Influence Of Indigenous Rock Phosphate On Vegetative Growth And Yield Performance Of Soybean (*Glycine Max* L.) In Ikorodu Agro Ecological Zone Nigeria

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Abstract: Phosphorus is a major plant nutrient next to nitrogen in augmenting plant metabolic activity ultimately reflecting on the crop yield. The study was designed to investigate the effect of variable rates of two sources of rock phosphate (Ogun and Sokoto) on the growth and performance of Soybean, laid out in Completely Randomized Design, replicated four times at the Screen house of Teaching and Research Farm, Lagos State Polytechnic, Ikorodu, Nigeria. There are 4 rates in all with control (0g, 5g, 10g and 15g) apply to each polybag. The rock phosphate was evaluated on the following agronomic parameters: plant height, number of leaves, leaf area and shoot fresh weight 9 weeks after sowing (WAS), number of pods at 9 WAS. Data collected were subjected to analysis of variance and results shows that rock phosphate (RP) application significantly ($P<0.05$) influenced growth and pod yield of soybean. It was also observed that Soybean responded to the different levels of rocks phosphate based on the available soil phosphorus.

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Introduction

The immobilization of phosphorus ultimately warrants for P application in amounts high enough to compensate for crop removal and fixation by soils. Phosphorus is a major plant nutrient next to nitrogen in augmenting plant metabolic activity ultimately reflecting on the crop yield. It is involved in a wide range of plant processes from permitting cell division to the development of a good root system, ensuring timely and uniform ripening of the crop. It is needed most by young, fast-growing tissues and performs a number of functions related to growth, development, photosynthesis and utilization of carbohydrates. The availability of P to crops depends on adsorption and desorption processes that are ultimately governed by the presence of calcium carbonate and the oxides of iron and aluminium (Jama *et al* 2000). At present, high cost of fertilizer, energy crisis and escalating cost of crude oil limit the use of fertilizer in developing countries like Nigeria. While, research efforts need to focus on the development of low input technologies, these will have to be considered with other management practices to ensure maximum efficiency of inputs. Hence, there is a need to find ways of increasing the availability of phosphorus in soil keeping the environment safe. Of the several ways suggested for improving the phosphorus availability in agricultural soils, use of organics and microorganisms has been stressed (Gaur, 1992).

Application of phosphorus fertilizer is often necessary for crop production in sub-Saharan African soils. However, the high cost of soluble phosphate fertilizer such as single or triple super phosphate has generated considerable interest in the utilization of rock phosphate (Nnadi and Haque, 1988; Chien and Hammond 1989; Akande et al., 1998). Finely ground rock phosphate is an apatite mineral not readily soluble in water, and when added to acid soils, the solubility of rock phosphate is increased.

Soybean is an introduced pulse crop in Nigeria in 1908 and the main growing area is the Southern Guinea zone. Its production has however been extended to other states in recent years (IAR&T, 1985). The main reason for its popularity in the world is its richest protein content as compared to other pulse crops. It also contains valuable oil, which is perhaps exceptional in pulse crops. Besides valuable protein and oil present in soybean, its utilization is not only limited to soybean flour and soya milk, but innumerable other products like plastics, paints, glue, linoleum, glycerine *etc*. are also manufactured. The objective of the present study is to evaluate the effects of rock phosphates on the growth of soya bean in south western Nigeria.

Materials and Methods

The study was carried out in the screenhouse at the Teaching and Research Farms of Lagos State Polytechnic, Ikorodu, Lagos State, Nigeria lies between Latitude 5° 10' N and Longitude 3° 16' E, located in the humid tropical rainforest agro-ecological zone.

The top soil used for the pot experiment was collected (20cm deep) randomly from a field previously under a secondary bush made up of some broad-leaves with a dominant population of grass weeds for over four month pre-trial. The core soil samples collected was mixed thoroughly, shed–dried and sieve through a 2mm screen. A composite soil sample was obtained from the sieved soil for texture and chemical characteristics. For example, particle size distribution by Boyoucos method (ICRDA, 1996), available P was determined according to the method of Bray and Kurtz (1945) total N and (%) was determined by the macro-kjedahl method described by Bremmer and Malvancy (1982). Soil PH (1:2) (soil/water) retention was determined by electrode method while % carbon was determined using the wet oxidation procedure of Walkely and Black (1934). Exchangeable potassium was determined by flame photometer, while cation exchange capacity (CEC) was determined by Amnonium acetate saturation method (Roades, 1982).

Ten (10) kilograms soil was weighed into each basally perforated polybags, the polybags were then arranged into completely randomized design in the screen house, teaching and research farm Lagos State Polytechnic, Ikorodu, Lagos State, Nigeria.

The treatments were indigenous rock phosphate (RP) (Ogun (ORP) and Sokoto (SRP)) and a sample was taken to the laboratory for the determination of its chemical constituents. The basic cations Ca^{2+}, Mg^{2+} and K^{+} were determined in flame photometric method and the available P was determined by Bray method (Bray and Kurtz, 1945).Results of the laboratory analysis for both rock phosphate and soil used are presented in (Table 1).

The treatments, replicated three times using Randomized Complete Block Design (RCBD) were randomly allocated to the polybags (3) making up a plot. Each treatment was mixed into the soil in each polybag at the following rates 0, 5, 10 and 15g and 1 litre of water was used to wet the soil in each polybag to aid the nutrient solubility.

TGX 306-02D cultivar of soya bean used for the experiment was obtained from Institute of Agricultural Research and Training (IAR&T) Ibadan, Nigeria and this was planted at 2 seeds per hole and later thinned to one vigorous seedling per stand. Foliage insect was control with the application of 5ml cypermethrin into 10 litres of water at 3 and 6 weeks after planting (WAP). Light weeding was done by hand pulling as at when due,

Data were collected on the following parameters: plant height, number of leaves, leaf area, fresh weight of shoot, number of harvested pods. The data on each parameter were subjected to analyses of variance (ANOVA) using GLM procedure in SAS (2004). Treatment means found to be significantly different from each other were separated by least significant differences (LSD) at $p < 0.05$.

Results

The chemical properties and textural classification of the experimental soils are presented in Table 1. The result revealed that the soil was sandy loam in texture with high proportion of coarse sand. The soil pH showed that the soil was slightly acidic with pH value of 5.45. The fertility status of the soil used for the study was low in major nutrient elements. The chemical analysis of the rock phosphate showed that SRP and ORP had 33.90% and 31.60% P_2O_5 respectively, 48.40% Ca, 107ppm Cl and 2.1% Fe_2O_3 (Table 1). This clearly indicated that the rock phosphate is a veritable P input in a P deficient soil.

The response of soy bean to RP application on vegetative growth and yield was presented in figure 1. Data obtained from the study indicated that plant height was significantly influenced by the application of rock phosphate. Mean plant height of soy bean that received SRP ranged from 57.75-67.30cm and ORP ranged from 61.97-69.80cm respectively. In both RP sources soy bean that received 15kg/bag recorded significantly higher plant height compared to other rock phosphate rates and the control bags recorded the shortest height. Mean number of leaves in SRP ranged from 18.80-20.97/plant and range from 20.05-24.75/plant in soy bean that received ORP. The soy bean that received no RP had the lowest number of leaves and differs significantly compared to those that received RP. The RP sources did not significantly affect stem girth growth. However, mean stem girth recorded in SRP ranged from 5.18-6.85cm^3 and mean stem girth in ORP ranged from 5.92-6.72cm^3. Leaf area development in soy bean that received SRP ranged from 9.5-13.13cm^2 and ORP ranged from 8.5-16.68cm^2. In both RP sources, leaf area development increased with the increase in application rates.

The effect of RP was highly significant ($p<0.05$) on fresh shoot and pod yield. The fresh shoot weight of soy bean supplied with SRP and ORP ranged from 16.27-23.37g/plant and 18.93-24.87g/plant respectively. The highest fresh shoot weight was observed in soy bean applied with 15kg RP and the lowest fresh shoot weight recorded in the control treatment. The number of pods harvested from soy bean that received SRP ranged from 20.4-27 pods/plant and ORP phosphate number of pods ranged from 19.5-24.5 pods/plant. Highest number of pods was recorded in soy bean that received 15kg rock phosphate and this was significantly different compared to control treatment.

Table 1: properties of the soil samples used and rock phosphate

Properties	value		Ogun rock	Sokoto rock
pH (H_20)	5.45	P_20_5	31.60%	33.90%
% Organic matter	0.20	Ca	48.40%	48.40%
% N	0.10	Cl	107ppm	107ppm
Avail. P (ppm)	0.43	Fe_2O_3	2.1%	2.1%
Exchangeable Base				
Ca Me/100g	1.68			
Mg Me/100g	1.07			
K Me/100g	0.06			
Na Me/100g	0.18			
CEC	8.26			
Exchangeable acidity	1.10			
% Base Saturation	86.70			
Extractable micro nutrient (ppm)				
Mn	5.20			
Fe	6.90			
Cu	0.15			
Zn	3.24			
Physical analysis				
Fine sand (%)	29.35			
Coarse sand (%)	45.67			
Silt (%)	11.45			
Clay (%)	13.35			
Textural class	Sandy Loamy			

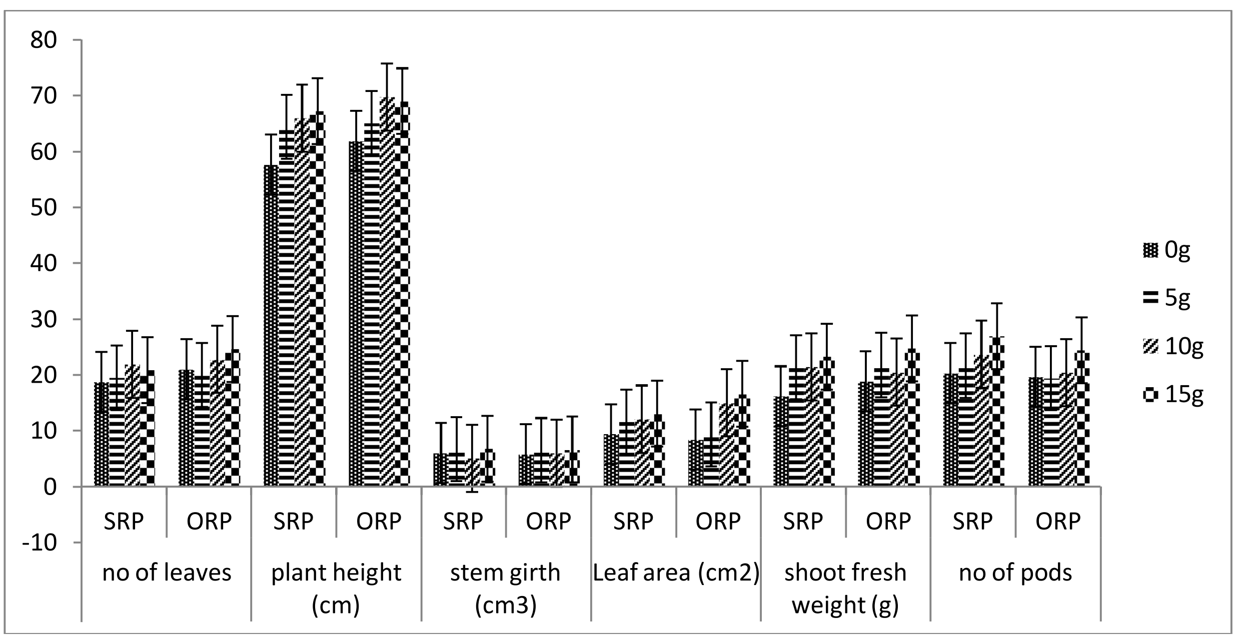

Figure 1: Growth and yield performance of soybean planted on soil amended with rock phosphate.

Discussion

Phosphorus deficiency is one of the most important fertility problems in tropical agriculture (Haru and Ethiopia, 2012). Its functions cannot be performed by any other nutrient, and an adequate supply of phosphorus is required for optimum growth and reproduction (Uchida, 2000). Phosphorus is needed in almost every phase of plant's vital processes (Panigrahy *et al* 2009; Tairo, and Ndakidemi, 2013). Its involved in several key plant functions, including energy transfer, photosynthesis, transformation of sugars and starches, nutrient movement within the plant and transfer of genetic characteristics from one generation to the next (Uchida, 2000).

The textural classification of the soil used for the study inferred that the soil was of good drainage and well aerated for good root penetration (Eleduma and Sanni, 2015). This is in agreement with the characteristics of the experimental site soil type – Alagba series (Sanni *et al* 2015). The field from which the soil used for the trial was collected had been cultivated for several years which might explain the low nutrient status (< 1.0%). This implies that cropping the soil without fertilizer use will not be economical and this justifies the use of the test crop and fertilizer input, being an N fixing plant and heavy P utilization. The positive response of soy bean to applied RP was due to the initial low fertility status of the soil used for the study. Soil pH was slightly acidic but was within the range for soy bean production. The observed low phosphorus content can be attributed to land use, vegetation and intensity of cropping at the site due to plant uptake from previous cropping. Available phosphorus (Bray 1) was very low (0.43 ppm) based on the 8-12 mg kg -1 critical level reported by Udo and Ogunwale (1977).

The agronomic effectiveness of RP can be enhanced through acid condition (Bationo and Kumar 2002). Phosphorus fertilizers could increase plant growth, especially if the P nutrient is a major limiting factor to the plant production (Lukiwati 2002). Application of RP had a positive effect on agronomic parameters of soy bean. It significantly improved the growth and yield of the test crop. The increase in plant height can reasonably be attributed to increased cell division and their elongation stimulated by adequate phosphorous availability (Sanaye *et al* 2015). Shahid *et al* (2009) provide a proof that increased phosphorus application enhances plant growth significantly. Increase in number of leaves and leaf area expansion leads to better utilization of solar radiation (Law-Ogbomo and Remison, 2008) and are bound to affect the overall performance of the plant as the leaves serves as the photosynthetic organ of the plant. Berg and Lynd, (1985) reported that phosphorus promote leaf area expansion in legumes.

The increase in fresh shoot weight came through better root development, which resulted in healthy crop growth and higher photosynthetic area due to increased leaf area. Also, the phosphorous supply augments nitrogen supply at critical growth stages like flowering and pod development through symbiotically fixed nitrogen which results better vegetative growth as well as pod development. These results corroborate the findings of Prasad et al. (1991). Higher yield recorded with 15kg was attributed to higher availability of P that might be responsible for effective nodulation. Okeleye and Okelana (1991) observed significantly increased nodulation, grain yield, and total dry matter for cowpea varieties in response to P application. The positive responses of soy bean to increase in RP level confirms the findings of Kasturikrishna and Ahlawat (1999) who reported that phosphorus is needed in relatively large amounts by legumes for growth and has been reported to promote, plant height, leaf area, biomass, yield, nodule number and nodule mass in different legumes.

The study revealed that ORP and SRP supplements are effective in improving the growth and yield of soy bean on phosphorus deficient soils. It is strongly recommended for adopt in the cultivation of soy bean in the study area. Further research work is needed to determine the application rates for sustainable soy bean cultivation.

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