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The Response of Bambara Groundnut (*Vigna Subterranea (L.)Verdc*). To Phosphate Fertilizer Levels In Igbariam South East Nigeria.

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Abstract: *A field study was carried out at Department of Crop Science and Horticulture experimental field, Anambra State University, Igbariam Campus, to study the response of Bambara groundnut Vigna subterranean (L.) verdc to phosphate fertilizer levels. The treatments consisted of four levels of Single Super phosphate 0 kg P/plot (SSP1), 0.37 kg P/plot (SSP2), 0.73 kg P/plot (SSP3) and 1.1 kg P/plot, (SSP4) equivalent to 55 kg P/ha, 110 kg P/ha and 165 kg P/ha respectively. The experiment was laid out in randomized complete block design (RCBD) and the treatments were replicated four times. Data collected were subjected to an analysis of variance test based on randomized complete block design (RCBD) and treatment means were separated using least significant difference (LSD=0.05). The result obtained from the field study showed that Bambara groundnut responded well to all the levels of P applied and was significant (P=0.05) in all the parameters assessed. Yield increased with the increasing rate of phosphate fertilizer in weight of pod, number of pod, number of nodules, length of the root, and number of leaf/plant, leave area/plant, number of branches, number of flowers and plant height that were measured at 6, 8, and 10 weeks after planting (WAP). The value of plant height and number of flowers obtained in SSP2 (67.04cm, 3.63) and SSP3 (71.01cm, 4.69), at 6WAP were statistically similar and significantly better than the control SSP1 (9.79cm, 2.82). The weight of pod in SSP2 (1.27 kg/ha) and SSP3 (1.36 kg/ha) were statistically similar and SSP2 (1.27 kg/ha) is not statistically better than the control (1.16 kg/ha). The SSP4 recorded the highest value and was significantly different from the other rates in all the parameters assessed with a yield value (1.62 kg/ha). Hence single super phosphate fertilizer at the rate of 1.1kgP/ha is considered adequate for Bambara groundnut in the studied area since it increases the productivity of the crop.*
Keywords: *Bambara groundnut, growth, phosphate, yield, fertilizer, soil, Igbariam.*

I. Introduction

In many developing countries of Africa, low protein intake predisposes, the people to many diseases such as heart and kidney diseases, typhoid fever etc and malnutrition. Hence poor body defense mechanism and the resultant effect is high death rate. In Nigeria for instance, the daily routine food consumption consisted of root and tubers, cereals and to smaller extent fruits. While the consumption of animal protein remains low virtually in every home.

Protein intake could be supplemented with vegetable proteins from legumes such as Bambara groundnut. The seed of this crop has been found useful in many diets. It can be mixed with maize or plantain and boiled, the seed may be ground into flour and used to prepare porridge or pre-soaked and ground into a paste which is used to prepare fried or steamed dishes and maize flour for traditional preparation can be enriched by the addition of Bambara groundnut (Brink *et al*, 2002). Thus the crop produces a balanced food, high protein content and source of plant protein in human body for the digestive system application (Okito *et al*, 2004. Embays, 2006). This crop has the potential of improving the nutrition of the people and less costly than animal protein. This crop has been found to improve soil conditions because of its nitrogen fixation. Despite these qualities, Bambara groundnut attract low patronage by farmers and researchers as is still commonly being grown by poor farmers at the subsistence level in Nigeria. Hence neglected and under utilized. But this is a crop ranked in important grain legumes after cowpea and groundnut (Diabate *et al*; 2005). In Igbariam South East Nigeria, very little or no data is available on Bambara groundnut on growth yield potential and nutrient requirement.

Crop growth and yield however require mineral nutrition which is supplied to the desired crop as manure. Manure is categorized as organic and inorganic fertilizer. There are various reports of inorganic fertilizer in the improvement of crop productivity and there are reports of the preference of inorganic fertilizer in the growth and productivity of crops. Therefore, there seems to be some level of specificity in crop adaptation to the type of fertilizer in order to increase its growth and yield potentials. It is in view of this that this investigation was conducted to study the response of Bambara groundnut to phosphate fertilizer levels in Igbariam South East Nigeria.

II. Materials And Method

This study was carried out at the experimental field of the Department of Crop Science and Horticulture, Faculty of Agriculture, Anambra State University, Igbariam Campus ($06^0$14'N, 06^0 45'E). The soil of the experimental site is Ultisol classified as Typic Tropaqualf (FDLAR, 1985) and belong to the sandy clay loam textural class and poorly drained. The detailed meteorological record during the period of the trial are presented in Table 1

Field method

Composite sample of the top soils (0-30cm) depth were taken with an auger before bed preparation. The samples were analyzed for physical and chemical properties using standard procedures described by Black (1965). Results of the soil analysis are presented in Table 2.The treatments consisted of four levels of single super phosphate which are as follows:

Control (SSP1) = 0kg P/plot.
SSP2 = 0.37kg P/plot equivalent to 55kgP/ha.
SSP3 = 0.73kg P/plot equivalent to 110kgP/ha.
SSP4 = 1.1kg P/plot equivalent to 165kgP/ha.

The P_20_5 in the super phosphate (orthophosphate) is 18% and the chemical compound or form used is Ca $(H_2PO_4)_2$. The experiment was laid out in a randomized complete block design (RCBD), with four replicates to give 16 plots, each measuring 3m x 4m. Plots were separated from each other by 0.5m path and each block was separated by 1m alley, with plant spaced at 20cm x 40cm intra and inter-row. Raised beds were used for better drainage. The single super phosphate levels were applied to their respective plots two weeks after planting, using ring method. O.4kg urea was applied in each plot as blanket treatment two weeks after planting using ring method to increase the vegetative growth of the crop .Two Bambara groundnut seeds were planted per hole at about 3cm deep to give a plant density of 108 plants/plot. The seedling was thinned down to one plant per hill two weeks after germination. Empty stands were supplied. Weeding was manually done using hoe and hand pulling at two weeks interval till harvest.

Table 1 Meteorological Observation during the period of the trial.

	July	August	September	October
Rain days (day)	16.0	15.0	16.0	14.0
Rainfall (mm)	12.1	18.3	21.4	17.2
Mean Minimum monthly Temperature (^{0}C).	16.4	23.4	22.6	22.7
Mean maximum monthly temperature (^{0}C).	21.0	29.7	29.4	29.8
Relative humidity (%) at 6.00Hrs	50.0	74.0	73.0	74.0
Relative humidity (%) at 18.00Hrs	62.0	94.0	84.0	83.0

Source: Meteorological unit, Faculty of Agriculture, Anambra State University Igbariam Campus.

Table 2 Physical and chemical properties of soils of the experimental site at gabriam.

Particle size distribution (%)	
Fine sand	42.2
Coarse sand	14.0
Silt	22.0
Clay	22.0
Textural class	Sandy Clay Loam
Soil characteristics	
PH in water (1:2.5)	4.90
PH in KCL (1:2.5)	3.90
Organic Carbon (%)	0.94
Organic Matter (%)	1.62
Total N (%)	0.19
Available P mg kg^{-1}	2.80
Exchangeable bases ($Cmolkg^{-1}$)	
Na^+	0.25
K^+	0.26

Ca^{2+}	1.80
Mg^{2+}	2.80
CEC	32.80
Exchangeable acidity ($Cmolkg^{-1}$)	
AL^{3+}	1.60
H^{+}	1.60

Agronomic parameters studied

Forty plants per plot were randomly selected at physiological maturity (6, 8 and 10 WAP) for the assessment of plant height, number of flowers, number of branches, number of leaves per plant, leave area per plant, number of pods and weight of pods. While 20 plants per plot were randomly selected for number of nodules and length of root using destructive sampling method. In all 60 plants/plot were sampled for the agronomic studies.

Data analysis

The data collected was subjected to statistical analysis of variance based on RCBD and the treatment effects were compared for significance using LSD at 5% alpha level (Steel and Torre 1980).

III. Result

The result of soil analysis of the experimented site presented in table 2 shows that the soil of the area is sandy clay loam. The soil is acidic and contains low level of major nutrient elements.

The plant height measured at 6WAP and 8WAP and number of flowers measured at 6, 8 and 10 WAP were significantly increased by single super phosphate (18% P_20_5) application, with all the levels of applied P (0.37kg, 0.73kg and 1.1kg). 1.1kg (SSP4) recorded the highest value in both plant height and number of flowers, but the value of plant height and number of flowers obtained in SSP2 and SSP3 at 6WAP were statistically similar and significantly better than the control (tables 3 and 4). The result also show that the values increase with increase rate in the phosphate level. The plant height result decreased sharply (table 3) as the WAP increased to 8weeks.While the number of flowers increased as the WAP increases (table 4). Number of branches measured at 6, 8 and 10WAP, leave area/plant at 6 and 8WAP and number of leaves/plant at 6, 8 and 10WAP (tables 5, 6 and 7) were also significantly increased by single super phosphate application. In each of this parameters measured SSP4 level recorded the highest value and the least value was obtained in the control plots. The values obtained from the parameters measured increased with the increasing rate of the single super phosphate application. The result of the number of branches (Table 5) indicated that the branches of the Bambara groundnut increased as the weeks after planting increased. The percentage increase from 6WAP to 10WAP for the treatments were SSP1 (15.96% - 20.21%), SSP2 (2.96 – 8.74), SSP3 (3.95% - 9.33%) and SSP4 (6.41% -12.29%), showing that control had more branches developed at the 10WAP compared to the other treatments. The leave area per plant result showed that the leave area of Bambara groundnut decreased with increase in the WAP, with the exception of SSP1 and SSP2 result that indicated an increase in the leave area per plant as WAP increased (Table 6). The number of leaves result (table 7) showed that the number of leaves of Bambara groundnut decreased sharply in 8WAP but increased a little in 10 WAP in SSP_2, SSP_3 and SSP_4. The SSP1 did not follow this order. It increased rapidly in 8WAP and decreased shortly in 10WAP.

The result in table 8 showed that the length of the root, number of nodules, number of pods and weight of pods were significantly increased by single super phosphate fertilizer levels. The values obtained in each of the parameter increased with an increase in the phosphate fertilizer levels. The root development and growth are more pronounced in SSP4 than any other rates. The amount of Nitrogen fixed (nodulation) in SSP4 is 87.5% higher than the control (SSP1), 80.6% greater than the SSP3 and 84.7 % higher than the SSP2. The numbers of pods are much in SSP4 with a value (359.75) compared to other rates of P applied. However the result of number of pods obtained in SSP2 and SSP3 were not different statistically but significantly better than the control plot (SSP1).

The yield result (weight of pod), showed that SSP4 recorded the highest value (1.62 kg/ha) and was significantly different from the other rates. The weight of pod in SSP2 and SSP3 were statistically similar and SSP2 is not statistically better than the control.

Table 3 the effect of single super phosphate fertilizer on the plant height (cm) of Bambara groundnut at 6 and 8 WAP.

Treatment	Plant height (cm) at 6WAP	Plant height (cm) at 8WAP
SSP1	9.79	10.59
SSP2	67.04	17.47
SSP3	71.01	20.65
SSP4	89.60	27.43
LSD	1.98	1.63

WAP = weeks after planting.
SSP1 – single super phosphate (control)
SSP2- single super phosphate 0.37kgP/ha rate
SSP3-single super phosphate 0.73kgP/ha rate
SSP4-single super phosphate 1.1kgP/ha rate

Table 4 the effect of single super phosphate fertilizer on the number of flower at 6, 8 and 10WAP.

Treatment Number of flowers Numbers of flowers Number of flowers at

Treatment	Number of flowers at 6WAP	Numbers of flowers at 8WAP	Number of flowers at at 10WAP
SSP1	2.82	3.21	4.98
SSP2	3.63	4.29	7.54
SSP3	4.69	6.04	10.84
SSP4	6.00	8.29	16.19
LSD	1.52	0.99	1.03

SSP1 – single super phosphate (control)
SSP2- single super phosphate 0.37kgP/ha rate
SSP3-single super phosphate 0.73kgP/ha rate
SSP4-single super phosphate 1.1kgP/ha rate

Table 5 the effect of single super phosphate fertilizer on the number of branches of Bambara groundnut at 6, 8 and 10WAP.

Treatment	Number of Branches / plant at 6WAP	at 8WAP	at 10WAP
SSP1	40.75	48.49	51.07
SSP2	50.09	51.62	54.89
SSP3	52.69	54.86	58.11
SSP4	55.74	59.56	63.55
LSD	2.05	0.51	1.23

SSP1 – single super phosphate (control)
SSP2- single super phosphate 0.37kgP/ha rate
SSP3-single super phosphate 0.73kgP/ha rate
SSP4-single super phosphate 1.1kgP/ha rate

Table 6 the effect of single super phosphate fertilizer on the leaf area per plant (cm^2) of Bambara groundnut at 6 and 8WAP

Treatment	Leave area / plant cm^2 6WAP	8WAP
SSP1	18.30	21.62
SSP2	22.13	25.91
SSP3	42.69	30.18
SSP4	59.17	37.29
LSD	1.94	0.79

SSP1 – single super phosphate (control)
SSP2- single super phosphate 0.37kgP/ha rate
SSP3-single super phosphate 0.73kgP/ha rate

SSP4-single super phosphate 1.1kgP/ha rate

Table 7 the effect of single super phosphate on the number of leaves / plant at 6, 8 and 10WAP.

Treatment	Number of leaves / plant		
	6WAP	8WAP	10WAP
SSP1	50.95	96.66	90.00
SSP2	141.96	100.39	101.75
SSP3	158.09	105.99	106.73
SSP4	166.49	111.65	112.45
FLSD	2.93	0.46	1.70

SSP1 – single super phosphate (control)
SSP2- single super phosphate 0.37kgP/ha rate
SSP3-single super phosphate 0.73kgP/ha rate
SSP4-single super phosphate 1.1kgP/ha rate

Table 8 the effect of single super phosphate on the length of the root (cm), number of nodules, number of pods and weight of pods (kg) of Bambara groundnut.

Treatment	Length of the root cm	Number of nodules	Number of pods	Weight of pod (kg/ha)
SSP1	11.6	27.0	228.5	1.16
SSP2	16.8	33.8	306.25	1.27
SSP3	22.45	42.0	318.75	1.36
SSP4	37.00	216.0	359.75	1.62
FLSD	3.06	1.72	29.10	0.20

SSP1 – single super phosphate (control)
SSP2- single super phosphate 0.37kgP/ha rate
SSP3-single super phosphate 0.73kgP/ha rate
SSP4-single super phosphate 1.1kgP/ha rate

IV. Discussion

The soil of the study area was found to be deficient in major plant nutrient elements. According to the soil fertility evaluation criteria by Ibedu *et al;* (1988) soil containing less than 0.20% N, 25.0 ppm P, exchangeable K of 0.40 meg/100g and exchangeable Mg of 3.0 meg/100g is regarded as being low in these nutrient. Therefore the soils of the experimental site was found to contain these nutrient elements at levels lower than the stipulated values, hence considered poor in these essential plant nutrient elements.

The plant height, number of flowers, branches, leaves and leave area of Bambara groundnut were observed to have been increased significantly by all the levels of applied P better than the control treatment. This is an indication that P application increases the vegetative growth of the Bambara groundnut and that Bambara groundnut responded to different rates of P nutrient supplements. Buah and Mwinkaara (2009) made similar observation when they reported that Bambara groundnut responds to different types of nutrients supplements and such nutrients should be replenished. The result indicated that flowers increases with increase in the level of phosphate fertilizer, this is in line with Baryeh, (2001) who reported that flowering starts 28 days after germination and may not cease before the end of the life of the plant. While Or *et al*, (1999) maintained that flowering in Bambara groundnut is species dependant and depends on the germination date, seasonal temperature profile as well as photo thermal response of the plant. The significant increase observed in these parameters in terms of P application could be explained by nitrogen and phosphorous interaction in the root zone of the soil, because availability of P increase N uptake of plant (Benedyeka *et al*, 1992) and Shaheem et al, (2007) reported that Nitrogen is relevant for the enhancement of vegetative growth as it provide the basic constituent of protein and nucleic acid. In deed nitrogen availability in the studied soil must be increased due to release of N from symbiotic nodules and dead roots of legume. Walley et al, {1996) made similar assertion in their studies in allocation and cycling of nitrogen in an alfalfa brome grass sward. The result could equally be explained on the basis that the rates of release of nutrients are much higher in the phosphate fertilizer. Tindall (1968) reported that inorganic fertilizers provide quickly major elements at the early stage of plant growth and development. Hence fulfill the plant need. The nature of result obtained in the control plots with regard to this parameters could be explained with the work of Stewart et al, (2005) that growth slows down in plants growing in poor P soil, reduce the number of new shoots and grow vertically. Indicating that in P unfertilized soils of the control plot; nutrients are not readily available for plant uptake. Hence reduced plant height, leaf development, branches and flowers compared with their P fertilized counterparts.

There were significant differences in the length of root and number of nodules performance of the crop with respect to the level of P applied. This indicates that P affected the root proliferation and development as well as nodulation in Bambara groundnut in the studied soil. The nature of the result obtained in SSP4 indicated that 1.1kg P/ha is adequate for the root and nodule development of Bambara groundnut in the study area. The result showed that increasing rate of P application has been associated with increased root growth and nodulation, which means the plant, can explore more soil for nutrients and moisture and more nitrogen availability. The amount of Nitrogen fixed (nodulation), suggests that with proper phosphate fertilizer management, Bambara groundnut could be that plant from which highly effective NO_3 tolerant symbioses can be identified of which Layzell and Moloney (1994) suggested that up to 300% N_2 fixation can be achieved in soils with such NO_3 tolerant symbioses. Hence NO_3 tolerant nodule ting mutants may not be necessary. The result also suggest that Bambara groundnut can be used as a cheap source of organic fertilizer in maintenance of fertility status of the soil in order to obtain stable and sustainable crop production. It can act as a source of residual nitrogen for the next cropping season. This is because inorganic source of N are very expensive and their losses are more compared to organic nitrogen fertilizer.

The number of pods of Bambara groundnut in the studied soil was found to have been increased significantly by all the level of P applied which indicated that P application affected the number of pods production. However, statistically the effect of number of pods production in SSP_2 and SSP_3 were similar, but significantly better than the control plots (SSP1). The result suggests that SSP4 is adequate for efficient and optimum pod production in the study area.

The yield result (weight of pod) is an evident that Bambara groundnut responded well to all the levels of P applied in this study, which shows that phosphorous plays an important role in many morphological and physiological processes that occur within the Bambara groundnut that translate into the kind of yield result obtained. The result indicated that the inorganic P application exerts strong influence on the Bambara groundnut growth development and yield. This influence might be linked to the environmental conditions, such as temperature and moisture Table 1, rates of fertilizer applied (0kg P/ha, 0.37kgP/ha, 0.73kgP/ha, 1.1kgP/ha), method of application (ring method), chemical form used (18% P_2O_5 of Ca $(H_2PO_4)_2$) orthophosphate and the quality of plant available P already in the studied soil (table2). As Tisdale *et al.*, (1993) suggests Band method increase the efficiency of P utilization by crops grown on low P soil as it reduces the contact between the soil and fertilizer, with a subsequent reduction in P adsorption (fixation) in soil.

The SSP4 shows significant differences in the performance of the Bambara groundnut with respect to all the levels of P applied (0kgP/ha, 0.37kgP/ha, 0.73kgP/ha and 1.1kgP/ha) in all the parameters assessed in this trial. Therefore the result is an indication that SSP4 level (1.1kgP/ha) is adequate for the growth and yield of Bambara groundnut.

V. Conclusion

From the result obtained it can be concluded that the application of 1.1kgP/ha is adequate and therefore recommended for the growth and yield of Bambara groundnut in Igbariam South eastern, Nigeria agro-ecological zone.

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