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Full Length Research Paper

Effect of partial replacement of organic fertilizer with Sokoto phosphate rock on the performance of forage cowpea (*Vigna unguiculata* (*L.*) Walp) in Sokoto Dry sub-humid zone of Nigeria

M. Musa* and H. M. Fakai
Department of Crop Science, Usmanu Danfodiyo University, Sokoto, P.M.B. 2346, Sokoto, Sokoto State, Nigeria.
*Corresponding Author Email: mbmukhtar@gmail.com

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ABSTRACT: Locally and easily available rock phosphate could be a sustainable source of phosphorus for legumes production in this region where phosphorus deficiency has been identified as the major problem to crop production. As such, a field experiment was conducted during the 2011 cropping season at the Botanical Garden of the Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto to evaluate the response of forage cowpea to partial replacement of organic fertilizer with Sokoto phosphate rock in Sokoto Dry sub-humid zone of Nigeria. Treatments consisted of five sources of phosphorus (organic fertilizer (OF) 100%, Rock phosphate (RP) 100%, OF: RP 50:50, OF: RP 75:25 and OF: RP 25:75) alongside with a control where no fertilizer was applied. The treatments were laid out in a completely randomized design (CRD) replicated three (3) times. Data were collected on plant height, leaf number, fresh and dry weights. Results obtained revealed significant effect of phosphorus sources on plant height, leaf number, fresh weight and dry weight. Plant height was higher in 100% OF and number of leaves per plant was higher in OF 100% and OF: RP 75:25 combination. Fresh weight and dry weight were higher in organic fertilizer (OF) 100%, OF: RP 75:50 and OF: RP 50:50. Thus, from the findings of this study, it could be concluded that organic fertilizer could be replaced with up to 50 % RP on P_2O_5 basis without significant reduction in the performance of forage cowpea.

Keywords: Dry sub-humid**;** forage cowpea; organic fertilizer; phosphate rock

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.)Walp) has been mainly used as a grain crop in the semi arid areas of sub-Saharan Africa. However, it could be grown as a forage crop or as a dual purpose crop that provides high protein grain for human consumption as well as crop residue of high nutritive value for feeding livestock. In some cultivars, the fresh seeds and immature pods are eaten as spinach and the immature leaves are eaten as vegetable (Onwueme and Sinha, 1999; Raemaekers, 2001). Despite the important role of cowpea as one of the major sources of food and fodder in Nigeria, the yield obtained in Nigeria is low compared to the yield obtained from other countries. The average yield obtained in Nigeria is about 0.25 to 0.43 t/ha of grains (FAOSTAT, 2005) and 1.5 to 6.9 t/ha of forage depending on the variety (Hazra and Singh, 1990), while the average grain yield in Cameroon is about 0.65 t/ha (Rowland, 1993). Cowpea being an important crop not only for grain but also for forage production (Hazra and Singh, 1990) there is the need to improve its production to meet the growing demand for food as well as fodder. Availability of nutrients in the soil is an important factor to be considered for effective growth and optimum yield of crops. Therefore, in order to obtain higher yield, fertilizers are needed to supply the crop with the nutrients that are lacking in the soil (FAO, 2000). Phosphorous is usually the most limiting nutrient for the growth of legumes in these regions (Rao *et al*., 1999). Throughout Africa, the region's abundant supplies of rock phosphate form and as yet under exploited resource that, with appropriate processing, could be used to promote the cultivation of groundnut and other legumes (Gibbons *et al*., 2002). High soil organic matter content is another important property that favours the dissolution of rock phosphate and its availability to plants (Chien *et al.* 1996; FAO, 2004). Thus the present study was undertaken to evaluate the effect of partial replacement of organic fertilizer with Sokoto phosphate rock on the performance of forage cowpea in Sokoto Dry sub-humid zone of Nigeria

MATERIALS AND METHODS

The experiment was conducted at the Botanical Garden of Biological Science Department Usmanu Danfodiyo

University, Sokoto. Sokoto is located on latitude of 13^0 01' N and Longitude 5^0 15' E at an altitude of 350 m above Sea level, Sokoto lies in the Sudan savannah agro-ecological zone of Nigeria and the climate of this area is dry sub-humid which is characterized by erratic and scanty rainfall (Singh, 1995). The annual rainfall ranges between 550 to 700 mm per annum while the minimum and the maximum temperatures are 15^0 C and 40^0 C respectively. The relative humidity ranges from 21 to 45% in the dry season and between 51 to 79% during the rainy season (Sokoto Energy Research Centre (SERC). Soil samples were collected within the experimental site at 0 – 20 cm depth using soil auger. The samples collected were used for the determination of soil physical and chemical properties (Table 1). The treatments consisted of five (5) phosphorous sources (Organic fertilizer 100%, rock phosphate 100%, organic fertilizer plus rock phosphate 50:50, organic fertilizer plus rock phosphate 75:25 and organic fertilizer plus rock phosphate 25:75) maintained at a recommended application rate of 40 kg P_2O_5 ha^{-1} alongside with a control, where no fertilizer was applied. The treatments were laid out in a completely randomized designed (CRD) replicated three (3) times. Ten kilograms (10 kg) of soil collected from the experimental site was placed in each experimental pot. All the fertilizer treatments were banded below the seed in the pot at planting. Two (2) seeds per pot were planted at 5 cm soil depth after the fertilizer was slightly covered with the soil to prevent direct contact with the seeds. Harvesting was carried out at ten (10) weeks after sowing. The entire plants were uprooted.

Table 1: Physicochemical properties of the soil at the experimental site during 2011 cropping season.

Physical properties	Values
Sand (gkg^{-1})	960
Silt ($g\ kg^{-1}$)	10
Clay ($g\ kg^{-1}$)	30
Textural class	Sand
Chemical Properties	
pH in H_2O 1.1 ratio	6.02
Total nitrogen (%)	0.03
Organic carbon ($g\ kg^{-1}$)	0.54
Available phosphorus ($mg\ Kg^{-1}$)	0.19
Exchangeable bases ($Cmol\ kg^{-1}$)	
Ca	0.25
Mg	0.45
K	0.31
Na	0.33
CEC ($cmol\ Kg^{-1}$)	8.2

Data collection and analysis

Data were collected on canopy height, leaf number, fresh weight and dry weight. The data collected were subjected to analysis of variance (ANOVA) procedure for completely randomized design (CRD) using SAS (SAS Institute Inc. Cary, NC, USA.) computer software. Mean separation was carried out using least significant difference (LSD) test.

RESULTS AND DISCUSSION

Plant height

Significant effect of phosphorus sources on plant height was observed at 4 and 8 weeks after sowing during the trial (Table 2). At 4 weeks after sowing (WAS), organic fertilizer (OF) 100% recorded taller (18.33 cm) plants whereas other sources (OF RP 50:50, OF, RP 75:25, OF, RP 25:75, RP 100%) recorded lower and similar values, while at 8 weeks after sowing (WAS) OF 100% recorded the highest value (36.00 cm) and the least (29.00 cm) was recorded where OF: RP 25:75 was applied. The finding here could be attributed to the fact that Organic Fertilizer (OF) 100% has greater ability to improve soil structure there by promoting water retention capacity of the soil and aeration than other sources used and hence the taller plants recorded. Organic Fertilizer also improves the soil chemical properties such as CEC, N, K, S and Ca (FAO, 2000). Hence, the higher plant height resulted from 100% organic fertilizer application could also be attributed to its higher N content than other sources. Mugwira (1985) reported that legumes have the ability to absorb and transform nitrogen from whatever source to vegetative yield.

Table 2: Plant Height of Cowpea at 4 and 8 WAS as Influenced by Phosphorus Sources during 2011 Cropping Season.

Treatments	Plant Height (cm) 4 WAS	8 WAS
Sources (S)		
Organic fertilizer (OF) 100%	18.33^a	36.00^a
Rock Phosphate (RP) 100%	16.17^b	31.67^b
OF:RP 50:50	15.83^b	31.67^b
OF:RP 75:25	15.67^b	31.33^b
OF:RP 25:75	15.25^b	29.00^c
SE (±)	0.326	0.581
Significance	S	S

Means in a column followed by the same letter (s) in superscript are not significantly different using LSD at 5% level; ns = not significant, s= significant.

Number of leaves per plant

Significant effect of phosphorus sources on the number of leaves was observed during the experiment (Table 3). At 4 WAS, OF 100% (2.08) and OF RP 75:25 (2.17) recorded higher and the least was recorded by OF RP 50:50 (1.58). At 8 WAS, OF 100% and OF: RP 75:25 recorded higher (5.58) values whereas other sources (RP 100%, OF: RP 50:50, OF: RP 25:75) recorded lower. The

Table 3: Number of leaves per plant of Cowpea at 4 and 8 WAS as Influenced by Phosphorus Sources during 2011 Cropping Season.

Treatment	Number of leaves 4 WAS	8 WAS
Sources (S)		
Organic fertilizer (OF) 100%	2.08[a]	5.58[a]
Rock Phosphate (RP) 100%	1.83[b]	4.33[b]
OF RP 50:50	1.58[c]	4.42[b]
OF RP 75:25	2.17[a]	5.58[a]
OF RP 25:75	1.83[b]	4.25[b]
SE (±)	0.071	0. 137
Significance	S	S

Means in a column followed by the same letter (s) in superscript are not significantly different using LSD at 5% level; ns = not significant, s= significant.

higher performance of 100% organic fertilizer and OF: RP 75:25 could be attributed to increased chemical (N, P and S) and physical (moisture retention and aeration) properties of the soil resulted from higher organic matter content than other sources used in the trial and hence the more number of leaves recorded. Similar effect of organics on legumes was reported by Chandrasekarane *et al.* (2007). Similarly, Lokanath and Parameshwarappa (2006) reported increase in leaf number and leaf area due to organic fertilizer application.

Fresh weight

Significant effect of phosphorus sources on fresh weight of cowpea was observed during the trial (Table 4). Organic fertiliser (OF) 100% recorded the highest (16.33) value and was similar with the application of OF: RP 50:50 and OF: RP 75:25 and the least was recorded by RP 100% (7.50 g).The superiority of organic fertilizer (OF) 100% and OF: RP combination over 100% RP source could be as a result of its ability to improve soil structure thereby promoting aeration and water retention capacity of the soil for an increased weight (FAO, 2004). Also the higher plant height and leaf number obtained as a result of organic fertilizer (OF) 100% application contributed to higher fresh weight recorded by sources containing organic fertilizer (OF). Similarly, Lokanath and Parameshwarappa (2006) reported increase in leaf number and leaf area and plant weight as a result of organic fertilizer application.

Table 4: Fresh weight of Cowpea as influenced by Phosphorus Sources during 2011 Cropping Season.

Treatment	Fresh Weight (g/Plant)
Sources (S)	
Organic fertilizer (OF) 100%	16.33[a]
Rock Phosphate (RP) 100%	7.50[c]
OF:RP 50:50	16.17[a]
OF:RP 75:25	13.17[ab]
OF:RP 25:75	11.00[b]
SE (±)	1.154
Significance	S

Means in a column followed by the same letter (s) in superscript are not significantly different using LSD at 5% level; ns = not significant, s= significant.

Dry weight

Significant effect of phosphorus sources on dry weight of cowpea was observed during the trial (Table 5). OF:RP 50:50 recorded higher (4.67g) value and was similar with the application of organic fertilizer 100% and OF:RP 75:25 (4.50 g) whereas 100% RP and OF:RP 25:75 recorded the least. The superiority of 100% organic fertilizer and OF: RP 75:25 and 50:50 could be attributed to higher organic matter content than other sources. Also, the similar values recorded where organic fertilizer was replaced with rock phosphate up to 50% P_2O_5 basis is an evidence of enhanced dissolution of rock phosphate in the presence of higher soil organic matter than either of the OF: RP 25:75 and 100% rock phosphate. FAO (2004) reported higher soil organic matter as an important soil property for enhanced dissolution of rock phosphate and its availability to plants.

Table 5: Dry Weight of Cowpea as Influenced by Phosphorus Sources during 2011 Cropping Season.

Treatment	Dry Weight (g/plant)
Sources (S)	
Organic fertilizer (OF) 100%	4.50[a]
Rock Phosphate (RP) 100%	2.50[b]
OF:RP 50:50	4.67[a]
OF:RP 75:25	4.50[a]
OF:RP 25:75	3.33[b]
SE (±)	0.291
Significance	S

Means in a column followed by the same letter (s) in superscript are not significantly different using LSD at 5% level; ns = not significant, s= significant.

Conclusion

Thus, from the findings of this study, organic fertilizer could be replaced with up to 50 % RP on P_2O_5 basis without significant reduction in the performance of forage cowpea in Sokoto Dry sub-humid zone of Nigeria.

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