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The effect of P fertilizers on seedlings height

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Abstract

The effect of P fertilizers (triple superphosphate, Senegal and Togo rock phosphates) were evaluated on oil palm seedlings at nursery. The study consisted of 4 levels of Phosphorus (P) fertilizers replicated 3 times and arranged in Randomized Complete Block Design. The P rates were Po, 6 g T SP, 7.5 g S RP and 8.2 g T RP applied per palm/month. Data was collected on seedling frond numbers, butt and height from 5 months after transplanting (MAT) to 12 months after transplanting (MAT). Data obtainedwere subjected to analysis of variance (ANOVA) using Genstat statistical package (12.1 ed.). The results showed that, P fertilizers, irrespective of source or levels had no significant effect on the parameters measured (frond numbers, butt and height), yet, values obtained were in agreement with earlier works by other researchers. The lack of significance was, however, attributed to the inherent sluggish growth nature of oil palm.SRP treated palms performed equally with the TSP palms and has the potential to be used on seedlings fertilization at the nursery.Field trial is therefore recommended with varying application rates of these phosphorus fertilizers and their potential on the vegetative growth of oil palm seedlings.

Key words: Oil palm, seedlings, triple superphosphate, rock phosphate, nursery

INTRODUCTION

Phosphorus (P) is a major growth-limiting nutrient, and unlike the case for nitrogen, there is no large atmospheric source that can be made biologically available (Ezawa*et al*., 2002). According to Imogie*et al*. (2011), a very crucial aspect of improving and maintaining soil fertility is the application of deficient nutrients of which phosphorus is one of the most important. Ghana currently has a total of 305 758 ha of oil palm of which more 80 % are cultivated by private small-scale farmers (MoFA, 2013). Though, 243 852 tons of oil palm is estimated to be produced, Ghana currently has an unmet demand 305 000 tons of

palm oil (MoFA, 2013). To maintain this oil yield potential, tropical soils often low in available P require addition of P fertilizers for optimum yield (Omoti 1989).

The common practice is to apply P in the form of superphosphates and diammonium phosphates to oil palm seedlings (Imogie*et al*., 2011). Many small-scale farmers in the tropics find it increasing difficult to afford this water-soluble commercial P fertilizer because of high cost and unavailability at the period of peak demand (Menon and Chien, 1990; Komolafe, 1997; Asomaning*et al*., 2006). Hence, the need to increase crop production with less expensive indigenous rock phosphates (RP's) merit the attention of local researchers (Asomaning*et al*., 2006). Large deposits of RP exist in West Africa (McClellan and Notholt, 1996), and their application to increase crop production has been investigated with varying degree of success (Akande*et al*., 2005; Akinrinde*et al*., 2006; Imogie*et al*., 2011). Over the past few decades, evidence has been obtained on the significant responses of oil palm to phosphorus fertilization in Ghana, Nigeria and Malaysia (Zaharah, *et al*., 1997; Danso*et al*., 2010; Imogie*et al*., 2011). The advocacy for the direct application of RP by Scientists lie in their relatively cheap, affordable, readily available and environmentally friendly nature (Amapu, 1990; Akande*et al*., 2005; Obigbesan and Akinrinde, 2000). Their high calcium content with great liming potential has also increased their usage (Insemila*et al*., 2006). Hence, the objective of this study was to evaluate the effect of P fertilizers on growth of oil palm seedlings at the nursery.

MATERIALS AND METHODS

Study site

The experiment was carried out at the Agronomy Nursery of Oil Palm Research Institute, Ghana (OPRI), Kade–Kusi, in the Eastern Region. The area falls within the semi deciduous forest zone and is characterized by bi-modal rainfall with mean annual rainfall of 1600 mm.Day temperatures range from a mean minimum of 20 ^{o}C to a mean maximum of 31 ^{o}C with relative humidity ranging from 95 % in the rainy season to 40 % in the dry season.

Nursery Activities

Maxi polybags (black) of dimension 35 × 45 cm were filled with 10 kg topsoil and arranged in triangular planting design of distance 70 × 70× 70 cm. The soil used was Ferric PlinthicAcrisol (FAO/UNESCO, 1990). The lower third of the bags were perforated to enhance drainage of excess water. Pre-nursery seedlings (Dura × Pisifera) at four leaf stage were transplanted into each of the maxi polybags and mulched with palm kernel shells.

Agronomic Practices

Watering of seedlings was done using the drip irrigation system after 3 days of no rain. Fertilizers were applied monthly/palm. Weeding (hoeing in-between polybags and hand picking within the polybags) was carried out manually. Prophylactic fungicide (diathane) and insecticide (actellic) were sprayed every two weeks and monthly respectively when necessary in controlling pest and diseases. Data collection was undertaken monthly, from 5 MAT to 12 MAT.

Experimental design and treatments

The experiment was a randomized complete block design with three replicates. Each treatment had 20 seedlings. Phosphorus fertilizers: triple superphosphate (TSP), Senegal rock phosphate (SRP) and Togo rock phosphate (TRP), were applied at four (4) levels as follows: No P fertilizers (P_o), TSP was applied at 6 g/palm/month (46 % P_2O_5), SRP at 7.5 g/palm/month (37 % P_2O_5), and TRP at 8.25 g/palm/month (33.5 % P_2O_5). All plants received a basal dressing of 6 g Urea (N) and 6 g Muriate of Potash (MOP) mixture/palm/month.

Growth parameters measured

Vegetative growth responses were measured on seedlings frond numbers, butt and height. Frond numbers were determined by counting the number of fronds per seedlings; height was measured from the soil level in the polybag to the top of the highest point of the seedling frond using a meter rule and seedlings butt was measured using a vernier caliper to determine the diameter at two places on the butt from the soil level. The butt was determined by the formula **(πd)**, where **π** was taken as 3.14 and **d** was the mean diameter measured on the seedlings' butt. All measurements were taken at monthly intervals from 5 MAT to 12 MAT.

Laboratory Analysis

Soil samples were air driedand passed through a 2 mm mesh sieve. Soil pH was determined using a HI 9017 microprocessor pH meter. The Walkley and Black procedure as modified by Nelson and Sommers (1982) was used to assess the organic C content in the soils. Total N was determined by Kjeldahl digestion method. The available P was extracted with a HCl:NH_4F mixture method as described by Bray and Kurtz (1945) and determined colorimetrically using the molybdenum blue method at the wavelength of 636nm. Exchangeable bases (calcium, magnesium, potassium and sodium) in the soil were determined in 1.0 M ammonium acetate extract and exchangeable acidity (hydrogen and aluminium) was determined in 1.0 M KCl extract.The Effective Cation Exchange Capacity (ECEC) was calculated as the sum of exchangeable bases and exchangeable acidity (Table 2). Soil particle size was determined by using the hydrometer method (Bouyoucos, 1962).

Table 1. Physical and chemical properties of the soil used

Property	**Value**
pH (1:2.5, H_2O)	5.1
Organic carbon (%)	0.76
Total nitrogen (%)	0.08
Exchangeable cations ($cmol_c/kg$)	
Ca	1.87
Mg	0.53
K	0.17
Na	0.05
Exch. Acidity ($cmol_c/kg$)	0.45
Available P (mg/kg)	4.70
Sand (%)	46.76
Silt (%)	31.44
Clay (%)	21.80
Texture	Loam

Statistical analysis

All agronomic data obtained wassubjected to analysis of variance (ANOVA) using Genstat statistical package (GenstatDiscovery Edition, 12.1 ed.) and separation of means was done by the use of least significance difference at $p < 0.05$.

RESULTS

Number of fronds per seedling

The effect of P fertilizers on seedling frond numbers is shown in Table 2. There was a gradual increase in frond numbers as growth progressed, however, at 9 MAT, about 10 % reduction in frond numbers was observed as a result of general pruning after which a steady rise was recorded. At 12 MAT, the growth pattern in all the P fertilizers were similar in that the frond numbers per seedling were relatively uniform and the effects were not significantly ($p>0.05$) different from one another.

Table 2. Effect of P fertilizerson number of fronds per seedling

	Number of fronds (No./plant)							
P fertilizers	5MAT	6 MAT	7 MAT	8MAT	9MAT	10MAT	11MAT	12 MAT
P**o (**Control)	5.83	6.83	7.00	7.50	6.33	7.50	9.00	9.50
TSP	5.58	6.92	7.00	7.12	6.25	7.42	8.75	9.25
SRP	5.75	6.92	7.00	7.42	6.58	7.75	8.75	9.33
TRP	5.67	7.00	7.00	7.33	6.50	7.58	9.00	9.42
Pr	0.797	0.954	1.00	0.722	0.328	0.682	0.753	0.808
Lsd (0.05)	0.534	0.593	0.536	0.616	0.402	0.579	0.658	0.546
CV (%)	11.21	10.28	9.18	10.05	7.51	9.18	8.90	7.82

Butt of seedlings

The application of P fertilizers, irrespective of source, had no significantly effect on seedlings butt throughout the experimental period (Table 3). Seedlings butt increased progressively from 5 MAT to 12 MAT. The P_o treated palms performed better than the P fertilizers on butt increment at 12 MAT. The increase in seedling butt of P_o over the P fertilizers was 2 % over TSP, 4 % over SRP and 2 % over TRP.

Table 3. Effect of P fertilizerson seedlings butt

	Seedling butt (cm)							
P fertilizers	5MAT	6 MAT	7 MAT	8 MAT	9 MAT	10 MAT	11 MAT	12 MAT
P_O(Control)	1.37	1.93	2.35	2.74	3.33	3.74	4.04	5.31
TSP	1.43	1.88	2.32	2.75	3.27	3.73	4.08	5.18
SRP	1.37	1.88	2.33	2.70	3.26	3.71	4.02	5.13
TRP	1.37	1.90	2.30	2.73	3.20	3.70	4.13	5.18
Pr	0.924	0.648	0.839	0.879	0.777	0.995	0.959	0.922

Lsd (0.05)	0.086	0.094	0.116	0.140	0.259	0.325	0.429	0.566
CV (%)	7.6	5.9	6.0	6.2	9.5	10.5	12.6	13.1

Seedling height

The effect of P fertilizers on seedlings height is shown in Table 4. There was a general progression in height from 5 MAT to 12 MAT, however, P fertilizers had no significant ($p>0.05$) effect on seedlings height throughout the experimental period. The highest height of 88.90 cm was recorded by P_o at 12 MAT.

Table 4. Effect of P fertilizers and microbe plus rates on seedlings height

	Seedling height (cm)							
P fertilizers	**5MAT**	**6MAT**	**7MAT**	**8MAT**	**9MAT**	**10MAT**	**11MAT**	**12MAT**
P_o (Control)	29.33	31.00	37.25	44.83	57.75	64.33	69.00	88.90
TSP	29.08	31.00	36.33	45.25	58.00	62.67	68.90	86.40
SRP	29.08	31.17	36.58	43.50	56.83	63.42	69.00	87.00
TRP	29.25	31.83	36.00	45.42	55.42	63.42	67.30	86.00
F pr. (0.05)	0.99	0.85	0.69	0.76	0.70	0.94	0.94	0.94
Lsd (0.05)	1.872	2.208	2.173	3.981	4.889	5.275	6.64	10.52
CV (%)	7.7	8.5	7.1	10.7	10.3	10.0	11.6	14.5

DISCUSSION

Seedlings frond numbers

The growth pattern in seedlings was similar in number of fronds per seedling irrespective of the P sources (Table 2). The observed lack of significant effect ($p>0.05$) may be due to poor root hairs development by seedlings (Phosri*et al*., 2010), which inhibited the uptake and usage of the applied inputs. The natural growth habit of the seedling by producing one frond per month could also be a factor and that any nutrient input might not influence the development of fronds. Lack of significance in seedling frond numbers was also reported by Garcia *et al*. (2012) using chemical fertilizers and compost and attributed it to low application rates. Similarly, Danso*et al*. (2013) using sole and amended green-gro compost reported lack of significant effect on frond numbers. Notwithstanding, the current trial recorded frond numbers similar to earlier works by Mutert*et al*. (1999) and IICA (2006) of 5 – 8 functional fronds of seedlings grown for 8 months at nursery. This according to Gomez *et al*. (2006) is indicative of high photosynthetic rate and the greater possibility of synthesizing biomass.

Seedling butt

Seedlings with no P fertilizer (P_o) produced larger butt than the P treated seedlings (Table 3). This lack of significant effect may be due to the fact that P was not limiting in the medium but nutrients other than P influenced seedlings growth. This was contrary to the results of Abidemi*et al*. (2006) when the application of P fertilizers, irrespective of source or rate, significantly ($p<0.05$) increased the butt of seedlings after 6 months of growth in the nursery.

Seedling height

As was evident from the study, seedlings height increased over the period following the application of P fertilizers, yet no significant ($P>0.05$) differences were observed (Table 4).This suggested that the applied amendments had no influence on seedlings height, perhaps, the inherent sluggish growth nature of the seedlings as indicated by Danso (2008) could explain the lack of significant response observed. SRP marginally increased seedling height more than the TSP. Thus, the expectation that water soluble P fertilizers should have superior effect over RP was not supported by this result. Similar observation was reported by Abidemi*et al.* (2006). Studies by Mutert*et al.* (1999) showed that after 8 months of nursery trial, healthy oil palm seedlings should be 0.8 to 1.0 m in height, whereas, TNUA (2013) reported 1 to 1.3 m for seedlings grown for 12 to 14 months in the nursery. Seedling heights averaging 0.8 to 1.0 m obtained in the present study was in agreement with the above authors. According to TNUA (2013), such heights would maintain higher frond production, bear earlier, produce heavy bunches, give higher fruit/bunch ratio and higher oil to mesocarp in the first year of harvest.

CONCLUSION

The application of P fertilizers produced growth patterns similar in frond numbers, seedling butt and height. TSP fertilizers did not elicit any superior effect on the parameters measured over the SRP and TRP. However, SRP performed favourably with the TSP and could therefore be used in raising oil palm seedlings in the absence of soluble P fertilizers.

REFERENCES

Abidemi, A. A., Akinrinde, E. A., and Obigbesan, G. O. (2006). Oil Palm {*Elaeisguineensis*) Seedling Performance in Response to Phosphorus Fertilization in Two Benchmark Soilsof Nigeria. *Asian Journal of Plant Sciences*, *5*(5), 767-775.

Akande, M. O., Adediran, J. A., Oluwatoyinbo, F. I. (2005). Effects of rock phosphate amended with poultry manure on soil available P and yield of maize and cowpea. Afri. J. Biotechnol. 4(5):444-448.

Akande, M. O., Makinde, E. A., Aluko, O. A. and Oluwatoyinbo, F. I. (2011). Rock phosphate amendment effects on Kenaf (*Hibiscus cannabinus* L.) growth and yield. Tropical and Subtropical Agro ecosystems, 14: 559-565.

Akinrinde, E. A., Abidemi, A. A. and Obigbesan, G. O. (2006). Oil palm (*Elaesisguineensis*) seedling performance in response to phosphorus fertilization in two benchmark soils of Nigeria. Asian Journal of Plant Sciences (5): 767-775

Amapu, U. C. (1990). Studies of potassium in soils supporting coconuts in Southern Nigeria: Potassium status and relationships with some soil properties. Nig. J. Palms Oil Seeds, 10(60): 23-39

Asomaning, S. K., Abekoe, M. K. and Owusu-Bennoah, E. (2006). Phosphate rock dissolution and availability in some soils of semi- deciduous rainforest zone of Ghana. West African Journal of Applied Ecology, vol. 10, no. 1.

Bouyoucos, G. J. (1962). Hydrometer method improved for making particle size analysis of soils. Agronomy Journal 53: 464-465.

Bray, R. H. and Kurtz, L. T. (1945). Determination of the total organic and available forms of phosphorus in soil. Soil Sci. 599: 39-45.

Danso, F. (2008). Development of sustainable nutrient management strategy for oil palm (*Elaesisguineensis*) nursery: NEBand Polyfeed evaluation. MSc. Thesis submitted to the Faculty ofAgriculture, KNUST Kumasi.

Danso, F., Adu, C., Opoku, A., Danso, I., AnimOkyere, S. and Larbi, E.(2013). Raising oil palm seedlingsusing soleand amended green-gro compost. Int. J. Agric. Sci. Soil Sci. 3(10):362-368.

Danso, I., Nuertey, B. N., Asamoah, T. E. O.,Tetteh, F. M., Danso, F., Afari, P. A., E.Y. Safo, E. Y. and Logah, V. (2010). The Effect of Rock Phosphate on Soil Nutrient Dynamics, Growth, Development and Yield of Oil Palm in the Semi-Deciduous Forest Zone of Ghana. Journal of Science and Technology, 30 (1): 30-44.

Ezawa, T., Smith, S. E. and Smith, F. A. (2002). P metabolism and transport in AM fungi. Plant Soil 244:221-230.

FAO, (1990). Soil Map of the World- Revised Lengend, 4th Draft. FAO. Rome. Fertilizer research 36: 141 – 150.

García, A., Angulo, J., Martínez, M. M. and Gutiérrez, V. (2012). Effect of phosphate - solubilizing bacteria and compost on the nutritional characteristics of the oil palm crop (*Elaeisguineensis* Jacq.) in casanare, Colombia. AgronomíaColombiana 30(2):274-281.

GenStat (2012). GenStat Release 12.1 ed. VSN International Ltd. UK.

Gómez, F., Oliva, M., Mielke, M., Ameida, A. and Leite, H. (2006). Photosynthetic irradiance-response in leaves of dwarf coconut palm (*Cocos nucifera* L., aracaceae): Comparison of three models. Scientia Hort. 109, 101-105.

IICA, Inter-American Institute for Cooperation on agriculture (2006). Cultivo de la palma africana. managua, nicaragua.

Imogie, A. E., Oviasogie, P. O., Udosen, C. V., Ejedegba, B. O. and Nwawe, A. (2011). Evaluation of some locally sourced phosphate rocks for oil palm production. Journal of Soil Science and Environmental Management. 2(6): 153-158.

Isenmila, A. E., Omoti, U. and Oviasogie, P. O. (2006). Development of alternative, cheap, easily available and affordable fertilizers from local rock minerals for the palms. The Journey so far. Paper presented at NIFOR Seminar, 28th Jun, pp. 1-20.

Komolafe, M. F. (1997). Effects of Sokoto Rock phosphate and poultry manure on maize. A B.Sc project submitted to the department of Agronomy, University of Ibadan, Nigeria. pp. 34-36.

McClellan, G. H. and Notholt, A. J. K. (1996). Phosphate deposits of tropical sub-Saharan Africa, In Management of Nitrogen and Phosphorus Fertilizers in sub-Saharan Africa. (Mokwunye, A.U. and Vlek, P. L. G. ed.), pp. 173–223. MartinusNijhoff Publishers, Dordrecht, The Netherlands.

Menon, D. G. and Chien, S. H. (1990). Phosphate availability to maize from partially acidulated phosphate rock and phosphate rocks compared with triple superphosphate. Plant and Soil, 127:123-128.

Mutert, E., Esquivez, A. S., de los Santos, O. A., and Cervantes, E. O. (1999). The Oil Palm Nursery: Foundation for High Production. Better Crops International, 13 (1): 39-40.

Ministry of Food and Agriculture (2013). Programme for the Promotion of Perennial Crops in Ghana. mofa.gov.gh. Accessed January, 2013.

Nelson, D. W. and Sommers, L. E. (1982). Total carbon, organic carbon and organic matter. In: Page,A.L., Miller, R.H., Keeney, D.R. (Eds.),Methods of soil Analysis, Part 2. Chemical and Microbiological Properties, 2nd ed. (Agronomy series no. 9) ASA, SSSA, Madison, Wis. Pp.539-579.

Obigbesan, G. O. and Akinrinde, E. A. (2000). Suitability of phosphate rocks for direct use as P sources for crop production. Nig. J. Soil Sci. 12:88-99.

Omoti, U. (1989). Fertilizer use economy in the oil palm in Nigeria through nutrition recycling. Proceeding of the International Conference on Palm and Palm Products, NIFOR 21st – 25th November, pp. 218-231.

Phosri, C., Rodriguez, A., Sanders, I. R. andJeffries, P. (2010). The role of mycorrhizas in more sustainable oil palm cultivation. Agriculture, Ecosystems and Environment, 135:187–193.

TNUA (2013).http://agritech.tnau.ac.in/agriculture/agri nutrient mgt oil palm.html.(Accessed June2013).

Zaharah, A. R., Zulkilfili, H. and Sharifuddin, A. A. (1997). Evaluatingthe efficacy of variousphosphate fertilizer sources for oil palm seedlings. Nutrient cycling in Agro systems, 47: 93-98.