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Agronomic and Yield Potentials of Bambara Groundnut *(Vigna Subterranea (L.) Verdc.)* in Northeastern Nigeria

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ABSTRACT

Field trials were conducted in 2015 rainy season on the Teaching and Research Farm of the Department of Crop Production and Horticulture, Modibbo Adama University of Technology, Yola and Department of Crop Science, Taraba State College of Agriculture, Jalingo to investigate the effect of inter-row spacing and nitrogen rates on the growth and yield of Bambara groundnut (*Vigna subterranean L.*). The experiments were laid out in a split-plot design with three nitrogen rates, 20 $kgNha^{-1}$, 25 $kgNha^{-1}$ and 30 $kgNha^{-1}$ as main plot treatments and four inter-row spacing of 20 cm, 25 cm, 30 cm and 35 cm as the sub plot treatment. Data were collected on the growth and yield parameters and were subjected to Analysis of Variance (ANOVA) and Least Significant Difference (LSD) procedure. Due to the findings it is suggested that nitrogen rate of 20$kgNha^{-1}$ and inter-row spacing of 35 cm should be adopted.

Introduction

Bambara groundnut is an indigenous African crop cultivated by small-scale subsistence farmers in semiarid, sub-Saharan Africa and tropical South West Asia. It is the fourth most important grain after cowpea (*Vigna unguiculata L.*) and groundnut (*Arachis hypogea L.*) and is named after the Bambara tribe of Mali that mastered the act of cultivating the crop (Hillocks et al., 2012, Jakusko, 2015). The pulse has an immense potential in enhancing food security especially in drought prone agricultural system. Its drought tolerance makes it ideal for production by resource poor farmers especially in communal and resettlement areas. As a result, it can grow well in communal areas where the pest and disease control is not seriously observed. The crop is intercropped with grain cereals to reduce risk of crop failure due to drought since it is more tolerant than other companion crops and can be produced under high temperature where other pulses fail to survive. (Vusamuzi, 1992, Akpalu, et. al., 2012).

In Nigeria, Bambara groundnut features predominantly in the traditional farming system as an inter-crop with grain cereals (maize, sorghum, and millet) and tuber crop (yam) without any definite pattern of precision (planting spacing, fertilizer application) even if it is cultivated as a sole crop. This inconsistency in the adoption of planting spacing and fertilizer application as factors for optimum yield is a gap that must be explored. It is on this premise that the study was conducted to

determine the effect of inter- row spacing and fertilizer rates on the growth and yield of Bambara groundnuts.

Materials and methods

The field trials were conducted in two locations during the 2015 cropping seasons. The first location was on the Teaching and Research Farm of the Department of Crop Production and Horticulture, Modibbo Adama University of Technology, Yola, with the latitude of 90 19″N and longitude 120 28″E, at an altitude of 185.9 m above the sea level. The annual rainfall of Yola ranges from 900 to 1100 mm from May to October. (Adebayo and Tukur, 1999). The second location was on the Teaching and Research Farm of Department of Crop Science, Taraba State College of Agriculture, Jalingo with the latitude of 80 56″N and longitude-110 50″E at an altitude of 1600 m above the sea level, mean annual rainfall is 750 to 1000 mm (TADP, 2012) in the experimental rainy season from May to October.

The two experimental sites were slashed and the land was prepared by conventional tillage with disc plough and later harrowed and leveled with a hand hoe. A local Bambara groundnut cultivar *yarshelleng* was obtained and used. The experiment was 3x4 factorial in a split plot design, three (3) nitrogen fertilizer rates (20,25 $kgha^{-1}$ and 30 $kgha^{-1}$) as main plot and four (4) inter row spacing (20, 25, 30 and 35 cm) as sub plot treatment with three replications. Bambara groundnut was planted on 28 and 30 July, 2015 at Yola and Jalingo locations at the peak of rainy season.

Sampled plants were taken from the sub plot of 3 m x 2 m for the experiment on germination percentage, plant height, number of leaves, number of branches in the 3rd, 6th and 9th weeks after sowing, as well as on the days of their 50 % flowering, on that of 95 % maturity, number of pods per plant, number of seeds per plant, weight of 100 seeds (g) and grain yield ha^{-1} at harvest. Data collected were subjected to Analysis of Variance (ANOVA) appropriate to split plot design and means separation was done using the least significant difference (LSD) at 5 % level of significance as described by Gomez and Gomez (1984) and GENSTAT, 4th edition.

Results and discussions

The data results on the effect of inter-row spacing and Nitrogen rates on percentage of seedlings emergence, and number of leaves at 3rd, 6th and 9th WAS are presented in Table 1. The result shows that there was no significant difference ($p \leq 0.05$) between seedlings emergence rate related to Nitrogen rates at both locations. For the number of leaves in the 3rd, 6th and 9th weeks after sowing /WAS/ Nitrogen rate shows no significant difference ($p \leq 0.05$).

Table 1. Effects of Inter-Row Spacing and Nitrogen Rate on Percentage of Seedlings Emergence and Number of Leaves per Plant of Bambara Groundnut in Jalingo and Yola in 2015 Cropping Season*

Treatment	% Seedlings Emergence		Number of Leaves 3WAS		Number of Leaves 6WAS		Number of Leaves 9WAS	
	Jalingo	Yola	Jalingo	Yola	Jalingo	Yola	Jalingo	Yola
Nitrogen Rates ($kgha^{-1}$)								
20	99.54	99.44	6.22	6.60	50.13	30.02	120.30	62.20
25	99.28	98.84	5.90	6.07	45.28	32.30	117.60	63.80
30	99.09	98.40	6.20	6.22	43.07	28.87	108.90	69.70
LSD	0.48	1.80	0.29	1.30	9.29	16.45	17.25	14.30
Significance	NS	NS	NS	NS	NS	NS	NS	NS
Spacing (cm)								
20	99.43	99.24	6.20	6.80	41.96	30.73	111.20	63.00
25	99.30	99.53	6.02	6.09	43.31	29.73	109.30	70.50
30	99.17	98.89	5.96	5.78	47.13	30.87	119.10	70.10
35	99.31	97.92	6.22	6.51	48.24	30.24	122.90	57.30
LSD	1.13	1.77	6.43	0.89	2.84	3.05	14.78	14.56
Significance	NS	NS	NS	NS	**	NS	NS	NS
Interaction (NxS)	NS	NS	*	NS	**	*	NS	NS

**Composed by the authors*

Table 2. Interaction between Inter-Row Spacing and Nitrogen Rates and its Effect on Number of Leaves per Plant in the 3rd Week after Sowing at Jalingo location in 2015 Cropping Season*

Nitrogen Rates	Spacing (cm)				
(kgha^{-1})	20	25	30	35	LSD
20	6.40	6.40	6.13	5.87	0.757
25	5.60	6.13	5.73	6.13	
30	6.60	5.53	6.00	6.67	
LSD (P≤0.05)	0.66 0.03				

Table 3. Interaction between Inter-Row Spacing and Nitrogen Rates and its effect on the Number of Leaves in the 6th Week after Sowing at Jalingo and Yola Locations in 2015 Cropping Season*

Nitrogen Rates (kgha^{-1})	Spacing (cm)									
	Jalingo					Yola				
	20	25	30	35	LSD	20	25	30	35	LSD
20	50.33	48.27	52.07	49.87	4.924	33.20	27.87	30.07	28.93	5.295
25	49.73	45.27	44.33	49.80		28.93	36.13	31.07	33.07	
30	45.80	36.40	45.00	45.05		30.07	25.20	31.47	28.73	
LSD (P≤0.05)	9.194 0.01					16.110 0.02				

**Composed by the authors*

However, significant difference was recorded in the 6 WAS at Jalingo location in inter-row spacing of 35 cm with a mean value of 48.24.

The data results on the effect of interaction between inter-row spacing and Nitrogen on number of leaves per plants in 3WAS for Jalingo is presented in Table 2. The result showed that at 3WAS 30 kg nitrogen rates and 35 cm inter-row spacing had the best interaction effect with the value of 6.67 and the least interaction was in case of 30 kg nitrogen rate and 25 cm inter-row spacing with a mean value of 5.53.

Table 3 presents the interaction between inter-row spacing and nitrogen rates on the number of leaves in 6 WAS at Jalingo and Yola locations. The results show that at Jalingo station, the best interaction was recorded in case of 20 kg nitrogen and 30cm inter-row spacing with a mean value of 50.02, the least interaction was recorded in case of 30 kg nitrogen and 25 cm inter-row spacing with a mean value of 36.40. Similarly at Yola station, 25 kg nitrogen had the best interaction with the mean value of 36.13 and the least interaction was recorded in case of 30 kg nitrogen and 25 cm inter-row spacing with a mean value of 25.20.

The effect of inter-row spacing and nitrogen rates on number of branches per plant and plant height in the 3rd, 6th and 9th WAS is presented in Table 4. The results showed that there was no significant difference ($p \leq 0.05$) between the number of branches and plant height at both weeks for the two locations concerning nitrogen rates. Regarding inter-row spacing, significant difference was recorded in the 6 WAS in Jalingo location for number of branches per plant, While Yola location had no significant difference. Similarly plant height in terms of inter-row spacing shows no significant difference ($p \leq 0.05$) for both locations.

The data results on the days of their 50 % flowering, those of 95 % maturity, number of pod per plants and seed per plants are recorded in Table 5, which indicates that nitrogen rates showed no significant difference ($p \leq 0.05$) in both locations. Regarding the inter-row spacing, days of 50 % flowering was significant at Jalingo location with 25cm inter-row spacing resulting in the highest mean value of 43.00. While Yola location showed no difference ($p \leq 0.05$). Days of 95 % maturity, number of pods per plants and number of seeds per plant show no significant difference ($p \leq 0.05$) in both locations.

Table 6 shows the effect of inter-row spacing and nitrogen rates on weight of 100 seeds (g) and grain yield per hectare. The result shows that both nitrogen rate and inter-row spacing showed no significant difference ($p \leq 0.05$) for both locations.

Table 4. Effects of Inter-Row Spacing and Nitrogen Rates on the Number of Branches per Plant and Plant height of Bambara groundnut at Jalingo and Yola in 2015 Cropping Season*

Treatment	Number of Branches/Plant						Plant height(cm)					
	3 WAS		6 WAS		9 WAS		3 WAS		6 WAS		9 WAS	
	Jalingo	Yola	Jalingo	Yola	Jalingo	Yola	Jalingo	Yola	Jalingo	Yola	Jalingo	Yola
Nitrogen Rates ($kgha^{-1}$)												
20	3.77	3.70	15.87	11.62	22.90	13.88	22.87	19.37	23.71	20.01	24.10	20.59
25	3.68	5.30	16.38	12.28	21.00	15.99	22.29	19.82	23.62	20.64	23.65	22.04
30	3.78	2.23	15.62	12.08	20.57	14.03	22.50	19.77	23.43	20.97	23.50	21.98
LSD	0.51	3.17	3.18	4.89	2.72	4.498	0.86	1.65	3.41	1.71	1.88	2.90
(P≤0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Spacing (cm)												
20	3.69	2.40	14.93	11.02	20.69	13.33	22.79	19.63	23.64	20.67	23.74	22.58
25	3.73	4.60	15.51	12.80	21.33	14.38	22.33	19.17	23.10	20.48	23.53	22.70
30	3.76	4.27	16.58	11.96	22.09	14.97	22.36	19.52	23.90	20.63	23.95	22.38
35	3.81	2.38	16.80	12.20	21.84	15.87	22.69	18.94	23.70	20.38	23.78	22.71
LSD	0.36	4.68	1.51	1.41	2.54	2.423	0.94	1.28	1.33	1.15	1.17	1.07
(P≤0.05)	NS	NS	*	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (NxS)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 5. Mean Effects of Inter-Row Spacing and Nitrogen Rates on Days of 50 % Flowering, Days of 95 % Maturity, and Number of Pods per Plant and Number of Seeds per Plant of Bambara Groundnut at Jalingo and Yola Locations in 2015 Cropping Season*

Treatment	Days of 50% Flowering		Days of 95% Maturity		Number of Pods per plant		Number of Seeds per plant	
	Jalingo	Yola	Jalingo	Yola	Jalingo	Yola	Jalingo	Yola
Nitrogen Rates (kgNha-1)								
20	42.50	42.17	110.25	105.75	27.13	11.37	27.38	11.78
25	42.00	43.00	109.67	106.00	22.45	12.85	22.65	13.10
30	42.50	42.67	106.08	107.00	17.10	13.33	17.25	13.58
LSD	1.30	1.94	7.87	4.34	10.16	2.57	9.97	2.82
(P≤0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Spacings (cm)								
20	42.78	43.00	108.33	105.00	23.24	12.40	23.49	12.64
25	43.00	42.11	108.78	106.89	23.09	12.02	23.47	12.16
30	41.89	42.78	109.44	106.56	22.27	12.80	22.44	13.33
35	41.47	42.56	108.11	106.56	20.31	12.84	20.51	13.16
LSD	0.95	1.07	0.69	1.38	3.27	2.49	3.24	2.72
(P≤0.05)	**	NS	NS	NS	NS	NS	NS	NS
Interaction(NxS)	NS	NS	NS	NS	NS	NS	NS	NS

NS= Not significant. **= Significant (P≤0.05)

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Table 6. Effects of Inter-Row Spacing and Nitrogen Rate on the Weight of 100 Seeds (g), Grain Yield ha^{-1} (kg) of Bambara Groundnut at Jalingo and Yola in 2015 Cropping Season.

Treatment	Weight of 100 Seeds (g)		Grain Yield ha^{-1} (kg)	
	Jalingo	Yola	Jalingo	Yola
Nitrogen Rates (kgha^{-1})				
20	83.19	80.69	1033	418
25	82.54	75.79	868	368
30	86.01	79.69	607	357
LSD	9.64	4.60	485	54.8
(P≤0.05)	NS	NS	NS	NS
Spacing (cm)				
20	83.57	79.48	959	391
25	84.20	74.70	826	367
30	83.71	80.24	798	407
35	84.18	80.48	761	359
LSD	4.93	6.58	192	86
(P≤0.05)	NS	NS	NS	NS
Interaction (NxS)	NS	NS	NS	NS

**Composed by the authors*

Conclusion

The results of the study showed that growth parameters were affected by application of nitrogen and inter-row spacing at the two trial locations. However, nitrogen fertilizer and inter-row spacing had no significant effect on plant emergence in Jalingo and Yola trial locations. This suggests that when conditions for germination are favourable, seeds would germinate and emerge even if the nutrient status of the soil is poor. This is in line with the report of Madukwe et al., (2010) which states that nitrogen fertilizer had no significant effect on germinability of bambara groundnut seeds. No significant difference was observed in terms of nitrogen rates effect on number of leaves per plant, number of branches per plant in the two locations. This is in line with the findings of Madukwe et al., (2010), Iliya (2010) and Kamithi et al., (2009) who suggest that influence of environment must have played out a role which could have counted for the few leaves and branches in crops.

Inter-row spacing with 35 cm had significant effect on the number of leaves per plant and number of branches per plant (48.24 and 16.80) in the 6 WAS at Jalingo location having the highest number of leaves and branches per plant. This agrees with Akpalu et al., (2012) and Akpalu (2010) who reported that the higher leaf number produced by the higher spacing could be attributed to reduced interplant competition. Non-significant effect of Spacing on number of leaves per plant and branches per plant in Yola location agrees with Jalal (2008) who attributed such phenomenon to weather conditions. Interaction between nitrogen rates and inter-row spacing had significant influence on the number of leaves and branches per plant in Jalingo and Yola locations. Plant height was not significantly influenced by spacing and nitrogen rates in both locations, this finding corroborated Ibudialo et al., (2013) and Jalal (2008) who observed no significant difference in the plant height in their research due to weather conditions.

Days of 50 % flowering were significantly influenced by 25 cm spacing in Jalingo location with the highest mean value (43.00), while nitrogen rates had no influence at both locations. This result may be due to environmental influence on the crop.

Number of pods per plant and number of seeds per plant showed no significant difference at both locations regarding both nitrogen rates and inter-row spacing as a result of lack of optimum amount of water in the plant critical period; this result coincides with the findings of Vurayai et al., (2011) who stated that Bambara groundnut is more sensitive to water stress during reproductive growth stage.

100-seed weight was not significantly influenced by nitrogen rates and inter- row spacing in the two locations. This agrees with the findings of Olukayode and Kolapo (2014) who reported that yield of legume is affected in favour of vegetative growth. The results on grain yield per kgha^{-1} followed the same trend as no significant difference was recorded by the treatments. This result agrees with those of Tanimu et al., (1991) and Chiezey et al., (2005) whose research conducted in Samaru, Zaria on Bambara groundnut showed no significant difference regarding the effect of nitrogen starter dose on the grain yield.

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