

EFFECT OF PLANT SPACING AND PHOSPHORUS ON THE GROWTH AND YIELD OF BAMBARA GROUNDNUT (*VIGNA SUBTERRANEAN* L.) IN A SOUTHERN GUINEA SAVANNA OF NIGERIA

Eifediyi^{1*}, E. K; Ogedegbe², Ahamefule, H. E¹, and Imam¹, A. Y.

¹Department of Agronomy, University of Ilorin, Ilorin, Nigeria

²Department of Crop Science, Ambrose Alli University, Ekpoma – Nigeria

*Corresponding author's email: eifediyi.ek@unilorin.edu.ng; kevificediyi@yahoo.ca

Abstract

Bambara groundnut is an indigenous crop to the savannah zone of Nigeria. Farmers in the region sow their seeds using sub-optimal plant spacing which often leads to low yield. A field experiment was therefore conducted at Teaching and Research Farm, University of Ilorin, Nigeria during 2017 cropping season to evaluate the performance of Bambara groundnut under varying plant population densities and P_2O_5 fertilizer. The experiment was a factorial arrangement fitted into a randomized complete block design replicated thrice. The factors were plant population density (444,444, 111,111, 49,383 ha^{-1}) and phosphorus rates (0, 20, 40, 60, 80 $kg\ ha^{-1}$). Data were collected on growth parameters; plant height and number of leaves at 4, 6, 8 and 10 weeks after planting and yield components; shelling percentage, number of pods per plants, weight of pods per plants, weight of shelled seeds per plant a number of nodules weight of seeds per hectare were collected after harvesting the data collected were subjected to analysis of variance (ANOVA) using GENSTAT statistical software (17th edition). Treatment means were compared using the least significant difference (LSD) at 5% level of probability. The result showed that plant population density and P_2O_5 fertilizer had no significant effect on vegetative and yield attributes of Bambara groundnut but significant effect was only observed for shelling percentage.

Keywords: Bambara; Spacing; Phosphorus Growth; Yield

Introduction

Bambara groundnut (*Vigna subterranea* (L.) Verdc.) is an indigenous leguminous crop which is cultivated by peasant farmers in the savannah zone of Nigeria. These farmers sow their seeds using wide spacing and low inputs which often results in suboptimal plant population density and low yield. Bambara groundnut has an important socio-economic role in tropical Africa, where they are a traditional food in areas (Brink et al., 2006). Moreover, its seeds are rich in proteins, minerals and vitamins (De Kock, 2013; Yao et al., 2015; Tsoata et al., 2017). One of the main attributes of Bambara groundnut is its tolerance to high temperature, poor soils (Temegne et al., 2015) and drought (Berchie et al., 2012; Tsoata et al., 2016; 2017) as well as its ability to produce seeds under conditions where groundnuts fail completely (Jideani and Diederiks, 2014) and therefore can be used to mitigate against food insecurity. Plant population density is an important factor in growth and yield of bambara groundnut (Sticksel et al., 2001). Egbe et al. (2009), have reported that plant population density is often low in farmer's fields with resultant low yields and this varies from location to location in eastern and western Africa. (Alhassan et al., 2012). Jakusko and Bebel (2009) had earlier reported higher seed yields per plant on application of 60 $kg\ ha^{-1}$ of P_2O_5 in Yola, North East Nigeria. This study was therefore conducted to evaluate the growth and yield of Bambara groundnut as influenced by rates in Ilorin, a southern Guinea savanna agro-ecological zone of Nigeria.

Material and Methods

Experimental site and Land preparation:

The experiment was carried out during the cropping season of 2017 at University of Ilorin Teaching and Research Farm. University of Ilorin was located on latitude $8^{\circ}49'$, longitude $4^{\circ}49'N$ and altitude 308m above sea level. The mean annual rainfall of 1200mm and the Soil is predominantly sandy loam. The land was cleared and prepared into beds of 2 m x 1m with 0.5 m in between the beds as alley way using hoe.

Soil analysis:

Soil sample were collected from 0-30cm depth with soil auger on the experimental site for laboratory analysis to determine soil pH, soil: water ratio (1:2) by using a glass electrode, total N content was determined by macro-Kjeldahl method (Bremner, 1982); available phosphorus was determined by following Bray No 1 (1N NH_4F + 0.5N) HCL extractant by vanadomolybdophosphoric acid method (Kuo, 1996), organic carbon was determined by using the modified Walkley-Black method (Nelson and Sommers, 1996) and extraction of exchangeable bases was done by using 1N ammonium acetate, exchangeable potassium and sodium were determined using flame photometry while calcium and magnesium were analyzed by atomic absorption spectrophotometry.

Experimental design:

The experiment was randomized complete block design in 3×5 factorial arrangements (15 x 15 cm) 444,444 plants ha^{-1} ; (15 x 30 cm) 222,222 plants ha^{-1} and (15 x 45 cm) 148,148 plants ha^{-1}) and phosphorus fertilizer was applied at the rate of 0, 20, 40, 60 and 80 $kg ha^{-1}$.

Data collection and analysis:

Data were collected on the following growth parameters; plant height and number of leaves at 4, 6, 8 and 10 weeks after planting and yield components; shelling percentage, number of pods per plants, weight of pods per plants, weight of shelled seeds per plant and weight of seeds per hectare were collected after harvesting. The data collected were subjected to general analysis of variance (ANOVA) using GENSTAT statistical software (17th edition). Treatment differences were compared using the Least Significant Difference (LSD) at 5% level of probability.

Result

Growth and yield components

The effects of plant population density and phosphorus rates on the growth parameters (petiole length and number of leaves) of bambara groundnut at 4, 6, 8 and 10 weeks after sowing are presented in Tables 1 and 2. The data indicated that at the four sampling periods, no significant difference was observed using the different plant population density and the phosphorus rates. Also there was no significant interaction. The data on the yield components of bambara groundnut is presented in Table 3. The data showed that increasing the plant population had no significant effects on number of pods, weight of seeds per plot and yield per hectare. However, the shelling percentage responded to population density ha^{-1} . Plants sown at 444,444 and 111,111 stands ha^{-1} were statistically similar in shelling percentage but significantly different ($P < 0.05$) from the 49,383 stands ha^{-1} .

Discussion

There was an increase in the petiole length due to increase in plant population density; although no significant difference was observed, may be attributed to competition for

space, light and nutrients compared to plants at lower plant population density. Effa *et al.* (2016) had reported that wider spacing increased nutrient availability and assimilate production thereby increasing the rate of growth. However, lower plant population density resulted in increase in the number of leaves produced hence more assimilate production, the overall pod number and seed yields were low. On the other, the higher populations produced more seeds which were smaller, but outweighed the yields of those planted at lower plant population density. Chaniyara *et al.* (2001) had earlier reported an increase in groundnut yield in response to narrow spacing and denser planting compared to wider rows. Toungos *et al.* (2009) reported an increase in grain yield of Bambara Groundnuts with increase in phosphorus rates up to 60kg/ha. The control gave the lowest yield.

Conclusion

The result of this experiment revealed that Bambara groundnut did not respond to increase in plant population density and phosphorus fertilizer application. This is a sharp contrast with the findings of other researchers. More work needs to be done to confirm this finding.

References

- Alhassan, GA, Kalu, BA, Egbe, OM. 2012, Influence of planting densities on the performance of intercropped Bambara groundnut with cowpea in Makurdi, Benue state, Nigeria, *International Journal of Development and Sustainability*, 1 (3): 860-879.
- Berchie JN, Opoku M, Adu-Dapaah H, Agyemang A, Sarkodie-Addo J, Asare E, Addo J, Akuffo H (2012). Evaluation of five Bambara groundnut (*Vigna subterranea* (L.) Verdc.) Landraces to heat and drought stress at Tono-Navrongo, Upper East Region of Ghana. *Afr. J. Agric. Res.* 7(2):250-256.
- Bremner, J. M. and Mulvaney, C. S. (1982). Total Nitrogen. 593-624. In: Page *et al.* (eds) ASA and SSA. Madison, W. I.
- Brink M, Grubben GJH, Belay G, Agrooh (2006). Ressources végétales de l'Afrique tropicale 1: Céréales et légumineuses. Edition M. Brink, 328p.
- De Kock C (2013). Bambara groundnut. http://www.underutilizedspecies.org/documents/Publications/bambara_groundnut_paper.pdf.
- Effa, E.B., Nwagwu, F.A., Osai, E.O. and Shiyam, J.O., 2016. Growth and yield response of Bambara groundnut (*Vigna subterranea* (L.) Verdc) to varying densities and Phosphate fertilizer rates in Calabar, South Eastern Nigeria. *Journal of Biology, Agriculture and Healthcare*, ISSN 2224-3208 (Paper) ISSN 2225-093X (Online) Vol.6, No.16, 2016
- Egbe, OM, Kalu, BA, Idoga, S. 2009. "Contribution of common food legumes to the fertility status of sandy soils of the moist savanna woodlands of Nigeria". *Report and Opinion Journal*, 1(1): 45 – 62.
- FAO (Food and Agriculture Organization): Rome. Food and Agriculture Organization (FAO) (2017). Statistique de production (FAOSTAT). Organisation des Nations Unies pour l'Alimentation et l'Agriculture (FAO). Rome. <http://www.fao.org/faostat/en/#home>.
- Food and Agriculture Organization (FAO) (2003). Gestion de la fertilité des sols pour la sécurité alimentaire en Afrique subsaharienne.
- Goli, AE. 1997. Conservation and Improvement of Bambara groundnut (*Vigna subterranea* [L.] Verdc). In: Heller, J., F. Begeman and J. Mushonga (Eds). *Bibliographical Review. Proceedings of an International Workshop held at Harare, Zimbabwe*, IPK/IPGRI: 4 – 10.

- Hubbell, DH, Kidder, G. 2009. *Biological Nitrogen Fixation*. University of Florida, IFAS Extension Publication, SL 16:1 – 4.
- IRAD (2013). Contribution de la recherche à l'amélioration de la production et de la consommation des légumineuses alimentaires au Cameroun. IRAD, Yaoundé, 57p.
- Jakusko, BB, Bebel, M. D. 2009. Effects of Different Levels of Phosphorus on Quantitative Characters / Yield and Productivity of Bambara groundnut (*Vigna subterranea*[L.] Verdc) in Yola, *Techno Science African Journal*, 3(1): 40 – 52.
- Jideani VA, Diedericks CF (2014). Nutritional, Therapeutic, and Prophylactic Properties of *Vigna subterranea* and *Moringa oleifera*. Department of Food Technology, Cape Peninsula University of Technology, Bellville, pp. 187-207.
- Karikari, SK, Wigglesworth, D J, Kwerepe, B C, Balole, TV, Sebolai, B, Munthali, DC. 1997. "Country Reports: Botswana. In: Heller, J., F. Begeman and J. Mushonga (Eds.). Conservation and improvement of Bambara groundnut (*Vigna subterranea* [L.] Verdc.), Proceedings of an International Workshops held at Harare, Zimbabwe. IPK/IPGRI, 11 – 19.
- Massawe, FJ, Dickson, M, Roberts, JA, Azam – Ali, SN. 2002, Genetic diversity in Bambara groundnut (*Vigna subterranea* [L.] Verdc.), landraces revealed by AFLP markers. Published on NRC Research Press Website <http://www.genome.nrc.ca>, Canada.
- Mkandiwire, FL, Sibuga, KP. 2002. Yield response of bambara groundnut to plant population and seedbed type. *African Crop Science Journal*, 10:39 – 49.
- Nelson, D. W. and Sommers, L. E. (1982). Total carbon, organic carbon and organic matter. Part 2, chemical and microbial properties. Agronomy monograph. No. 9.
- Temegne NC, Mbogne TJ, Nbandah P, Youmbi E, Taffouo VD, Ntsomboh-Ntsefong G (2015). Effect of phosphate deficiency on growth and phosphorus content of three Voandzou (*Vigna subterranea* (L.) Verdc.) varieties. *IOSR IOSR J. Agric. Vet. Sci.* 8(9):2-59.
- Toungos, DT, Sajo, AA, Gungula, DT. 2009. Recommended fertilizer levels on Bambara groundnut (*Vigna subterranea* [L.] Verdc.) in Yola, Adamawa State, Nigeria. *Agricultural Journal*, 4(1):14 – 21.
- Tsoata E, Temegne NC, Youmbi E (2016). Analysis of early physiological criteria to screen four *Fabaceae* plants for their tolerance to water stress. *Int. J. Recent Sci. Res.* 7(11):14334-14338.
- Tsoata E, Temegne NC, Youmbi E (2017a). Analysis of early biochemical criterion to screen four *Fabaceae* plants for their tolerance to drought stress. *Int. J. Curr. Res.* 9(1):44568-44575.
- Tsoata E, Temegne NC, Youmbi E (2017b). Analysis of early growth criterion to screen four *Fabaceae* plants for their tolerance to drought stress. *RJLBPCS* 2(5):94-109.
- World Food Programme (WFP) (2016). Hunger Statistics. World Food Programme. <http://www.worldhunger.org/2015-world-hunger-and-poverty-facts-and-statistics/>.
- Yakubu, H, kwari, JD, Sandabe, MK. 2010. Effect of phosphorus fertilizer on nitrogen fixation by some grain legumes varieties in sudano – sahelian zone of North -Eastern Nigeria. *Nigerian Journal of Basic and Applied Sciences*, 18(1) 44 – 49.
- Yao DN, Kouassi KN, Erba D, Scazzina F, Pellegrini N, Casiraghi C (2015). Nutritive Evaluation of the Bambara Groundnut Ci12 Landrace [*Vigna subterranea* (L.) Verdc. (*Fabaceae*)] Produced in Côte d'Ivoire. *Int. J. Mol. Sci.* 16(9):21428-21441.

Table 1: Effects of plant population density and phosphorus on the petiole length of Bambara groundnut at 4, 6, 8 and 10 weeks after sowing (WAS).

Treatment	Weeks After Sowing(WAS)			
	4	6	8	10
Population density (PD)				
444,444	5.36	6.59	6.59	10.56
111,111	4.94	7.71	9.39	11.36
49,383	5.32	7.27	8.83	10.84
LSD _(0.05)	NS	NS	NS	NS
Phosphorus level(PL) (Kgha ⁻¹)				
0	5.22	7.70	8.99	11.27
20	4.44	5.27	6.44	8.24
40	5.50	7.55	9.44	11.50
60	5.16	7.33	8.89	10.77
80	6.27	8.50	10.39	12.44
LSD _(0.05)	NS	NS	NS	NS
LSD _(0.05) Interaction, PD+PL	NS	NS	NS	NS

Table 2. The effects of plant spacing and phosphorus on the number of leaves of Bambara groundnut at 4, 6, 8 and 10 Weeks after sowing (WAS).

Treatment	Weeks After Sowing(WAS)			
	4	6	8	10
Population density (PD)				
444,444	20.13	37.87	55.83	71.20
111,111	27.00	43.50	69.50	75.00
49,383	20.55	36.91	52.51	71.16
LSD _(0.05)	NS	NS	NS	NS
Phosphorus level(PL) (Kgha ⁻¹)				
0	19.83	37.17	61.56	74.61
20	15.00	24.50	36.17	54.83
40	21.94	39.61	48.17	79.50
60	20.55	38.11	51.83	72.33
80	25.44	45.17	64.83	74.50
LSD _(0.05)	NS	NS	NS	NS
LSD _(0.05) Interaction, PD+PL	NS	NS	NS	NS

Table 3. The effects of plant population density and phosphorus on the shelling percentage, number of pods, weight of seeds per hectare and number of nodules of Bambara groundnut.

Treatment	Shelling percentage	Number of pods	Weight of seeds per plot(g)	Yield ha ⁻¹ (kg)
Population density (PD)				
444,444	47.74	17.89	28.67	2867
111,111	58.05	22.53	36.49	3649
49,383	95.82	19.53	32.07	1856
LSD _(0.05)	15.37	NS	NS	NS
Phosphorus level (PL) (kg ha ⁻¹)				
0	51.87	21	32.5	1900
20	45.3	21.22	34.0	2022
40	48.21	21.78	37.22	2034
60	50.11	14.37	22.78	1278
80	58.61	21.55	38.89	2044
LSD _(0.05)	NS	NS	NS	NS
LSD _(0.05) Interaction, PD+PL	NS	NS	NS	NS