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Effect of Potassium (K) Source on Oil Palm Yield at Okomu Oil Palm Plc, Ovia North East L.G.A. of Edo State

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Abstract The study investigated effect of K sources on oil palm fresh fruit bunch (ffb) production at Okomu Oil Palm Plc, from 1999 to 2008. Two sources of K were evaluated at four rates. The sources of K evaluated were inorganic fertilizer Murate of Potash (MOP) at 1.0, 1.5, 2.0 and 2.5 kg/palm/year and local rock mineral that is Potassium Rock Mineral (PRM) at 1.67, 2.50, 3.33 and 4.16 kg/palm/year respectively. These were evaluated along the Control that is the zero application. The field layout was Randomized Complete Block Design (RCBD) in four replicates. Data were collected on oil palm fresh fruit bunch (ffb) production components (mean bunch number, mean bunch weight kg / bunch and ffb production ton / ha). Data collected were subjected to analysis of variance (ANOVA) and their means were compared using New Duncan's Multiple Range Test (DMRT) at 5% level of probability. Applied K source enhanced soil nutrient status thus making the soil nutrient available for optimum oil palm ffb production over the control. The applied K source significantly $P \neq 0.05\%$ affected ffb production. Bunch number, bunch weight and ffb production were significantly higher in palm receiving K fertilizers than the control. As rates of K application increases the ffb production also increases until what seem to be optimum rates of 2.0 K / palm / year was reached beyond which there was no significant increases in ffb production. Generally palms treated with K fertilizers in- respective of source of K fertilizer were highly significant than the control.

Keywords Potassium Rock Mineral, Fresh Fruit Bunch (FFB), Components, Yield, Production

1. Introduction

Potassium is important in the growth and development of the oil palm and is required in the plant's general metabolism in the movement of the stomata (water economy), activating cell division (Manciot, *et al.* 1981). Potassium action is equally manifest in all production factors; that is number of inflorescences and fruit bunch (ffb) production. According to Amalu (1990), insufficient potassium in the soil give rise to poor growth of palms, with thin trunks, sparse canopy, few and smaller fronds and leaflets. Omoti (1989) reported that over 50% of the total potassium in the soil is removed by fruits which are permanently lost to the plantation.

This loss of nutrients must be made good by fertilizer application, if good yields are to be obtained and sustained. Improving the fertility of the soil has consistently been pinpointed as one of the most critical factors (among myriad of others) in the bid to promote the sustainability of agriculture in Nigeria. A very crucial aspect of improving and maintaining soil fertility is the application of deficient nutrients of which potassium is one of the most important in oil palm cultivation both in the nursery and in the field (Omoti; 1989). Potassium fertilizer is usually apply to oil palm as inorganic fertilizer in form of Murate of Potash (MOP), NPKMg (12-12-17-2) e.t.c., howerever with the soaring cost and scarcity of these fertilizer, the fertilization of oil palm plantation has become very expensive indeed. The oil palm fertilization accounts for 25-30% of the total production costs in mature palm (Omoti, 1989). These have necessitated the need to look inwards for the alternative source of minerals such as potassium rock bearing minerals as fertilizers for oil palm manuring (Mc Chellen and Kamwengery, (1992).

Research Scientists and Organization have advocated the direct application of local bearing rocks as fertilizers to recapitalise the soils (Gerner and Baanante, 1995; Isenmila and Omoti; 2003; Kuyvenhoven and Lanser, 1999). The advantages of using potassium rock bearing rocks as fertilizer lies in their relatively cheap, environmentally friendly and readily available over the conventional inorganic fertilizer Murate of Potash. The minerals are found in abundant quantities in Nigeria (NIFOR, 1998). The cost of acidulation is removed, high in potassium and other plant nutrients such as phosphorus, magnesium. However, their use as fertilizer for oil palm fertilization is still at its lowest web. Thus, there is the need to evaluate the effect of potassium bearing rock minerals as fertilizers on oil palm fresh fruit bunch (ffb) production and this will enable us to developed alternate fertilizer for oil palm fertilization, thus helping farmers to

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maximize their returns in oil palm investment.

2. Materials and Methods

The trial was conducted at Okomu Oil Palm Plc., located at Udo Village, in Ovia North East Local Government Area of Edo State. Oil palm plantation established in 1993 with NIFOR EWS Seedlings G99 at Okomu was used for the trial. The trial commenced in 1998 when the palms were about 5 years old. Two sources of potassium (K) fertilizers were evaluated at four levels each along with control. The two sources of K tested and their rates are as follows:-

(a) Murate of Potash (MOP) at 1.0, 1.5, 2.0 and 2.5 kg / palm / year.

(b) Potassium Rock Minerals (PRM) at 1.67, 2.50, 3.33 and 4.16 kg / palm / year respectively.

These were compared with the control. Basal application of 0.5 kg Urea, 0.5 kg SSP and 0.5 kg dolomite (Mg) / palm / year were applied to all treatment palms except the control.

The trial consists of 9 treatments and these were laid out on the field as Randomized Complete Block Design (RCBD) replicated four times. Each treatments plot consists of 8 palms and guard row palms separating each plot and block from each other. Two palms row make one block with 4 palms per row in a plot and each separated by guard row palm before the next plot and also palm row separating block. The blocks were parallel to each other. Treatments were applied at a radius of 1m away from the palm base. The fertilizers were evenly spread round the palm base within the ring weeded circle of 2.0 m diameter.

The chemical composition of the Potassium Rock Mineral was determined. The K of the potassium rock mineral was extracted in 6N HCL, and there after the nutrients in the extract were determined using various analytical procedures Table 1. Soil samples were collected from two depths 0-15 cm and 15-30 cm before and 24 months after treatments application. The composite soil samples collected were bulked, processed and analysed for soil physical and chemical properties Table 2 using standard soil analytical procedures.

Leaf samples were collected 24 months after treatments application. Leaf 17 was sampled, processed and analysed for leaf nutrient composition as affected by applied varied rates of K fertilizers Table 6.

Data were collected on fresh fruit bunch (ffb) production components on forthrightly bases. The data collected were analysis statistically using analysis of variance (ANOVA). When F was found to be significant, their means were separated using New Duncan's Multiple Range Test (DMRT) at 5% level of probability.

3. Results and Discussion

The chemical composition of Potassium Rock mineral (PRM) evaluated along with imported Murate of Potash is presented in Table 1. The composition of the fertilizer nutrients in analysed PRM indicates that potassium rock mineral is an excellent source of K. It is high in K_2O (36.02 %), P_2O_5 (11.84 %) and Mg (3.65 %) content but low in Ca (16.25 %) which makes it an excellent fertilizer material for the fertilization of palms.

The soil physical and chemical properties of the experimental sites before treatments application is presented in Table 2. The results of the physical and chemical analyses of the soils show that the coarse fractions (sand and silt) dominate the soil texture. The soil mean pH values of 5.69 indicates moderately acidic soils. The organic carbon, total available N and exchangeable cations were relatively very low. The organic carbon values (0.12g kg^{-1}) were below the critical value of 10g kg^{-1} considered to be optimum for optimum crop production.

Application of K sources slightly increased soil pH, available P_2O_5 and exchangeable calcium 24 months after treatments application Table 2. Isemila and Omoti, (2003), reported that rock minerals build up soil nutrient gradually and among such nutrients is soil available P. This may be attributed to their slow nutrient released in the soil.

Table 1. Chemical nutrient composition of K source as extracted with 6N HCL

% values of nutrient concentration							
K sources	Mg	P	K	Na	Ca	Al	Fe
PMOP	-	-	60	-	-	-	-
PRM	3.65	11.84	36.02	2.19	16.25	0.36	0.50

Table 2. Soil physical and chemical composition of experimental site before and 24 months after treatments application

Properties	before	24 months after
pH	5.58	5.80
Org. Carbon (%)	1.24	1.19
Total N (%)	0.103	0.09
Available P (ppm)	7.80	12.57
Exchangeable (Meq/100g)		
K	0.33	0.33
Mg	0.48	0.25
Na	0.40	0.11
Ca	1.92	2.11
Soil particles		
Sand (%)	8.74	80.4
Silt (%)	2.3	9.3
Clay (%)	10.1	10.1
Texture	S	LS

4. Effect of Applied Varied Rates of K Fertilizers on FFB Production

The oil palm mean bunch number production as affected by applied varied rates of K is presented in Table 3. Statistical analysis shows that treatments had significant (p 0.05) effect on mean bunch number / palm. Highest mean bunch number (16.0) was obtained when K was applied at 2.0 kg / palm / year. Table 4 show mean single bunch weight (kg / bunch) as affected by applied K fertilizers. Mean single bunch weight (kg/bunch) were significantly (p 0.05) affected by applied varied rates of K fertilizers. Mean single bunch weight increases as rates of application increases until what seem to be optimum 2.0kg / palm / year was reached beyond which there was a declined in mean bunch weight.

The markedly effect of K on fresh fruit bunch components irrespective of sources over the control show that K is an essential element required by oil palm for optimum yield. Omoti (2003) reported that K and N are the key element required by mature palm for optimum fresh fruit bunch production. Potassium play essential roles in palm flowering (inflorescence production) and fruit formation this may be seen as palm treated with K fertilizers has high bunch number, bunch weigh and ffb production (ton/ha) than the control. The responded of palms to varied rates of K increase as K rate increases until what seem to be optimum rate 2.0kg / MOP / palm / year and 3.33kg PRM / palm / year was reached beyond which there was no significant increases as rates increases.

Table 3. Effect of K sources on mean bunch number at Okomu Oil Palm Plc, from 1999 – 2008

Rate of application		Mean bunch Number / palm / year									
K source	Kg/palm /year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Control	0.0	5.4 b	6.3 b	6.5 c	6.0 c	7.5 c	7.0 c	8.0c	8.3c	7.0c	7.9d
MOP + BD	1.0	8.5 a	9.0 a	11.5 ab	11.3 b	12.5 a	11.9 b	11.9 b	11.0b	13.5a	12.6c
MOP + BD	1.5	6.4 ab	8.0 ab	12.0 ab	11.9 b	12.0 a	10.5 b	10.5 b	13.4a	14.6a	14.0b
MOP + BD	2.0	5.3 a	10.5 a	14.5 a	14.0 a	13.5 a	14.0 a	14. 0 a	12.0a	15.0a	16.5a
MOP + BD	2.5	8.3 a	10.3 a	14.3 a	13.5 a	13.0 a	11.5 b	11.5 b	12.0 a	14.6a	16.0a
PRM + BD	1.5	8.4 a	9.0a	10.5 b	11.5 b	10.5 b	12.5 b	12.5 b	9.5 bc	8.6c	10.5d
PRM + BD	2.25	6.1 b	7.0 b	10.0 b	11.9 b	9.3 b	11.0 b	11.0 b	9.4 bc	11.5b	12.c
PRM + BD	3.0	6.3 ab	7.5 b	9.9 b	11.8 b	10.1 b	13.0 a	13.0 a	12.0 a	14.0a	14.2b
PRM + BD	3.75	6.0 b	7.0 b	8.5 b	11.0 b	10.5 b	12.5 b	12.5 b	12.0 a	13.5a	14.5a

Mean with the same alphabet in the same column are not significantly different from each other at 5% level of probability in the New Duncan's Range Test (DMRT).
Key:
BD: Basal dressing 0.5 kg urea, 0.5 kg SSP and 0.5 kg dolomite / palm / year
MOP: Murate of Potash
PRM: Potassium Rock Mineral.

Table 4. Effect of K source on Single Bunch Weight at Okomu Oil Palm Plc, form 1999 t0 2008

Rate of application		Mean Single Bunch Weight kg / bunch									
K source	Kg/palm /year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Control	0.0	8.9b	10.5b	12.5b	10.5c	12.6c	13.5c	9.8c	10.5c	11.7d	14.5e
MOP + BD	1.0	10.2a	12.0b	13.8a	14.5b	15.4b	16.8b	12.0b	13.5b	15.0c	17.5d
MOP + BD	1.5	10.53a	12.0a	14.0a	16.8b	16.5b	17.5b	13.5b	16.5b	17.5b	20.5b
MOP + BD	2.0	10.9a	12.7a	14.8a	19.5a	20.3a	21.5a	16.0a	18.9a	20.5a	25.4a
MOP + BD	2.5	10.5a	12.5a	14.9a	18.0a	19.5a	21.0a	14.7a	18.0a	19.0a	22.3b
PRM + BD	1.5	10.0a	11.0b	12.5b	14.5b	15.0b	16.0b	11.5b	14.5b	16.4c	18.0d
PRM + BD	2.25	8.5b	10.5b	13.0b	15.8b	17.5b	18.5b	13.7b	15.6b	17.0b	20.1c
PRM + BD	3.0	9.1ab	11.5ab	13.9b	16.9b	18.4ab	19.5a	15.6a	17.5ab	19.4a	22.5b
PRM + BD	3.75	8.9b	11.6ab	13.8b	15.5b	18.0ab	19.0b	14.0a	17.1ab	18.5ab	22.0b

Mean with the same alphabet in the same column are not significantly different from each other at 5% level of probability in the New Duncan's Multiple Range Test (DMRT).

Table 5. Effect of K source on Fresh Fruit Bunch (FFB) production at Okomu Oil Palm plc, form 1999 t0 2008

Rate of application		Mean bunch Number / palm / year									
K source	Kg/palm /year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Control	0.0	8.9c	7.5c	8.01d	9.2d	10.5c	11.0c	11.3d	8.7e	9.5	10.5
MOP + BD	1.0	10.4a	11.9a	12.0b	13.0b	12.0b	14.0b	14.0c	10.5d	12.0	12.5c
MOP + BD	1.5	9.5b	11.7a	13.0a	13.5b	13.1a	15.5a	15.0b	12.3c	14.5	15.0b
MOP + BD	2.0	11.6a	12.0a	14.0a	15.0a	13.6a	16.5a	17.5a	14.5a	16.0	17.5a
MOP + BD	2.5	10.5a	11.7a	13.5a	14.0a	13.4a	16.1a	16.5a	13.1b	15.6	17.0a
PRM + BD	1.5	8.1b	9.5b	10.0c	11.5c	11.0b	12.0c	13.5c	9.5e	10.5	12.6c
PRM + BD	2.25	7.2c	10.5b	11.5b	12.0b	11.6b	12.7c	13.9c	10.5d	11.5	13.9c
PRM + BD	3.0	9.5b	10.9b	12.0b	13.6b	11.9b	13.9b	15.9ab	12.0c	15.0	15.8b
PRM + BD	3.75	8.6b	9.8b	11.7b	13.3b	11.3b	12.0c	15.0b	11.5cd	13.9	14.5b

Means with the same alphabet in the same column are not significantly different from each other at 5% level off probability by the New Duncan's Multiple Range Test (DMRT).

The palm responded more in early years to applied MOP than PRM. The quick responses of palms to applied MOP than PRM may be attributed to the fact that mop mineralized quickly than PRM which mineralized gradually. According to Isenmila (2007), for quick response to alleviate K deficiency MOP are suitable while for long time effects, PRM are effective substitutes and PRM at 3.33kg/palm/year gave the highest bunch number, bunch weight and fresh fruit bunch production throughout the year. Palm receiving 2.0kg/MOP/palm/year performed better than palm receiving potassium rock minerals at all levels, were not significantly different from palms receiving potassium rock minerals at 3.33 and 4.16kg PRM / palm / year respectively.

Effect of K sources on leaf nutrient concentration 24 months after planting is presented in table 6. Applied K irrespective of sources had effect on leaf K, Mg, and Ca concentration when compared to the control. The leaf K nutrient concentration increases as rates of K application increases except while that of Mg and Ca increases initially, there after decreases as rates of application increases. However the K, Mg and Ca leaf concentration were higher in fertilizer palms than control.

Table 6. Effect of K Sources on Oil Palm Leaf Nutrient Concentration at Okomu Oil Palm Plc 24 Month after Treatment Application

K sources	Rate of application kg/palm/year	P	K	(%) Mg	Ca
Control	0.0	0.5	0.5	0.26	0.74
MOP + BD	1.0	0.43	0.63	0.38	0.77
MOP + BD	1.5	0.39	0.59	0.49	0.61
MOP + BD	2.0	0.35	0.59	0.46	0.70
MOP + BD	2.5	0.49	0.66	0.44	0.65
PRM + BD	1.5	0.52	0.68	0.49	0.70
PRM + BD	2.25	0.49	6.69	0.58	0.60
PRM + BD	3.0	0.39	0.81	0.45	0.72
PRM + BD	3.75	0..45	0.78	0.41	0.59

5. Conclusions

Locally sourced potassium rock mineral compete favourably with mutate of potash as K sources for manuring oil palm. Applied K irrespective of sources performed had significant effects on fresh fruit bunch components. The highest bunch number, bunch weight and ffb (ton/ha) were obtained when K was applied at 2.0kg MOP/palm/year and 3.0kg PRM / palm / year from 2004 to 2008 of the production season. Application of MOP at the rate of 2.0kg/palm/year was highly significant over the potassium rock mineral, however increasing MOP to 2.5kg/palm/year did not produced any appreciable increased, thus 2.0kg/palm/year of MOP seem to be optimum rate of application for MOP and 3.0kg/palm/year for PRM. PRM application for a period of nine years on the soil had positive effect on oil palm fresh fruit bunch production. In conclusion for quick response to alleviate K deficiency MOP should be used, however for long term corrective measures PRM can be used as a substitute.

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