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PERFORMANCE OF FIVE VARIETIES OF COWPEA (*VIGNA UNGUICULATA* L.WALP) AS AFFECTED BY THE APPLICATION OF PHOSPHORUS FERTILIZER AT YOLA, NORTHEASTERN NIGERIA

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ABSTRACT

A factorial experiment was conducted to evaluate the influence of phosphorus fertilizer at four different levels on growth, nodulation and yield of five cowpea varieties:-Sampea 6, Sampea 10, Sampea 11, Sampea 12 and Kanannado, comprised of20 treatment combinations laid out under split-plot design and replicated three times with a view to selecting cowpea (Vigna unguiculata L. Walp) varieties that can produce good yield under low soil phosphorus level. Soil samples were collected from the experiment site and routinely analyzed before the experiment. Plant parameters studied included the number of leaves, vine length, number of branches, nodule count, haulm grain, total dry matter yield, N, P and K contents of haulm and grains. Results obtained from recorded and statistically analyzed data revealed that no significant effect of P fertilizer application at all levels on cowpea growth and yield. It is therefore recommended that there is no need to apply N and K to cowpea planted in the same fertility status fields as in the present experimental site. Further studies required to be conducted with higher phosphorus rates.

KEYWORDS: *Cowpea, Phosphorus fertilizer, Phosphorus Level, Total Dry Matter Yield*

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INTRODUCTION

Northeastern Nigeria is a major cowpea growing area which constitutes up to 47% of cowpea production in Nigeria on annual basis. The soils of Northeastern Nigeria are inherently low in native fertility and are partially deficient in phosphorus because the soils are low in apatite bearing minerals which gave rise to soils low in native P. Among the factors responsible for low yield of cowpea is particularly phosphorus (P) deficiency and is the most limiting soil fertility factor for cowpea production in most tropical soils (IITA, 2003). Response to other nutrients uptake is also often limited due to the low level of phosphorus in the soil and therefore negatively affects crop production to a large extent. Phosphorus is highly immobile in soils and almost becomes unavailable. Thus its application time and rate are of utmost importance if the varietal yield potentials of cowpea are to be achieved (Singh *et al.,* 1997). Cowpea is grown under a wide range of soil types provided drainage is good. The pods yield of Cowpea is estimated at 350 kg/ha of pods (FED, 2002). Singinga*et al.* (2000) reported that leguminous crops require higher amounts of P than non-leguminous crops. Cowpea (*Vigna unguiculata* L. Walp) is a tropical herbaceous annual crop that belongs to the Family Fabaceae

(formally Leguminoseae) and subfamily Papillinoideae of the flowering plants. Cowpea prefers temperatures between 20 - 35^{o}C for optimum growth. Most short duration cowpea cultivars require 600 mm rainfall per annum while medium to long duration cowpeas require 600 – 1500 mm rains (Ranchies, 1987). Cowpea is a cash crop that is traded in either fresh or processed form. It is light adaptable and drought tolerant thus it fits well into diverse production systems and is equally an important source of protein for human and livestock. The pods are used for direct consumption and can be cooked, spiced and eaten alone or with vegetables, maize, rice, yam etc. They can also be processed into snacks or soaked and ground for making local dishes such as *alele, kosai,* soup etc. The seeds contain about 21-23% protein, 57% carbohydrate with vitamins (thiamin 0.59 mg kg^{1}, riboflavin 0.22mg^{1}) and minerals (Calcium 111g kg^{1}, Iron 6.2 mg kg^{1}) on the dry weight basis and vary with cowpea age and variety (Berry 1981). The cowpea haulms is a good animal feed either in dried or fresh form. It has high crude protein, digestibility, and minerals with low fiber contents (Tarawali*etal.,*1997). Farmers also store cowpea haulms for sale as animal feed at the peak of the dry season thus improving their income (Quinn, 1997).

Cowpea crop has the ability to fix up to 70 to 350KgN/ha from the atmosphere in association with nodule bacteria *(Bradyrhizobiumspp.*) and replenishes the soil with upto 40- 50kg N/ha/year(Quinn 1997). This made it a potent soil amendment, green manure, and cover crop. The leaf litter from shaded leaves, flowers, and root residues decay *in-situ*, contributing to the soil organic matter pool that improves soil nutrient status. The spreading habit of cowpea provides ground cover thus suppressing weeds and act as protection against soil erosion (Mortimore*et al.,* 1997).

This present experiment was carried out to evaluate the performance of five varieties of cowpea and the haulms concentration of N, P and K as affected by the application of different levels of phosphorus fertilizer in the study area.

MATERIALS AND METHODS

Experimental Site

A field experiment was carried out during the 2016 cropping season at the Teaching and Research Farm of the School of Agriculture and Agricultural Technology, Modibbo Adama University of Technology, Yola located between latitudes 12° 30$^{'}$- 13$^{'}$ 8° 14$^{'}$ N, longitude 9°21$^{'}$-14° 3$^{'}$ and 9°21$^{'}$- 16° 3$^{'}$ situated at an altitude of 152m above sea level in the Northern Guinea Savannah agro-ecological zone of Nigeria with annual average rainfall of 900mm. The soils of the experiment site are classified as Typic-Haplustalf (Musa *et al., 2007*) having a sandy loam texture.

Soil Sampling and Analysis

Soil samples were collected at random from the experimental field at a depth of 0-20cm before the commencement of the experiment and analyzed for physical and chemical properties. Samples were air-dried under laboratory conditions and sieved through 2mm mesh sieve. Soil particle size distribution was determined using the hydrometer method (Bouyoucos, 1962) and the soil texture was determined by use of the soil textural triangle. Soil pH we reanalyzed by using 1:2.5 soil: water suspension using a glass Electro calomel electrode pH meter (Mclean, 1962) while the soil organic carbon was analyzed by using Walkley-Black wet combustion procedure (Nelson and Sommers, 1982) and the estimation of organic matter was carried out by multiplying the organic carbon content with 1.724 (The VanBemmelen factor). Further, total nitrogen using the Macro Kjeldahl method described by Bremmer and Mulvaney (1982); phosphorus by using the Bray-1 test method with dilute acid fluoride as the extract ant (Jackson, 1967); exchangeable base cations which were extracted using ammonium acetate at pH 7.0, calcium and magnesium- Ethylene DiamineTetraacetic Acid (EDTA) titration method (Heald, 1965); potassium and sodium by using the flame photometer

method.

Experimental Design and Layout

A split plot design was adopted using five cowpea varieties (Sampea 6, Sampea 10, Sampea 11, Sampea 12, and Kanannado, as main plot factor, CV_x and four levels of single super phosphate fertilizer (0, 8, 16, and 24 kg/ha) as the sub-plot factor, P_x. Twenty (20) treatment combinations, CV_xP_x were obtained, randomized and replicated three times. The experimental plots which measured 3.75m x 4.25m each was laid out with 0.5m between plots and 1.0m between replications. Single super phosphate (SSP) fertilizer used as phosphorus source was broadcasted and incorporated into the topsoil seven days before sowing at the rates of 0,8,16 and 24 kg/ha. Cowpea seeds were sown at the rate of 3 seeds per hole at a depth of 3 to 4cm with 25cm plant-plant spacing, giving 16 stands per row and 75cm between rows, giving 4 rows per plot. Weeding was done twice manually at 21 and 49 DAS. Harvesting was done manually when the pods had turned yellowish brown. The insect pest control especially grasshoppers population was done by the use of Lambda master 2.5% E.C (Lambda-halothrin, 9.8%). This was sprayed by knapsack sprayer (100ml in 15 liters of water) at the interval of each 14 days and at flowering stage, aphids were controlled with sprayingsunpyrifos48 % E.C. (Chlorpyrifos-methyl) at the rate of 50mlto 15 liters of water at 10 days interval.

Agronomic Characters of the Cowpea Varieties

Four cowpea varieties (Sampea 6, Sampea 10, Sampea 11 and Sampea 12) were obtained from the Institute for Agricultural Research (IAR) Samaru Zaria, Nigeria, while one local variety, Kanannado, was obtained from the Yolamain market. Sampea 6, Sampea 10, Sampea 11 is white seeded Cowpea varieties and is semi determinant with medium-term maturity (75 – 80 days) and moderately resistant to pest and diseases with high photosynthetic efficiency. Sampea 12 is a dual purpose Cowpea variety having medium to large brown seeds with a rough seed coat. IITA (1984) reported that Kanannado is a spreading variety, white seeded, semi determinant with medium-term maturity of about 70 to 75 days and also resistant to pest and diseases.

Data Collection and Plant Sampling

Five plant stands per plot were selected from the center of each plot for data collection at 21 and 42 days after sowing (DAS). A number of leaves on each plant was counted and the average recorded at 21 and 42 DAS.A ruler was used to measure the lengths of five cowpea plants from ground level to the tip of the terminal apex. The mean values for the five samples were recorded per plant at 21 and 42 DAS. A number of branches per cowpea plant was counted from five plants sample and the average was recorded as a number of branches per plant at 21 and 42 DAS. At 65 DAS two plants were removed from the third row to the right in each plot. A hoe was used to lose the soil surrounding the roots of each plant before removal. The plant roots were then washed carefully and nodules were separated for ease of counting. Matured pods were harvested from two central rows of each plot. The seeds were collected and weighed using weighing balance. The weights were later expressed in kilograms per hectare by multiplying the weight (kg/plot) by $10{,}000m^2$and dividing the result by the area of the harvested plot ($15.94m^2$).

Plant Sample Analysis

Based on procedures described by Jaiswal (2003) total nitrogen in the haulms plant digest was determined by the Micro-kjeldahl method, phosphorus in the plant digest was determined using the vanadomolybdate method, while potassium concentration was determined by flame photometer.

Data Analysis

Data collected were subjected to analysis of variance of split-plot design and the means were separated using the least significant difference, LSD test at 0.05 percent level of significance (Panse and Sukhatme, 2000). Statistical analyses were performed using CROPSAT version 8.0 statistical package.

RESULTS AND DISCUSSIONS

Physical and Chemical Properties of the Experimental Soil

Results of routine analysis for physical and chemical properties of the experimental soil (0-20 cm) are presented in Table 1.The soils are sandy loam with a high sand fraction of more than 60%, low silt and clay fractions. The pH (H_2O) and pH (Kcl) of the soil are near neutral (6.22) and moderately acidic (5.38), respectively. Electrical conductivity, EC value of 0.15 indicates no crop hazard. Organic carbon and total nitrogen contentment of the soil were low indicating the very low level of soil organic matter while available phosphorus, exchangeable potassium (K), calcium (Ca), magnesium (Mg) and sodium (Na) contents were between the low to medium. Cation exchange capacity (CEC) was low due to low clay fraction but with a high percentage base saturation (PBS).

Number of Leaves per Plant at 21 and 42 DAS

Results obtained due to effects of cowpea varieties and application of phosphorus fertilizer revealed no significant effect on the number of leaves at 21 and 42 DAS. Kanannado variety recorded a higher number of leaves per plant (14.48) at 21 DAS followed by variety Sampea 12 (14.45) at 21 DAS (Table 2). However, at 42 DAS variety sampea 12 recorded a higher number of leaves per plant (84.53) fallow by variety sampea 6 (81.67) as presented in Table 2.This shows that number of leaves was not affected by applied phosphorus. It is likely that there is already adequate phosphorus in the soil that met crop requirement or the immobility and the low level of phosphorus in the soil made it unavailable for the crop take up. Olusola, (2009) reported that crops take up only about 15 – 30% of applied phosphorus, while the 60% is adsorbed to the soil. This study is in conformity with FPDD, (2002) report and Daramy, (2017), but contradict the report of Olaleye*et al.* (2012) who reported the increase in cowpea growth following phosphorus fertilizer application.

Effect of Cowpea Varieties and Phosphorus Fertilizer Levels on Vine Length at 21 and 42 DAS

There was no significant effect of phosphorus fertilizer application at all levels on vine length and varieties at 21 and 42 DAS as shown in Table 3. Varieties sampea 10 had higher vine length (13.43) at 21 DAS followed by sampea 6 (13.17) at 21 DAS. Varieties sampea 11 (12.22) had the least vine length at 21 DAS while sampea 10 (22.89) had the highest vine length followed by sampea 12 (22.38) at 42 DAS.

Effect of Cowpea Varieties and Phosphorus Fertilizer Levels on Nodule Count, Grain Yield and Haulm Weight

The result presented in Table 4 showed that application of phosphorus did not have any significant at ($P>0.05$) effect on the nodule count, grain yield and haulm weight has shown slight positive response due to phosphorus

fertilizer application that is not statistically significant. Highest nodule count (33.25), grain yield (2890.51) and haulm weight (13.35) were obtained with variety sampea 11. Although cowpea varieties have been reported to respond differently to P fertilizer application, generally results obtained did not show any significant effects on most soils of the tropics (Okeleye and Okelana, 1997).

Effect of Cowpea Varieties and Phosphorus Fertilizer Levels on Straw N, P and K Contents

Result presented in Table 5show that application of phosphorus fertilizer had no statistically significant result on the N, P and K content of cowpea straw in different varieties of cowpea. Sampea 10 and 12 had the highest level of N content at 2.96 %. Sampea 10 and 11 had the P content of 0.98% in straw with K content of 1,89% being highest in sampea 11.

CONCLUSIONS AND RECOMMENDATIONS

This study showed that there is no significant effect of phosphorus fertilizer application on the parameters studied: number of leaves, vine length, nodule count, haulm weight and grain yield of the cowpea varieties. It is therefore concluded that there is no need to apply phosphorus fertilizer to the soils of the study area when cropped to cowpea and fields with similar characteristics and fertility status. In addition, there is the need for further studies involving phosphorus availability and uptake by crops in these soils. Such studies will help to establish and recommend the optimum phosphorus application rates for especially cowpea in the area.

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APPENDICES

Table 1: Physical and Chemical Properties of the Experimental Soil

Parameters	Value
Sand (%)	64.10
Silt (%)	21.11
Clay (%)	14.79
Textural Class	Sandy Loam
pH (water) 1:2.5 pH (KCl) 1:2.5 Organic carbon (g/kg)	6.22 5.38 1.42
Electrical conductivity (mmhos/cm)	0.15
Total nitrogen (g/kg)	0.09
Available phosphorus (mg/kg) Exchangeable Potassium (cmol/kg)	7.60 0.25
Exchangeable Calcium (cmol/kg)	2.31
Exchangeable Magnesium (cmol/kg)	1.19
Exchangeable Sodium (cmol/kg)	0.31
Cation Exchange Capacity (meq/100g)	4.75
PBS (%)	85.47

Table 2: Effect of Cowpea Varietiesand Phosphorus Fertilizer Levels on Number of Leaves at 21 and 42 DAS

Cowpea Varieties	Number of Leaves 21 DAS	42 DAS
Kanannado	14.48	80.26
Sampea 6	14.23	81.67
Sampea 10	13.69	80.55
Sampea 11	13.78	80.14
Sampea 12	14.45	84.53
LSD (5%)	NS	NS
SED	1.15	6.15
Fertilizer Rates(+5 Kg/ha FYM)		
0 kg/ha	13.67	72.48
8 kg/ha	13.99	74.93
16 kg/ha	14.52	77.58
24 kg/ha	14.13	76.79
LSD (5%)	NS	NS
SED	1.96	4.83

Key: DAS= Days after Sowing

Table 3: Effect of Cowpea Varietiesand Phosphorus Fertilizer Levels on Vine Length at21 and 42 DAS

Cowpea Varieties	Vine Length (cm) 21 DAS	42 DAS
Kanannado	12.35	21.35
Sampea 6	13.17	21.42
Sampea10	13.43	22.89
Sampea 11	12.22	21.37

Sampea 12	12.27	22.38
LSD (5%)	NS	NS
SED	1.06	1.89
Fertilizer Rates(+5 Kg/ha P_2O_5)		
0 kg/ha	12.67	21.57
8 kg/ha	12.76	21.87
16 kg/ha	12.69	20.63
24 kg/ha	13.45	22.65
LSD (5%)	NS	NS
SED	0.89	1.50

Key: DAS= Days after Sowing

Table 4: Effect of Cowpea Varieties and Phosphorus Fertilizer Levels on Nodule Count, Grain Yield and Haulm Weight at Harvest

Cowpea Varieties	Nodule Count Grain Yield Haulm Weight (kg/ha) (Kg/ha)		
Kanannado	28.93	2089.14	10.87
Sampea 6	32.69	2630.37	13.25
Sampea 10	28.64	2203.16	10.73
Sampea 11	33.25	2890.51	13.35
Sampea 12	31.28	2706.42	12.31
LSD (5%)	NS	NS	NS
SED	5.47	962.91	1.46
Fertilizer Rates (+5 Kg/ha P_2O_5)			
0 kg/ha	24.38	1803.44	10.65
8 kg/ha	25.33	2022.26	11.67
16 kg/ha	24.70	2358.53	11.82
24 kg/ha	28.49	2448.71	12.05
LSD (5%)	NS	NS	NS
SED	4.58	647.11	1.63

Key: DAS= Days after Sowing

Table 5: Effect of Cowpea Varieties and Phosphorus Fertilizer Levels on Haulms N, P and K Contents

Cowpea Varieties	N Content (%)	P Content (%)	K Content (%)
Kanannado	2.73	0.89	1.86
Sampea 6	2.93	0.92	1.81
Sampea 10	2.96	0.88	1.83
Sampea 11	2.74	0.98	1.89
Sampea12	2.96	0.92	1.85
LSD (5%)	NS	NS	NS
SED	0.28	0.01	0.33
Fertilizer Rates(+5 Kg/ha P_2O_5)			
0 kg/ha	2.81	0.89	1.72
8 kg/ha	2.82	0.92	1.83
16 kg/ha	2.86	0.97	1.85
24 k/ha	2.95	0.96	1.82
LSD (5%)	NS	NS	NS
SED	0.13	0.01	0.29

Key: DAS= Days after Sowing