 56 g per seedling with palm height (130.5 cm), while the least palm height (94.3 cm) was obtained at the control were no fertilizers was applied.

The number of frond production as influenced by applied fertilizers is presented in Table 4. The statistical analysis showed that applied fertilizers had no significant difference on the number of frond production. The non-significant difference observed is an indication that the production of leaves by oil palm seedlings is genetically influenced. A similar finding was observed by Imogie *et al*. (2020) on the efficacy of vimpel fertilizers on the growth and development of oil palm seedlings. The effect of applied treatment on palm seedling girth is presented in Table 5. Statistical analysis indicated that seedling girths at 3 and 6 months were not significantly different from each other (Table 5). The applied fertilizer effects become evident at 9 and 12 months after planting where treatment significantly influenced seedling girth. Application of 28 g NPKMg and 56 g Boost xtra gave the highest seedlings girth (23.5 and 22.3 cm) respectively. The least seedling girth was obtained from the control plot (15.5cm).

The significant difference observed in seedlings' girth was due to the availability of adequate nutrients in the soil which was translated by the plant into growth and development. Palm height increased as rates of applied nutrients increased and was significantly different from each other except in NPKMg (solid fertilizer) where the high rate was not significantly different from the lower rate of 28 g per seedling. In terms of performance, Boost xtra 20:20:20 at both 28 and 56 g per seedling was next to NPKMg, followed by Advantage 20:20:10 with Operon and control in that order. The performance of seedlings in this order may be attributed to the fact that NPKMg, Boost xtra and Advantage contained three or more of the major plant nutrients needed for optimum growth and development,

Table 5. Means of oil palm seedling girth (cm) at 3, 6, 9 and 12 months after planting as affected by treatments.

Treatment	3	6	9	12
Control	6.6	10.5	12.5[c]	15.5[c]
28 g NPKMg 12 : 12 : 17 : 2	7.9	11.9	16.5[a]	23.5[a]
56 g NPKMg 12 : 12 : 17 : 2	7.8	11.9	15.5[a]	22.4[a]
28 g Advantage 20 : 20 : 10	7.3	10.5	14.5[b]	20.0[b]
56 g Advantage 20 : 20 : 10	7.5	13.9	15.5[a]	21.0[b]
28 g Boost xtra 20 : 20 : 20	7.9	13.2	14.7ab	22.1a
56 g Advantage 20 : 20 : 20	7.6	15.5	15.0[a]	22.3[a]
28 g Operon 20 : 0 : 0	7.0	13.0	14.0[b]	18.9[bc]
56 g Operon 20 : 0 : 0	7.8	14.2	14.8a[b]	20.5[b]

Mean with the same alphabets are not significantly different from each other at 5% level of probability by Turkey's Honest Significance Difference (THSD).

Table 6. Mean of yield (fresh and dry) matter and percentage transplantable seedling at 12 months after planting.

Treatments	Fresh weight (g)	Dry weight (g)	Transplantable (%)
Control	240.[c]	105.8[c]	68.0[c]
28g NPKMg 12:12:17:2	326.3[a]	198.5[a]	97.7[a]
56g NPKMg 12:12:17:2	324.3[a]	195.9[a]	96.5[a]
28g Advantage 20:20:10	301.2[b]	155.7[b]	85.7[b]
56g Advantage 20:20:10	317.2[ab]	163.7[b]	89.0[b]
28g Boost xtra 20:20:20	314.2[b]	184.4[ab]	87.7[b]
56g Boost xtra 20:20:20	322.9[ab]	189.7[a]	95.0[b]
28g Operon 22:0:0	297[b]	169[b]	88.7[b]
56g Operon 22:0:0	308[b]	177[b]	90.5[a]

Mean with the same alphabets are not significantly different from each other's at 5% level of probability by Turkey's Honest Significance Difference (THSD).

unlike Operon that contained only one major plant nutrient. Oil palm seedlings treated with fertilizers (singly and in combination) either liquid or solid performances were significantly better than oil palm seedlings that received no fertilizers (control). The significant effects of applied fertilizers on the palm height, girth, and leaf area over the control are due to the importance of adequate soil nutrients due to applied fertilizer. According to Uwumarongie-Ilori *et al*. (2012), applied organic and inorganic fertilizers significantly increased palm height, girth and leaf area over the control. They attributed this to the applied treatment.

Effects of fertilizers application on fresh weight, total dry matter and per cent transplantable seedling

The effects of applied fertilizers on seedling fresh and dry matter yield and percentage transplantable seedlings are presented in Table 6. Applied fertilizers had significant effects on fresh and dry matter yield and percentage transplantable seedlings. There was marked significant ($p \leq 0.05$) differences observed among the treatments due to applied fertilizers. Highest fresh and dry matter yield (326.3 and 198.5 g) and transplantable percentage (97.7%) seedling was obtained when seedlings were treated with 28 g NPKMg 12:12:17:2/seedling and this was followed by palms treated with 56 g Boost xtra (322.9 and 189.7g fresh and dry matter yield) and percentage transplantable seedlings (95.0%) while the lowest fresh and dry matter yield (240 and 105.8 g) and percentage transplantable seedlings (68%) were obtained in the control treatment. The result is in agreement with Ogeh *et al.* (2014) finding. According to them applied fertilizers significantly influenced *R. hookeri* seedlings macro nutrient uptake, concentration and development over the control. The performance of oil palm seedlings over the control is attributed to the fact that NPKMg, Advantage 20:20:10 and Boost Xtra contains the essential macro nutrients which make the fertilizers a balanced nutrient for the seedlings. Seedlings receiving 28 g NPKMg, 56 g Boost xtra and Advantage 20:20:10 markedly performed better than any other rates. The least seedling fresh weight, dry matter yield and transplantable percentage were obtained from the control.

Conclusion

The significant response of oil palm seedlings to applied liquid fertilizer NPKMg 12:12:17:2 at various rates over the

control showed the need for fertilizer supplements in oil palm nurseries. Applied liquid fertilizers Operon 20:0:0, Advantage 20:20:10 and Boost xtra all significantly affected the oil palm seedling height, girth, dry matter yield and percentage of transplantable seedlings. They compete favourably with the conventional NPKMg 12:12:17:2, in enhancing seedling development. The fertilizers contain nitrogen which is essential for oil palm seedlings growth at early stage in the nursery, however other nutrients such as phosphorus, potassium and magnesium must be supplied in appropriate dosage to prevent nutrient imbalance in the soil that may lead to poor seedlings development. In conclusion, Operon 20:0:0, Advantage 20:20:10 and Boost xtra could be used at 56 g/seedling as alternate fertilizer to NPKMg 12:12:17:2 at 28 g/seedling when it is not available. The soil initial nutrient composition could not support optimal palm growth, thus application of external input such as fertilizer the granular and liquid fertilizer which resulted to better performance of oil palm treated with fertilizer over control. This is because the palm needs both macro and micro nutrients in adequate form to actualize its genetic potential.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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