EFFECT OF NITROGEN AND PHOSPHORUS FERTILIZERS ON THE YIELD AND YIELD COMPONENTS OF BAMBARA GROUNDNUT (*Vigna subterranea* (L) *verdc*) IN MUBI, ADAMAWA STATE.

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ABSTRACT
The study was carried out to investigate the effects of various rates of nitrogen (0, 15, 30, and 45 kg N/ha) and Phosphorus (0, 20, 40 and 60 kg P/ha) fertilizers on the yield and yield components of bambara groundnuts. The experiment was carried out during the 2006 and 2007 cropping seasons at the Resaerch and Demonstration farm, Department of Crop Science, Adamawa State University, Mubi. The experiment was laid out in split-plot design with nitrogen assigned to main-plot and phosphorus to sub-plot and replicated three times. Parameters measured were stand count at harvest, number of pods/plant, number of seed/pod, seed diameter, weight of 100 grains, and grain yield (kg/ha). The application of 60 kg P/ha resulted in increased nodulation, number of pods/plant and grain yield of the crop. The highest number of pods (38.0) and seed yield (1,771.7 kg/ha) were recorded with the application of 60 kg P/ha, while the lowest seed yield (1,449.5 kg/ha) were recorded at the control (0 kg P/ha). Nitrogen and phosphorus interaction significantly increased the number of seed/pod and grain yield of the crop. Based on the findings of the study in Mubi, fertilizer levels of 15 kg N/ha and 60 kg P/ha are recommended.

Key words: Bambara groundnut, nitrogen, phosphorus, yield, yield components

INTRODUCTION
Bambara groundnut (*Vigna subterranean (L.) verdc*) is a leguminous food crop that is cultivated for its subterranean pods. The crop is an indeterminate annual legume which exhibits a wide range of growth characteristics from open (spreading) to compact (bunched) types and grows up to 30cm in height (Doku and Karikari, 1972).

The center of origin of the crop has been a subject of controversy, but it is generally accepted that the wild plants were found in Northern Nigeria in places such as Jos in Plateau state, Hong Local Government in Adamawa state and Garua in Northern Cameron (Happer, 1970). Bambara groundnut is the third most important pulse crop in Nigeria after groundnut and cowpea (Coudert, 1984). It features predominantly in the traditional farming system all over the country as an inter-crop with cereal and other crops, although it is planted as a sole crop in many areas (Linemann, 1988). The crop is presently grown throughout the tropics because of its adaptation to areas of low rainfall and low soil fertility as well as being relatively tolerant to pest and diseases as compared to other leguminous crops (Duke, 1981).

Bambara groundnut is a pulse crop of immense potential in enhancing food security especially in drought-prone agricultural system. Its drought tolerance makes it ideal for production by poor resource farmers especially in communal and resettlement areas. As a result, it can grow well in communal areas where pest and disease control are not given serious attention (Vusamuzi, 1992). Seed yield in most countries ranges from 650 to 850 kg/ha (Stanton, 1990). Although it is an important crop in West Africa, yields are very low, ranging from 300 to 800 kg/ha. (Begemann, 1986). Also, bambara groundnut has not received the research attention that would be expected for such an important crop. There is need to increase production and yield potentials through improved agronomic practice and efficient use of fertilizers to ensure optimum productivity. Results of fertilizer tests conducted in Nigeria to

determine the effects of nitrogen and phosphorus fertilizers on the growth and yield of the crop have been inconsistent (Nnadi *et al.*, 1976; Tanimu and Yayock, 1989). Mubi-white is a widely grown cultivar in Mubi and its environs. It is erect (bunchy) late maturing (95 – 155 days), high yielding with a medium sized pod. Its cream white seeds are considered the best in terms of quality and attracts higher price than other cultivars. The cultivar is drought tolerant and is reported to be one of the most pest and disease free crops and can be grown as an inter-crop with cereals and other leguminous crops in mubi (Maunde, 2002). Despite the wide spread cultivation of bambara groundnut in Mubi, there is no recommended fertilizer rates that will ensure optimum production of the crop. In line with the above, the research was designed with the following objectives: -

i. To evaluate the effects of nitrogen and phosphorus fertilizers on the yield and yield components of bambara groundnut.
ii. To determine the interaction between phosphorus and nitrogen fertilizers on the yield and yield components of bambara groundnuts.

MATERIALS AND METHODS

The experiment was conducted during the 2006 and 2007 cropping season on the Research and Demonstration Farm of the Department of Agronomy, Adamawa State University, Mubi. Mubi lies within latitude $10^{o}08'$N and $10^{o}30'$N and longitude 13^{o} 10'E and $13^{o}25'$E (Obiefuna *et al*, 1997). The rainfall is single- peaked, commencing in early May with the highest rainfall recorded in the month of August and terminates in early October. The mean annual rainfall ranges from 100mm in May to 900mm in August (Adebayo, 2004).The experimental site has been previously put under cultivation in the past years to sorghum and maize. The area is sandy loam with good drainage. Mubi-white cultivar was used for the trial. Seeds saved from previous harvest were used as planting material. The experiment was laid out in a split- plot design replicated three times. The treatments consisted of four levels of nitrogen (0, 15, 30 and 45 kg N/ha) which was assigned to the main- plot, and four levels of phosphorus (0, 20, 40, and 60 kg P/ha) used as sub-plot treatment. Urea 46%N and single super phosphate (18% P_2 0_5) were used as of source of nitrogen and phosphorus respectively. Nitrogen and phosphorus fertilizers were applied basally on each plot during land preparation.

The sowing was done at the spacing of 20 cm x 40 cm on 2nd July 2006 and 6th July 2007 respectively. Seeds were sown with the use of a rope and a hoe. Two seed/hole were planted at the depth of about 3 cm. All the data collected were subjected to analysis of variance (ANOVA) appropriate to split-plot design as described by Gomez and Gomez (1984) and treatment means were separated using Least Significance Difference (LSD).

RESULTS AND DISCUSSION

The application of nitrogen and phosphorus had no significant effect ($p = 0.05$) on the number of plants at harvest (Table 1). There was also no significant interaction ($p = 0.05$) between nitrogen and phosphorus fertilizer on the number of plant at harvest in 2006. The same trend was observed in 2007 (Table 2)

The application of nitrogen had no significant effect ($p = 0.05$) on the number of pods/plant. However, application of phosphorus gave a significant effect ($p = 0.05$) on number of pods/plant. Thus, increased phosphorus levels from 20 kg P/ha to 60 kg P/ha resulted in significantly more number of pods/plant. The number of pods/plant increased from 32.6 to 38.5 in 2006 and from 34.0 to 37.5 in 2007 when phosphorus level was increased from 20 kg P/ha to 60 kg P/ha (Table 1). The increase in the number of pods/plant indicated that phosphorus is essential for fruit and seed development and improves quality of seed and pod. There was also a tendency of more response of phosphorus by the crop with more levels of phosphorus fertilizer (Tanimu and Yayock, 1987). In 2006 cropping season, plots that received 45 kg N/ha produced the lowest number (33.2) of pods/plant (Table 1).The

decrease in number of pods/plant indicates that nitrogen requirement of the crop were met through nitrogen fixation making them less dependent on anthropogenic sources of nitrogen. This agrees with the work of Tanimu and Yayock (1987) which indicate an increase in nitrogen levels of 45 kg N/ha resulted in a decreased number of pods/plant. There were also significant interactions between nitrogen and phosphorus levels on the number of pods/plant. The combination of 60 kg p/ha and 0 kg N/ha gave the highest number of pods/plant (40.9), while the lowest number of pods/plant (38.0) were recorded when 0 kg N/ha and 0 kg P/ha was applied (Table 1 and 3). This demonstrates a complementary effects of soil nitrogen with additional phosphorus on bambara groundnut, in which residual nitrogen promotes vigorous growth and increase photosynthetic capacity of the crop, while phosphorus increase root development and yield of bambara groundnut (Guaye and Bordeleau, 1988). The result of the study agrees with the work of Maunde (2002), in samara Zaria, who reported that the interaction of nitrogen and phosphorus fertilizer increase number of effective nodules, number of seed/pod and grain yield of bambara groundnut.

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Table 1. Mean of number of plants at harvest, number of pods/plant, number of seeds/pods, 100 grain weight, seed diameter, and grain yield/ha 2006 and 2007 cropping seasons.

Treatments	Number of plants at harvest		Number of pods /plant		Number of seeds/pods		Seeds diameter		100 grain weight (kg)		Grain yield (kg/ha)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Nitrogen (KgN/ha)												
0	74.0	68.7	34.8	34.0	1.35	1.3	1.5	1.6	77.9	82.4	1483.0	1457.0
15	73.8	67.3	33.3	33.3	1.23	1.2	1.3	1.6	76.9	83.3	1420.7	1458.9
30	731.6	68.9	33.2	33.2	1.25	1.2	1.6	1.7	77.9	83.8	1418.2	1436.8
45	71.9	68.7	33.0	33.2	1.27	1.4	1.7	1.8	77.8	83.2	1417.5	1436.0
LSD	2.5	1.7	3.0	3.2	32	0.11	0.19	0.14	1.28	1.48	69.2	124.0
Prop of F	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Phosphorus (KgP/ha)												
0	73.3	67.9	32.6	34.0	1.27	1.2	1.2	1.1	76.8	83.2	1360.2	1449.5
20	73.7	67.7	37.0	34.7	1.22	1.2	1.2	1.1	76.8	83.5	1372.2	1691.0
40	74.6	68.8	375	36.1	1.23	1.2	1.3	1.2	76.3	83.8	1472.7	1617.3
60	73.4	68.8	38.5	37.5	1.22	1.2	1.3	1.2	77.5	83.3	1472.9	1771.7
LSD	1.6	1.7	3.0	3.0	0.17	0.10	0.20	0.13	1.43	1.09	1417.0	773.0
Prob of F	NS	NS	*	*	NS	NS	NS	NS	NS	NS	*	*
Interaction (N x P)	NS	NS	*	*	NS	NS	NS	NS	NS	NS	*	*

WAS = Weeks after sowing Ns = Not Significant * =Significant (P=0.05)

Table 2. Combined analysis of stand count at harvest, number of pods/plant, number of seed/pods, seed diameter, 100 grain weight, and grain yield kg/ha

Year	Stand count at harvest	Number of pods/plant	Number of seed/pods	Seed diameter	100 grain weight	Grain yield (kg/ha)
2006	70.4	32.6	1.2	1.7	80.1	1437.6
2007	71.6	31.8	1.3	1.5	80.7	1576.2
Mean	71.0	32.2	1.3	1.6	89.4	1506.9
LSD	1.8	1.4	0.06	0.4	0.8	71.2
Prob of F	NS	NS	NS	NS	NS	*
Nitrogen (Kg N/ha)						
0	71.3	31.4	1.3	1.5	80.2	1470.0
15	70.5	33.3	1.2	1.5	80.1	1439.8
30	70.2	33.2	1.2	1.6	80.7	1427.5
45	69.8	31.1	1.2	1.7	80.5	1426.7
Mean	69.8	32.9	1.2	1.6	80.3	1441.0
LSD	1.9	2.6	0.08	0.51	0.98	73.2
Prob of F	NS	NS	NS	NS	NS	NS
Phosphorous (Kg P/ha)						
0	70.6	33.3	1.2	1.1	80.5	1404.8
20	70.7	35.8	1.2	1.1	80.0	1531.8
40	71.8	36.8	1.2	1.2	80.0	1545.0
60	71.8	38.0	1.2	1.2	80.4	1545.0
Mean	71.2	35.2	1.2	1.1	80.3	1518.9
LSD	2.8	2.4	0.08	0.12	1.09	81.8
Prob of F	NS	NS	NS	NS	NS	NS
Interaction (NxP)	NS	*	NS	NS	NS	*

Ns = Not Significant * =Significant (P=0.05)

Application of nitrogen and phosphorus fertilizers had no significant effects (p = 0.05) on seed diameter of bambara groundnuts in 2006 and 2007 cropping seasons (Table 1). There was also no significant interaction between the fertilizer levels on seed diameter (Table 2). Neither the application of nitrogen nor phosphorus had a significant effect (p = 0.05) on 100 grain weight in 2006 and 2007 cropping seasons (Table 1). Similarly, there was no significant interaction between fertilizer levels on 100 grain weight of the crop (Table 2).

Nitrogen had a significant effect (p = 0.05) on grain yield of bambara groundnut in 2006 cropping season. An increase in nitrogen levels from 30 kg N /ha to 45 kg N/ha significantly decreased grain yield of bambara groundnut. Grain yield of bambara groundnut decreased with increased levels of nitrogen from 1483 kg/ha to 1417.5 kg/ha in 2006 and 1457.0 kg/ha to 1436.0 kg/ha in 2007 cropping season. An increased level of nitrogen from 0 kg N/ha to 45 kg N/ha resulted into a decrease in yield of the crop from 1470 kg/ha to 1426.6 kg/ha (Table 1). This may be as a result of combined effect of nitrogen in the root nodules of the crop which inhabits nodulation as reported by Ohara (1988). The result also agrees with the report of Tanimu and Yayock (1987) at Samaru Zaria, who noted that application of nitrogen fertilizer significantly depressed yield and 100 seed weight of bambara groundnut. This agrees with the work of Toungos (2007) and Maunde (2002) that there were an increase in yield of bambara groundnut with increased level of phosphorus fertilizers. Increasing the levels of phosphorus from 25 kg P/ha to 50 kg P/ha increase the grain yield of the crop, similar results were also reported in Botswana by Romolemana (1999). The interaction between nitrogen and phosphorus was also significant in 2006 and 2007. An application of 60 kg P/ha gave a yiled of 1669.3 when 0 kg N/ha was applied (Table 4)

Table 3. Interaction between nitrogen and phosphorus fertilizer on number of pods/plant in 2006 and 2007 cropping seasons at 30 and 40 DAS

	N Level kg N/ha 2006					N Level kg N/ha 2007				
Kg P/ha	0	15	30	45		Kg P/ha	0	15	30	45
0	36.7	63.4	36.3	35.8		0	38.0	37.5	37.7	36.9
20	38.9	38.6	38.5	30.0		20	38.3	37.8	38.1	37.2
40	39.1	38.9	37.7	38.2		40	39.0	38.5	38.8	37.9
60	39.6	39.4	39.2	38.7		60	40.9	39.2	39.5	38.6
LSD	3.1					LSD	3.1			

Table 4. Interaction between nitrogen and phosphorus fertilizer on grain yield kg/ha in 2006 and 2007 cropping seasons at 30 and 40 DAS

	N Level kg N/ha 2006					N Level kg N/ha 2007				
Kg P/ha	0	15	30	45	Kg P/ha	0	15	30	45	
0	1327.8	1296.7	1395.4	1402.1	0	1502.2	1504.2	1490.9	1503.7	
20	1221.6	1190.4	1289.2	1295.8	20	1629.0	1624.9	1611.4	1610.5	
40	1377.9	1456.8	1445.5	1452.2	40	1592.1	1588.1	1574.4	1573.6	
60	1315.0	1318.8	1417.6	1424.2	60	1669.3	1663.3	1651.7	1623.8	
LSD	73.2				LSD	124.5				

CONCLUSION

Based on the results obtained from the study, it could be concluded that bambara groundnut like any leguminous crops fixes its own nitrogen through the nitrogen-fixing bacteria *Rhizobia* spp. There was a significant decrease in grain yield (kg/ha) of bambara groundnut following the application of nitrogen fertilizer. However, the application of phosphorus fertilizer increased grain yield (kg/ha). The highest yield of 1,771.7 kg/ha was obtained with the application of 60 kg P/ha.

RECOMMENDATION

Based on the findings of the study, the best fertilizer levels for optimum production of bambara groundnut in Mubi was 15 kg N/ha and 60 kg P/ha. A multi-locational experiment on the effects of fertilizer levels on the yield and yield components of bambara groundnut in Mubi should also be carried out.

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