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Phosphorus Uptake and Use Efficiency by Cowpea in Phosphocompost and Chemical Fertilizer Treated Nutrient Degraded Acid Soils

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Abstract

Phosphorus uptake on chemical fertilizer treated tropical soils is challenged by high phosphorus fixing and leaching potentials. Phosphocompost is a new organic fertilizer in Nigeria. Phosphorus uptake and use efficiency of phosphocompost was studied on two acid soils from Ilesha and Ogbomoso, Nigeria during 2012 and 2013 cropping seasons. Two phosphocompost: C1 and C2 applied at 2.5 and 5.0 t/ha were investigated. NPK 15:15:15 at 40 kg P_2O_5/ha, SSP (40 kg P_2O_5/ha) - urea mix (20 kg N/ha), sole SSP (40 kg P_2O_5/ha), sole lime (1 t/ha) and an unamended plot were compared. Cowpea was the test crop. Data were taken on soil available P, phosphorus uptake, phosphorus use efficiency (PUE), and relative agronomic efficiency using data on soil available P (RAE_p) and cowpea dry shoot weight (RAE_{dsw}). Phosphorus uptake was significantly ($p<0.05$) higher in phosphocompost compared to chemical fertilizer treated and untreated plots. Phosphorus uptake ranged from 1.3 – 7.9, 1.0 – 4.4 and 0.5 – 1.7 kg/ha in phosphocompost, chemical fertilizer and unamended plots respectively across the two cropping seasons. The PUE were higher in chemical fertilizer treated plots with a range of 11.4 -152.9 % while phosphocompost gave a range of 2.2-19.8 % across the two locations. Regression analysis revealed RAEp, RAE_{DSW}, available P and P uptake to contribute up to 82, 83, 82 and 75 % respectively to cowpea grain yield in Ogbomoso experimental location. Increasing RAEp, available P, P uptake, PUE and soil pH were dominant predictors for increased cowpea grain yield in Ilesha experimental location.

Keywords: Phosphocompost; Phosphorus use efficiency; Phosphorus uptake; Acidic soils; Cowpea grain yield

Abbreviations: ECEC: The Effective Cation Exchange Capacity; TEB: Total Exchangeable Bases; TEA: Total Exchangeable Acidity; SSP: Single Supper Phosphate; PUE: Phosphorus Use Efficiency; RAE: Relative Agronomic Efficiency; OEL: Ogbomoso Experimental Location; IEL: Ilesha; RAE_p: Relative Agronomic Efficiencies Using the Soil Available Phosphorus Data; DAP: Diammonium Phosphate

Introduction

Phosphorus is an essential macronutrient that plays vital role in living organisms. Adequate P availability results in improved root growth, crop quality, energy storage and higher grain yield in crops [1]. It is highly limiting in most tropical soils [2,3]. The low activity clay dominating mineral constituent of the highly weathered tropical soils has been identified as a factor limiting availability of P in soils [4]. Acid tropical soils are characterized by high concentrations of oxides and hydroxides of Al and Fe that have insatiable appetite for P [4]. Management practices including the use of chemical P fertilizers and liming materials are popular in optimizing crop performance and yield on nutrient degraded soils in the tropics [5]. The limitations to use of P fertilizer are rising procurement cost, susceptibility losses to leaching, run off (on sandy textured soils) and fixation by soil inorganic colloids [6].

Nutrient use efficiency by crops is the ability of crops to produce high yield in soils limited in the nutrient added [7]. Nutrient use efficiency is high when enhanced crop yield is obtained from reduced fertilizer input cost and nutrient losses into the soil environment. Phosphorus use efficiency on field treated with conventional chemical fertilizers have been reported low (range of 5 – 40 %) for many tropical soils [6]. Low P use efficiencies in chemical fertilizers are contributed mainly by losses to leaching, run-off and fixation by soils [8]. Nutrient losses from farms are important in soil degradation and underground water pollution [9]. Benefits of improved soil organic matter on soil physical and chemical properties as it affects nutrient use efficiency have been reported [10]. Soil organic matter from applied green manure, crop residues, animal manure and compost improved soil aggregate stability, increased water and basic cation holding capacities and chelate toxic Al and Fe [11].

Phosphocompost is phosphorus enriched compost [12]. It is a relatively new soil amendment in many developing countries in the tropics. It is however popular in areas with natural depot of rock phosphate. It is prepared from mixture of rock phosphate, carbon sources (e.g. sawdust, rice bran, plant residues etc) and protein sources (e.g. animal manure) are common [12,13]. Phosphocompost when compared with conventional compost has lower ammonium-N and C/N ratio with improved total nitrogen, soluble phosphorus and organic acids (formic, citric, Lactic and acetic acids) [13]. The application of phosphocompost on strongly acid soils had been reported to improve soil pH, organic matter, total nitrogen, available P, P uptake of crops [14,15] compared to chemical fertilizers [13]. The researchers [13] also reported the ability of phosphocompost to chelate toxic Al ions helps to increase phosphorus use efficiency. Cowpea is an important grain legume in Africa. It serves as major source of dietary protein for man. Phosphorus deficiency and soil acidity are important factors militating against high yield of cowpea on tropical soils [16]. Importance of phosphorus in cowpea nutrition has been reported by [17] to initiate nodule formation and enhance efficiency of symbiotic nitrogen fixing organisms (rhizobium). The objectives of this study were to assess the P availability, uptake and use efficiencies of phosphocompost (by cowpea) prepared from bone meal fortified rice bran and sawdust based composts.

Materials and Methods

Description of the experimental sites

The study was conducted at two sites in Oyo and Osun States, south western Nigeria (Figure 1). The locations and history of the experimental sites are given in (Table 1). Osun study location was at the Teaching and Research Farm of the Leventis School of Agriculture, Imo, and Ilesha while that of Oyo was at the Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso. The soils of the Ilesha study site originate from rocks rich in amphibole, gneiss and biotite schist. The soil is characterized by reddish colour and low base saturation [18]. It is classified as Ultisols using Soil Survey Staff (2010) according to [19]. Soil at the Ogbomoso study site was formed on a basement complex and characterized by large concretions resulting in hard pan formation [18]. The soil is sandy and greyish with high base saturation [18]. The soil is classified as Alfisols using Soil Survey Staff (2010) according to [20].

Table 1: Location, Land use, parent materials and soil types of the experimental locations.

Soil Tag	Site Location	Land Use	Soil Series	USDA Taxonomy	Parent Material
Ilesha	07° 36"N, 04° 46"E, 1368 ft ASL, Osun State	Annual cultivation of maize and cassava with NPK 15:15:15 fertilizer usage for fertility management.	Itagunmodi	Ultisols	Basement complex
Ogbomoso	08° 10"N, 04°10"E, 1160 ft ASL, Oyo State	Previously used for annual maize and cassava production with application of urea and NPK 15:15:15 fertilizers. It was abandoned for crop production due to nutrient depletion two years before the start of this experiment.	Gambari	Alfisols	Basement complex

ASL: Above Sea Level

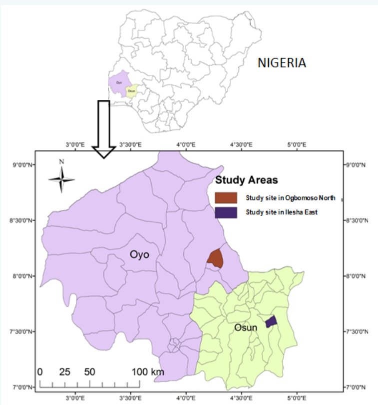

Figure 1: Map of Nigeria showing the experimental locations.

Soil sampling, preparation and routine analysis

The fields were sampled to depth of (0-20) cm. The soil samples collected were air dried, passed through 2 mm sieve and subjected to routine analysis. The physical and chemical analyses of the soil samples were carried out at the Department of Agronomy, University of Ibadan. Particle size was determined by hydrometer method [21]. Soil pH was determined on a 1:2 (soil: water) ratio after 15 minutes equilibration period using a glass electrode calibrated in pH buffers 4, 7 and 9. Organic carbon was determined by the dichromate wet oxidation method as described by [22]. Phosphorus was extracted with Bray P-1 solution and the P in the extract was determined by Molybdate blue colour method of [23] with Spectronic 20. Exchangeable cations (Ca, Mg, K and Na) were extracted with 1 N NH_4OAc (pH 7) at a soil: extracting

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solution ratio of 1:10 for 15 minutes. The concentration of Ca and Mg were read on the Atomic Absorption Spectrophotometer while those of K and Na were read on the Flame Photometer. Exchangeable acidity was extracted with 1 N KCl and titrated against 0.01N NaOH. Exchangeable Al was determined by further titration of the same extract with 0.01N HCl as described by [24]. The effective cation exchange capacity (ECEC) was obtained by the sum of the total exchangeable bases (TEB) and total exchangeable acidity (TEA). Total Nitrogen was determined by Macro-Kjeldahl method as described by Bremner [25].

Field layout, treatments and experimental design

The fields were mechanically cleared, ploughed and harrowed. It was laid out in eleven plots per replicate with each measuring 2 m x 2 m. Two phosphocompost (preparation process described in [15]) tagged C1 and C2 applied at 2.5 and 5 t/ha (equivalent to 1 and 2 kg/4 m^2) were investigated. The bone meal for compost fortification was applied at the rate of 40 kg P2O5/ha equivalent to 546 g/ 4 m2. Three chemical fertilizer plots viz: Urea applied at 20 kg N/ha (equivalent to 17.7 g/4 m2) mixed with Single Supper Phosphate (SSP) applied at 40 kg P_2O_5/ha (equivalent to 88.9 g/4 m^2), NPK 15:15:15 applied at 40 kg P_2O_5/ha (equivalent to 106 g/4 m^2) and a plot that received SSP at 40 kg P2O5/ha (equivalent to 88.9 g/4 m2) were included. Plots that received lime alone and no amendment were also compared. The experiment was laid out in a randomized complete block design with three replications resulting in 33 experimental plots per location. Phosphocompost treatments were applied only during the 2012 cropping season. The 2013 cropping was used to assess residual potentials of the phosphocompost on soil P availability, uptake and use efficiency by cowpea. Similar chemical fertilizer rates as 2012 cropping were however reapplied to chemical fertilizer plots during the 2013 cropping. Cowpea (Ifebimpe variety) was the test crop during both cropping seasons.

Data collection

Soil samples collected at harvesting were analysed for available P using the procedure earlier described. Cowpea grain yield and dry shoot weight were assessed at harvesting. Phosphorus contents in the shoots were determined after harvesting. The Vanado-molybdate yellow method was followed for phosphorus determination as described by [22]. The phosphorus content in the shoot was used for the estimation of phosphorus uptake as:

P uptake = Phosphorus content x Dry shoot weight [13]. Phosphorus use efficiency (PUE) and relative agronomic efficiency (RAE) of the phosphocompost using dry shoot weight (RAE_{DSW}) and soil available P data (RAE_P) were estimated following the formulae adopted by [13].

PUE = P uptake from treatment – P uptake from control x 100

Applied Phosphorus

RAE_{DSW} =Dry shoot weight from PC - Dry shoot weight from control x 100

Dry shoot weight from SSP - Dry shoot weight from control

This formula was modified (using soil available phosphorus data) as

RAE_P = Avail. P from Phosphocompost–Avail. P from control x 100

Avail. P from SSP – Avail. P from control

Statistical analysis

The soil, plant and yield data collected from each field were subjected to analysis of variance using Genstat statistical package and significant means were separated using Duncan's multiple range test at 5 % probability level. Regression analysis was utilized to predict contributions of the phosphocompost efficiency data to cowpea grain yield.

Results

Physical and chemical properties of the experimental soils

The physical and chemical characteristics of the soils are shown in (Table 2). The soil at Ogbomoso experimental location (OEL) was moderately acidic with pH 5.7 while that at Ilesha (IEL) was strongly acidic with pH 4.8. The two soils were deficient in available P, total N, organic carbon and exchangeable calcium. Exchangeable acidity concentration was high in IEL soil series and low in OEL.

Table 2: Physical and chemical properties of the soils at the experimental locations.

Parameters	OEL	IEL
pH (water, 1:2)	5.7	4.8
Org. Carbon (g/kg)	8.4	13.2
Total N (g/kg)	1.0	1.3
Avail. P (Bray-1) (mg/kg)	1.9	3.6
Exchangeable Cations (cmol/kg)		
Ca	1.15	0.98
Mg	0.20	0.48
H	0.70	0.90
Al	0.10	1.20
Ex. Acidity (cmol/kg)	0.80	2.10
ECEC (cmol/kg)	2.45	3.96
Particle size (g/kg)		
Sand	820	530
Silt	80	150
Clay	100	320
Textural class	Sandy loam	Sandy clay loam

OEL: Soil at Ogbomoso experimental location; IEL: Soil at Ilesha experimental location

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Nutrient contents of the phosphocompost tested

The nutrient contents of the phosphocompost tested are shown in (Table 3). Phosphocompost C1 was higher in phosphorus content while C2 was higher in nitrogen and organic carbon. Both however were alkaline in reaction making them suitable for use on acid soils.

Table 3: Nutrient contents of the phosphocompost tested.

Phosphocompost	pH (H_2O)	N (g/kg)	Org. C (g/kg)	P(g/kg)	Ca (g/kg)	Mg (g/kg)	K (g/kg)	Na (g/kg)
C1	9.1	4.1	259.5	83.6	64.9	5	5.7	66.3
C2	9.4	5.2	294	68.3	64.6	5.2	7.5	67.2

Effects of phosphocompost, lime and chemical fertilizers on soil available P in two acid soilP

Phosphocompost application significantly increased available phosphorus in the soils compared to lime, chemical fertilizers and AC (Table 4). Phosphorus availability increased with increasing phosphocompost application rate. Similar available P concentrations were observed from all the chemical fertilizer treated plots during each cropping per location. Higher soil available P concentrations were recorded from IEL compared to OEL.

Table 4: Effects of phosphocompost, lime and chemical fertilizers on soil available P in two acid soils.

Means followed by the same letter (s) in the same column are not significantly different by DMRT at $p<0.05$. AC: Absolute Control; L: Lime; C1 – C2: Phosphocompost type 1 and 2; Values preceding C1, C2, C3 and C4 are rates of phosphocompost application. SSP: Single superphosphate; NPK: NPK 15:15:15.

Treatments	Available P (mg/kg)			
	Ilesha		Ogbomoso	
	2012*	2013	2012	2013
AC	5.13 e	2.31 e	2.6 e	2.1 d
Lime	6.75 e	2.7 e	3.0 e	2.0 d
2.5C1	44.76 d	16.69 bc	24.3 c	22.0 b
5C1	144.5 a	26.6 a	61.62 b	35.5 a
2.5C2	67.43 c	12.19 c	68 .0 a	21.0 b
5C2	76.56 b	18.43 b	70.8 a	32.5 a
NPK	14.5 e	9.7 d	3.1 e	7.9 c
Urea+SSP	13.2 e	9.8 d	8.1 d	9.4 c
SSP	13.5 e	10.8 d	9.4 d	9.6 c

*cropping season.

Phosphorus uptake by cowpea on phosphocompost, lime and chemical fertilizer treated acid soils

Phosphocompost and chemical fertilizers improved phosphorus uptake in both soils compared to lime and AC (Table 5). Phosphocompost gave P uptake range of 1.9- 5.6 and1.3- 7.9 kg/ha in IEL and OEL respectively across the two cropping. A range of 1.0 - 4.4 and 1.0 – 3.1 kg/ha were observed from chemical fertilizer treated soil from IEL and OEL respectively across the two cropping. Phosphocompost C1 increased P uptake with reducing application rate in IEL while it increased P uptake with increasing application rate in OEL. Phosphorus uptake however reduced generally across all the phosphocompost treated plots in the 2013 cropping.

Table 5: Phosphorus uptake by cowpea on phosphocompost, lime and chemical fertilizer treated acid soils.

Means followed by the same letter (s) in the same column are not significantly different by DMRT at $p<0.05$. AC: Absolute control; L: Lime; C1 – C2: Phosphocompost type 1 and 2, Values preceding C1, C2, C3 and C4 are rates of phosphocompost application. SSP: Single Superphosphate; NPK: NPK 15:15:15.

Respectively Phosphocompost C2 gave a range of 7.8 – 17.4 and 2.2 – 21.3 % in IEL and OEL respectively.

Treatments	Phosphorus uptake (kg/ha)			
	Ilesha		Ogbomoso	
	2012*	2013	2012	2013
AC	1.7 d	0.6 d	0.5 e	0.8 f
Lime	1.8 d	1.3 c	0.8 de	1.1 e
2.5C1	5.2 a	2.7 b	2.5 c	4.1 b
5C1	4.5 b	3.7 a	7.9 a	6.1 a
2.5C2	4.7 b	1.9 c	3.9 b	4.4 b
5C2	5.6 a	3.4 a	1.3 d	2.2 d
NPK	4.4 b	1.7 c	1.5 d	1.5 e
Urea+SSP	3.6 c	1.1 c	1.0 d	3.1 c
SSP	3.7 c	1.0 c	2.5 c	1.7 e

Cropping season

a. Phosphorus use efficiencies of phosphocompost and chemical fertilizers by cowpea: Phosphorus use efficiencies of treatments applied were highest in chemical fertilizer treated plots at both experimental locations (Table 6). The NPK fertilizer consistently gave highest PUE at IEL. Lower phosphocompost application rate had higher PUE at both locations except in phosphocompost C1 at OEL during 2012 cropping. Phosphocompost C1 gave PUE range of 6.6-17 and 9.7-17.6 % in IEL and OEL respectively. Phosphocompost C2 gave a range of 7.8- 17.4 and 2.2 – 21.3 % in IEL and OEL respectively.

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Table 6: Phosphorus use efficiencies of phosphocompost and chemical fertilizers by cowpea.

AC: Absolute Control; L: Lime; C1 – C2: Phosphocompost type 1 and 2, Values preceding C1, C2, C3 and C4 are rates of phosphocompost application. SSP: Single Superphosphate; NPK: NPK 15:15:15.

Treatments	Phosphorus use efficiency (%)			
	Ilesha		Ogbomoso	
	2012*	2013	2012	2013
AC	0.0	0	0	0
Lime	0.0	0	0	0
2.5C1	17.0	10.1	9.7	16.0
5C1	6.6	7.5	17.6	12.6
2.5C2	17.4	7.8	19.8	21.3
5C2	11.5	8.2	2.2	4.1
NPK	152.9	64.2	54.9	41.4
Urea+ SSP	60.8	16.8	14.8	71.9
SSP	64.2	11.4	63.2	28.6

Cropping season

a. Relative agronomic efficiencies of phosphocompost, lime and chemical fertilizers using soils available P (RAE_P) cowpea dry shoot weight (RAE_{DSW}) data in two acid soils: Relative agronomic efficiencies using the soil available phosphorus data (RAE_P) were highest in the phosphocompost treated plots at both experimental locations compared to chemicals fertilizer and lime treatments (Table 7). The RAEP were higher across all the treatments during 2012 cropping season at both locations. The efficiency of available P released from the applied phosphocompost C1 was 2 and 4 times higher than the referenced single super phosphate fertilizer in IER and OEL respectively at the end of 2013 cropping season. The RAEDSW on the other hand was higher across all the treatments at both locations during the 2013 cropping season. Phosphocompost application again had higher RAEDSW compared to chemical fertilizer and lime except in IEL during 2012 cropping season. Higher application rate of phosphocompost C1 and lower rate of C2 gave higher RAEDSW at both locations.

Table 7: Relative agronomic efficiencies using available P (RAEP) and cowpea dry shoot weight (RAE DSW) data in two acid soils.

Treatments	Relative Agronomic Efficiency (DSW) (%)				Relative Agronomic Efficiency (DSW) (%)			
	Ilesha		Ogbomoso		Ilesha		Ogbomoso	
	2012*	2013	2012	2013	2012*	2013	2012	2013
AC	0	0	0	0	0	0	0	0
Lime	19	5	6	-1	19	4186	9	161
2.5C1	473	169	321	268	91	7828	63	1071
5C1	1665	286	870	448	47	16513	218	2274
2.5C2	744	116	964	254	56	198893	93	805
5C2	853	190	1006	408	58	16368	10	288
NPK	112	87	7	77	131	9206	55	374
Urea+ SSP	96	88	81	97	79	1831	6	753
SSP	100	100	100	100	100	100	100	100

Cropping season

a. Contributions of selected soil chemical and phosphocompost efficiency parameters to cowpea grain yield in two acid soils: The contributions of selected soil chemical and phosphocompost efficiency parameters to cowpea grain yield at the end of the trial are presented in (Figures 2 & 3). All the parameters considered had positive relationship with cowpea grain yield. However, at the OEL, RAEp, RAE_{DSW}, available P and P uptake contributed up to 82, 83, 82 and 75 % in the cowpea grain yield. Increasing RAEp, available P, P uptake, PUE and soil pH were dominant predictors of increased cowpea grain yield in IEL.

Discussion

Phosphocompost applications increased available P in the soils studied. This is first attributed to increases in soil pH (data not presented) brought about by the phosphocompost applied. Increases in soil pH had been reported on acid soils treated with organic materials [15,26,27]. Increasing soil pH enhanced P release from adsorbed site of the soil colloid into soil solution

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and eventual uptake by cowpea. The increased P uptake in phosphocompost treated soils was most likely due to plant establishment and proper root development induced by the water soluble P mineralized into the soil by the phosphocompost. This is in agreement with the findings of [13,28]. [29] Identified toxic levels of Al and Ca deficiencies in acid soils as dominant factors restricting root elongation in plants sown on acid soils which impair efficient nutrient uptake. This is possibly the situations in the unamended and chemical fertilizer treated plots in this work. Ability of phosphocompost to improve nutrient uptake, use efficiency and over all grain yield had been reported [14].

Phosphorus use efficiencies (PUE) were generally lower in phosphocompost compared to chemical fertilizer treated plots. It was exceptionally low in 5C1 in IEL and 5C2 in OEL [13]. Also observed higher PUE in single super phosphate over phosphocompost in their work. This suggests an inverse relationship between available P in phosphocompost treated soils and PUE. Treatments 5C1 and 5C2 were responsible for highest available P in their respective treated soils. Interestingly, NPK treated soils during similar cropping gave least available P in both soils. These lower PUE in phosphocompost compared to chemical fertilizer may suggest possible losses/uses of phosphate ions by phosphocompost through other means than plant uptake. One of the possible ways is utilization by increasing microbial population in the treated soils. Phosphorus is a major source of energy to living things including soil microbes. The reducing PUE with increasing application rate rightly affirms these findings. Microbial population and activities were reported to increase in soils with increasing application rate of organic amendments [26]. The result therefore was increased P usage from the soil P pool for metabolic activities and body building by the microbes [30]. Had earlier explained the fate of biologically fixed phosphate. He described it as a better form of P fixation compared to inorganic P fixation by oxides of Al and Fe. Phosphorus fixed biologically by soil microbes will eventually be released into readily available P form when the microbes expire.

The relative agronomic efficiencies (RAE) were very high in phosphocompost compared to chemical fertilizer and sole lime treated soils [13]. Also reported higher RAE in phosphocompost compared to single super phosphate and rock phosphate. The results from the present work suggests phosphocompost to be a more efficient P source in the soils studied compared to chemical fertilizers tested. The phosphocompost prepared from agro waste (sawdust, rice bran, poultry manure and bone meal) did not only reduce environmental pollution associated with the reckless discharge of these wastes into the environment but gave an environmentally friendly fertilizer. Similar higher RAE in organic amendment integrated with diammonium phosphate (DAP) treated soils had been reported [31] compared to sole DAP and poultry manure [14]. Attributed the ability of phosphocompost to easily supplement readily available phosphate ions in the soil solution to the generally higher relative agronomic efficiencies recorded in soils been treated by phosphocompost.

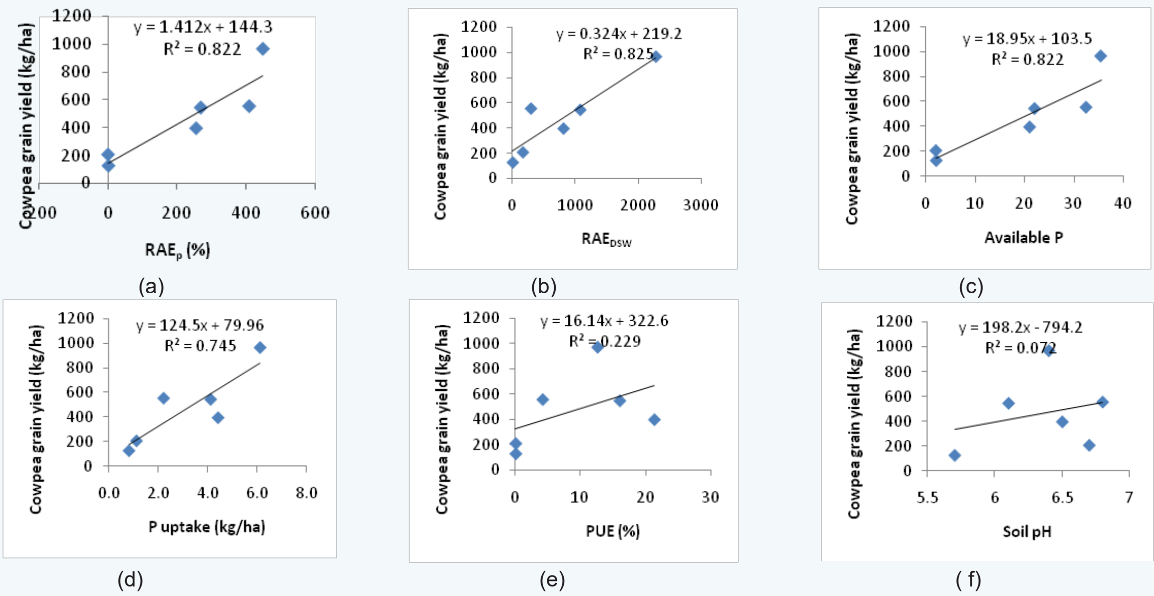

Figure 2: Contributions of (a) relative agronomic efficiencies using soil available P (RAEp) (b) cowpea dry shoot weight (RAEDSW) (c) soil available P (d) P uptake (e) P use efficiency and (f) soil pH to cowpea grain yield at Ogbomoso experimental location.

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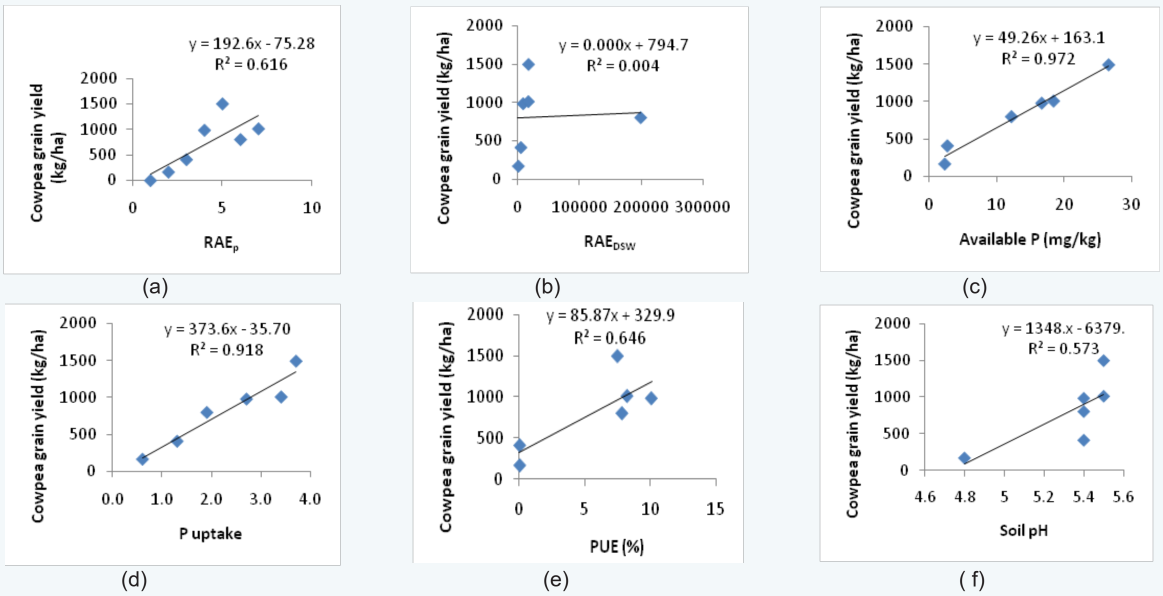

Figure 3: Contributions of (a) relative agronomic efficiencies using soil available P (RAEp) (b) cowpea dry shoot weight (RAEDSW) (c) soil available P (d) P uptake (e) P use efficiency and (f) soil pH to cowpea grain yield at Ilesha experimental location.

Conclusion

Usage of phosphocompost at both rates studied on acidic nutrient degraded soils in Ilesha and Ogbomoso, south western Nigeria will go a long way to reduce high application rates of chemical fertilizers on these fragile soils. Phosphocompost will not only reduce P deficiencies, improve P uptake and grain yield of crops but also enhance recycling of agro-waste into useful soil amendments (which is not a usual practice among farmers in the experimental locations). It will also reduce environmental pollution associated with reckless disposal of raw agro-wastes.

References

1. Douglas BB, Philip TD (2012) Managing phosphorus for crop production. Agronomy Fact 13.Publication distribution Centre, Pennsylvania State, pp. 1-2.
2. Anetor MO, Akinrinde EA (2007) Lime effectiveness of some fertilizers in a tropical acid Alfisols. Journal of Central European Agriculture 8(1): 17-24.
3. Horst WJ (2000) Fitting maize into sustainable cropping systems on acid soils of the tropics. In: Management and conservation of tropical acid soils for sustainable crop production. Proceedings of consultants meeting organized by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Vienna 41-50.
4. Harter RD (2002) Acid soils of the tropics. Echo Technical Note 48.
5. Franklin ON (2012) Ameliorating soil acidity in Ghana: A concise review of approaches. ARPN Journal of Science and Technology Special issue, ICESR 2: 1-9.
6. Syers JK, Johnston AE, Curtin D (2008) Efficiency of soil and fertilizer phosphorus use: reconciling changing concept of soil phosphorus behaviour with agronomic information.
7. Graham RD (1984) Breeding for nutritional characteristics in cereals. In: Tinker, P.B. and Lauchli, A. (Eds.), Advances in plant nutrition, vol. 1.Praiger Publisher, New York, USA, pp. 57 -102.
8. Baligar VC, Fageria NK, He ZL (2001) Nutrient use efficiency in plants. Communications in Soil Science and Plant Analysis 32(7-8): 921-950.
9. Blair G (1993) Nutrient efficiency-what do we really mean. Genetic aspects of plant mineral nutrition. In: Randall, PJ, et al. (Eds.), Kluwer Academic Publishers, Dordcrecht, the Netherlands, Europe, pp. 205-213.
10. Baligar VC, Fageria NK (1997) Nutrient use efficiency in acid soils: Nutrient management and plant use efficiency. In: Monitz AC, et al. (Eds.), Plant - soil interactions in low pH: Sustainable Agriculture and Forestry Production. Brazilian Soil Science Society Compinas, Brazil, South America, pp. 75-93.
11. Fageria NK (1992) Maximizing crop yields. Marcel Dekker, New York, USA, pp. 15-18.
12. Chen JH, Jeng-Tzung WU, Wei-Tin H (2001) Effects of compost on the availability of nitrogen and phosphorus in strongly acidic soils. Technical Bulletin, FFTC Publication, pp. 1-10.
13. Hellal FAA, Nagumo F, Zewainy RM (2013) Influence of phosphocompost application on phosphorus availability and uptake by maize grown in red soil of Ishigaki Island, Japan. Journal of Agricultural Sciences 4(2): 102-109.
14. Ajaym KK, Verma MM, De N (2012) Phosphocompost influences nutrient use efficiency, yield and quality of rice (Oryzasativa). Asian Journal of Soil Science 7(2): 172-177.
15. Oyeyiola YB, Omueti JAI, Kolawole GO (2015) Effects of phosphocompost on acidity indices in an acidic soil in Ilesha, south-western Nigeria. In: Rahmann G, et al. (Eds.), Proceeding of the 3rd African Organic Conference. Achieving Social and Economic Development through Ecological and Organic Agriculture Alternatives, Lagos, Nigeria, Africa.
16. IITA (2003) Crop and farming systems. International Institute of tropical agriculture, Ibadan, Nigeria, Africa, pp. 24-27.
17. Nkaa FA, Nwokeocha OW, Ihuoma O (2014) Effect of phosphorus fertilizer on growth and yield of cowpea (Vigna unguiculata). IOSR Journal of Pharmacy and Biological Sciences (IOSR-JPBS) 9(5): 74-82.
18. Amusan A, Ashaye TI (1991) Granitic-Gneiss derived soils in humid forest tropical south-western Nigeria 1. Genesis and classification. Ife Journal of agriculture 13: 1-10.
19. Smyth AJ, Montgomery RF (1962) Soils and land use in central western Nigeria. Government Printer, Ibadan, pp. 214-250.
20. Olatunji OO (2011) Forms and distribution of sesquioxides and effects

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on phosphate sorption in some soil on basements complex of south-western Nigeria. Ph.D. Thesis, LAUTECH, Ogbomoso, Nigeria, Africa, pp.192.

21. Bouyoucos GJ (1961) Hydrometer method improved for making particle size analysis of soils. Agronomy Journal 54(5): 464-465.
22. IITA (1978) Selected methods for soil and plant analysis. Manual series No.1 (2nd edn), pp. 1-24.
23. Murphy J, Riley JP (1962) A modified single solution method for the determination of phosphate in natural waters. Analytica Chimica Acta 27: 31-36.
24. Cassio HA, Takashi M, Andre FL (2003) Exchangeable aluminium evaluation in acid soils. Scientia Agricola 60(3).
25. Bremner JM (1982) Nitrogen-urea. In: Methods of soil analysis. Page, AL, Miller RH (Eds.), 2nd edition, Madison, pp. 699-709.
26. Haynes RJ, Mokolobate MS (2001) Amelioration of Al toxicity and P deficiency in acid soils by additions of organic residues: a critical review of the phenomenon and the mechanisms involved. Nutrient Cycling in Agro ecosystem 59(1): 47-63.
27. Iyamuremye F, Dick RP, Baham J (1996) Organic amendment and phosphorus dynamics 1: Phosphorus chemistry and sorption. Soil Science 161(7): 426-435.
28. Kisinyo PO, Pthieno CO, Gudu SO, Okalebo JR, Opala PA, et al. (2014) Immediate and residual effects of lime and phosphorus fertilizer on soil acidity and maize production in western Kenya. Experimental Agriculture 50(1): 128 -143.
29. McCray JM, Sumner ME (1990) Assessing and modifying Ca and Al levels in acid sub soils. Advances in Soil Science 14: 45-75.
30. Tan KH (2011) Principle of soil chemistry. (4th edn), New York, USA, CRC Press, pp.10- 85.
31. Mujeeb F, Rahmatullah JA, Ahmad R, Akhtar J (2010) Integration of organic and inorganic P sources for improving P use efficiency in different soils. Soil and environment 29(2): 122-127.

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