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Effect of Phosphorus Fertilizer and Spacing on Growth, Nodulation Count and Yield of Cowpea (*Vigna unguiculata* (L) *Walp*) in Southern Guinea Savanna Agroecological Zone, Nigeria

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Abstract: The experiments were conducted during 2009 and 2010 rainy season at the research and teaching farm of the college of agriculture, Lafia, Nasarawa state, Nigeria. To determine the effect of phosphorus fertilizer and spacing on growth, nodulation count and yield of cowpea (*Vigna unguiculata*) in southern guinea savanna agroecological zone, Nigeria. The treatments consisted of three levels of phosphorus 0, 20 and 40 kg/ha and three levels of spacing: 15x40, 30x60 and 45x80 cm factorially combined to form nine treatments which were laid in a Randomized Complete Block Design (RCBD) and replicated three times to form twenty seven plots. The result showed that Phosphorus fertilizer had a significant ($p<0.05$) effect on the entire growth and yield parameter assessed in both years. 40 kg/ha of phosphorus gave a significantly higher number of nodulation count/plant (34.95 and 32.24), number of pod/plant (20.64 and 20.24), seed weight/plant (39.56 and 37.64), pods weight/plant (51.45 and 45.31) and seed weight/ha (1.56 and 1.52 t/ha) in both years. The spacing also had a significant ($p<0.05$) response on almost the entire growth and yield parameter assessed except on the weight of 100 seeds. Spacing of 30×60 cm did not differ significantly with 45x80 cm which gave similar result in the no. of pod/plant, seed weight/plant, pods weight/plant and seed weight (t/ha) in both years.

Keywords: Growth, nodulation, phosphorus, spacing, yield and cowpea

INTRODUCTION

Cowpea (*Vigna unguiculata*) is an important grain legume in the dry savanna of the tropics covering 12.5 million hectares with annual production of about 3.3 million tons (FAO, 2005). Nigeria is the world's largest producer with 2.1 million tones followed by Niger with 650,000 tones and Mali with 110,000 tons (IITA, 2003). Cowpea grows best on fertile, loam soils with rainfall of 760-1520 mm during the growing period, and thrives best on dry areas of Northern part of Nigeria (Magani and Kuchinda, 2009). The grain is a good source of human protein, while the haulms are valuable source of livestock protein (Fatokun, 2002). Cowpea is an important legume crop in the dry savannas region of Africa, especially West Africa. In spite of the fact that grain yields are low, cowpea has continued to be a popular crop among farmers in Nigeria. This is because cowpea is a source of income for many smallholder farmers and contributes to the sustainability of cropping systems and soil fertility improvement in marginal lands through provision of ground cover and plant residue, nitrogen fixation and suppressing weed (Reamaekers, 2001).

Phosphorus is among the most needed elements for crop production in many savanna soils; because many savanna soils are Phosphorus deficient due to intense cultivation of the land without adequate application of restorative measures to rejuvenate the fertility of the soil (Chude, 1998).

The deficiency can be so acute in some soils of the savanna zone of western Africa that cowpea seedling growth may ceases as soon as the Phosphorus stored in the seed is exhausted (Kang and Naggos, 1983). Phosphorus is critical to cowpea yield because of its multiple effects on nutrition and also nodulation (Okeleye and Okelana, 1997). Maximum yield of a particular crop in a given environment can be obtained at spacing where competition among the plants is minimal. Ahmed and Abdelrhim (2010) observed that this can be achieved with optimum spacing which not only utilize soil moisture and nutrients more effectively but also avoids excessive competition among the plants. However, beyond certain limit yield cannot be increased with decreasing/increasing row spacing. Hence, optimum spacing induces the plant to achieve its potential yield. The multiple effects of phosphorus fertilizer and adequate spacing on cowpea growth, yield and nodulation cannot be overemphasized. Magani and Kuchinda (2009), reported that, for economic growth and yield, cowpea required 37.5 kg/ha of phosphorus in northern guinea savanna agroecological

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zone of Nigeria. Also researchers like Kang and Osiname (1979) and Singh *et al*. (2011) have also documented phosphorus requirement of cowpea in southern and the extreme northern part of Nigeria respectively. However, in spite of the increase in cowpea production by the small holder farmers in the southern guinea savanna agroecological zone of Nigeria, there is dearth of documented information on the fertilizer and other agronomic requirement of cowpea.

Therefore, the objective of this study is to determine the adequate spacing and appropriate level of phosphorus fertilizers to be applied on cowpea for optimal growth, nodulation count and yield in southern guinea savanna agroecological zone of Nigeria.

MATERIALS AND METHODS

The experiments were conducted during 2009 and 2010 rainy season at the research and teaching farm of the college of agriculture, Lafia, Nasarawa state, Nigeria. The study area falls within southern guinea savanna agroecological zone of Nigeria, and is located between Latitude 08.33 N and Longitude 08.32 E. Rainfall usually starts from March-October and the average monthly rainfall figures ranges from 40-350 mm. The months of July and August usually records heavy rainfall. The daily maximum temperature ranges from 20.00-38.5ºC and daily minimum ranges between 18.70-28.2ºC. The months of February to early April are the months that have the highest maximum temperature while the lowest maximum temperature months are recorded in December and January because of the prevailing cold harmattan wind from the northern part of the country at this period. The relative humidity rises as from april to a maximum of about 75-90% in July. (NIMET, 2010). The treatments consisted of three levels of phosphorus 0, 20 and 40 kg/ha and three levels of spacing: 15×40, 30×60 and 45×80 cm factorially combined to form nine treatments which were laid in a Randomized Complete Block Design (RCBD) and replicated three times to form twenty seven plots. The plot size was 3 m by 4 and 0.5 m between plots and 1m between replicates. Soil samples were taken at a depth of 0-15 cm before planting in each season and were analyze to determine their physic-chemical properties as presented in Table 1.

The land was cleared, ploughed and harrowed. Cowpea (*Vigna unguiculata*) Kananade variety was obtained from NADP seed shop Lafia and planted on the ploughed and harrowed experimental plots. Weeds were control by three hoes weeding at three, six, and twelve weeks after sowing. Insect pest were controlled by spraying cypermethrim before and after flower formation to control cowpea thrips and also karate 5EC was later sprayed for control of cowpea pods insects. The cowpea was harvested through handpicking as soon as many of pods were dried to harvest maturity. In each plot, four plants were selected in the net plot for collection of the following data in both years: number of leaves, number of branches, plant height (cm), number of nodules/plant, number of pods/plant, number of seed/plant, pod weight/plant (kg/ha), weight of 100 seeds/plot (kg/ha), seed weight/plot (kg/ha), and seed weight/ha. The data collected were subjected to analysis of variance using GENSTAT, and where there is a significant difference; the means were separated using F-LSD at 5% probability level

Table 1: Physicochemical properties of the soil of the experimental site at Lafia, Nigeria in year 2009 and 2010

Soil composition	2009	2010
Mechanical composition		
Clay (g/kg)	9.43	9.42
Silt (%)	26.10	29.32
Sand (%)	65.54	64.84
Textural class (USD)	Loamy sand	Loamy sand
Chemical composition		
pH (H_2O)	6.85	6.53
pH ($0.01MC_aCl_2$)	6.57	6.50
% organic carbon (g/kg)	1.05	1.31
Available P (mg/kg)	1.02	1.16
Total nitrogen (N) %	0.86	1.08
Exchangeable cations (cmol/kg)		
Calcium	9.84	9.90
Magnesium	5.84	6.00
Sodium	94.21	92.64
Potassium	65.42	67.24
Cation exchange capacity	2.84	2.86

RESULTS

The physic-chemical properties of the soil samples of the experimental site (Table 1) showed that the soil was sandy loam, low in total N (0.86 and 1.08) and available phosphorus (1.02 and 1.16 mg kg-1) in both years of cropping. This result tallied with work of Agbede (2009), who characterized the savanna soils as highly leached ferruginous ultisols low in O.M., N and P but high in K content.

Phosphorus fertilizer had a significant ($p<0.05$) response on number of leaves, number of branches, vine length and number of nodules per plant of cowpea in both years (Table 2). Application of 40 kg/ha of phosphorus fertilizer produced the highest number of leaves (20.81 and 24.82), number of branches (7.85 and 7.95), vine length (90.02 and 78.00) and roots nodules (34.95 and 32.24) in both years. However, the control produced the lowest response to all the growth parameters and number of roots nodules/plant assessed in both years. The spacing also had significant ($p<0.05$) influence on number of branches, vine length, and nodulation count in both years. The spacing of 45×80 cm recorded significantly higher number of branches (7.17 and 6.98), vine length (75.67 and 75.85 cm) and nodulation count (32.21 and 34.53), which is statistically at par with 30×60 cm spacing of cowpea.

Table 2: Effect of phosphorus fertilizer and spacing on the growth parameters and nodulation count of cowpea at 8WAP

	No. of leaves		No. of branches		Vine length (cm)		Nodulation count	
Treatments Phosphorus (kg)	2009	2010	2009	2010	2009	2010	2009	2010
0	17.23b	18.31b	4.11c	3.95c	80.40c	62.34c	21.43c	20.53c
20	19.26a	20.20b	5.56b	5.34b	86.79b	70.90b	28.20b	26.06b
40	20.81a	24.82a	7.85a	7.95a	90.02a	78.00a	34.95a	32.24a
Spacing (cm)								
15×40	18.00b	18.15c	5.64b	6.02b	85.04b	68.05b	25.23b	26.12b
30×60	19.72a	19.03b	6.10a	6.96a	94.34a	73.65a	27.45b	28.54b
45×80	20.81a	21.45a	7.17a	6.98a	95.67a	75.85a	32.21a	34.53a
LSD (0.05)	1.40	2.32	1.09	0.86	2.52	3.01	4.42	4.21

Means in the same column followed by the same letter (s) are not significantly different ($p \leq 0.05$) according to LSD

Table 3: Effect of phosphorus fertilizer and spacing on the yield parameters cowpea at harvest

Treatments	No. of pod/plant		seed wt/plant (g/plant)		pods wt/plant (g/plant)		100 seeds wt (g)		Seed wt/ha (t/ha)	
Phosphorus (kg)	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
0	15.26b	14.42c	30.42c	28.84c	38.92c	35.92c	19.12	19.23	0.97c	0.89c
20	17.05b	18.01b	35.85b	32.65b	40.05b	39.42b	19.53	19.56	1.14b	1.02b
40	20.64a	20.24a	39.56a	37.64a	51.45a	45.31a	20.52	20.02	1.56a	1.52a
Spacing (cm)										
15×40	15.32b	15.42b	28.43b	30.04b	35.35b	36.24b	20.23	18.82	1.02b	1.01b
30×60	16.87b	17.05a	32.02a	32.65a	42.52a	45.26a	20.54	19.54	1.43a	1.45a
45×80	19.56a	19.68a	34.20a	33.24a	45.68a	46.18a	21.35	19.59	1.48a	1.49a
LSD (0.05)	2.32	2.12	2.24	1.20	4.84	3.01	2.02	1.68	0.21	0.40

Means in the same column followed by the same letter (s) are not significantly different ($p \leq 0.05$) according to LSD

Phosphorus fertilizer showed a significant ($p<0.05$) effect on the entire yield parameter assessed in both years, except on the 100 seed weight (Table 3). Fourty kg/ha of phosphorus gave a significantly higher no. of pod/plant (20.64 and 20.24), seed weight/plant (39.56 and 37.64), pods weight/plant (51.45 and 45.31), and seed weight/ha (1.56 and 1.52 t/ha). The spacing also had a significant ($p<0.05$) response on almost the entire yield parameter assessed except on the weight of 100 seeds. Spacing of 30×60 and 45×80 cm gave statistically the same result in the no. of pod/plant, seed weight/plant, pods weight/plant and seed weight (t/ha) in both years.

DISCUSSION

The significant response of cowpea to Phosphorus fertilizer application observed in terms of growth parameter and nodulation count may be attributed to the fact that Phosphorus stimulates root and plant growth, initiates nodule formation as well as influences the general efficiency of the rhizobium-legume symbiosis, thereby optimizes the Biological Nitrogen Fixation (BNF) system of legume. This result agreed with the findings of Norman *et al.* (1995) and Ankomah *et al*. (1995). Also, increase in level of phosphorus fertilizer application resulted to increased grain yield of cowpea. This could be attributed to the fact that Phosphorus helped in producing higher nodulation count, which resulted in higher nitrogen fixation. This led to the production of more leaves and branches for higher photosynthetic ability. This finding coincide with the result of the work of Singh *et al*. (2011), who reported the maximum yield of cowpea at 37.5 kg P/ha in the Sudan savanna agroecological zone of Nigeria. Magani and Kuchinda (2009), reported a similar finding of 35.5 kg/ha of phosphorus did not differ significantly with 70 kg/ha as best level of phosphorus application on cowpea in the northern guinea savanna agroecological zone of Nigeria.

Generally, decreasing the plant spacing means increasing the plant population in a given area of land and also increased competition among plants for soil moisture, nutrient, light and carbon dioxide. This might explain the significant effect of plant spacing on most of the parameters measured in the present study. Plant spacing had a significant effect on most growth and yield components measured in this study. These findings are in accordance with the previous results reported by Hamad (2004) and Asiwe and KUTU (2009); they indicated that cowpea plants produced at the lowest densities, set good number of pods than those at the higher densities.

CONCLUSION

From this study, it can be concluded that 40 kg/ha phosphorus fertilizer and 30×60 cm spacing could be the best fertilizer level and spacing for growth, nodulation count and yield of cowpea in southern guinea savanna agroecological zone. However, further locational trials should be conducted within the zone to confirm this result.

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