ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3595287

INTERNATIONAL JOURNAL OF RESEARCH – GRANTHAALAYAH
A knowledge Repository

Science

EFFECTS OF NITROGEN RATE ON GROWTH AND YIELD OF BAMBARA GROUNDNUT (*Vigna subterranea* (L.) *Verdc.*) IN JALINGO, TARABA STATE, NIGERIA

M. M. Tyoakoso [1], M. D. Toungos [1], M. Babayola [2]
[1] Department of Crop Production and Horticulture, Modibbo Adama University of Technology, Yola, Nigeria
[2] Adamawa State University, Mubi, Nigeria

Abstract

Field experiments was conducted during the 2015 rainy season at Teaching and Research Farm of Department of Crop Science, Taraba State College of Agriculture Jalingo, to investigate the effect of Nitrogen rates on the growth and yield of Bambara groundnut (*Vigna subterranean* (L.) Verdc) in Jalingo. The experiments was laid out in split-plot design with three replications and three nitrogen rates, 20kgNha^{-1}, 25kgNha^{-1} and 30kgNha^{-1} as main plot treatment while four intra-row spacing, 20cm, 25cm, 30cm and 35cm as the sub plot treatment. The sub plot size was 3m x 2m (6m^2). The nitrogen rate doses were applied a week after emergence of the seedlings. Data collected were, percentage seedlings emergence, number of leaves per plant, number of branches per plant, plant height, number of nodules per plant, number of effective nodules per plant, number of non-effective nodules per plant, days to 50% flowering, number of pods per plant, number of seeds per plant, 100 seeds weight, grain yield per plot and grain yield per ha^{-1}. Data collected were subjected to Analysis of Variance (ANOVA), means were separated using Least Significant Difference (LSD). The results showed that nitrogen rate applied had no significant influence on growth and yield characters. However, significant influence was recorded of intra-row spacing on number of leaves per plant and number of branches per plant at 6WAS with a mean value of 48.24 and 16.80 respectively. Intra-row spacing, 25cm gave the highest mean number (3.14) of non-effective nodules per plant at 30 DAS while 25cm gave the highest number of days to 50% flowering. The result of the interaction revealed that there were significant interaction between Nitrogen rates and intra-row spacing on the number of leaves at 3 WAS and 6WAS. It is recommended that nitrogen rate of 20kgNha^{-1} and intra-row spacing of 35cm be adopted for Bambara groundnut in Jalingo.

Keywords: Nitrogen; Nodules; Plant Height and Yield.

Cite This Article: M. M. Tyoakoso, M. D. Toungos, and M. Babayola. (2019). "EFFECTS OF NITROGEN RATE ON GROWTH AND YIELD OF BAMBARA GROUNDNUT (Vigna subterranea (L.) Verdc.) IN JALINGO, TARABA STATE, NIGERIA." *International Journal of Research - Granthaalayah*, 7(12), 67-76. https://doi.org/10.5281/zenodo.3595287.

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3595287

1. Introduction

Bambara groundnut (*Vigna subterranea* (L.) Verdc) is a crop belonging to the legume specie subterranea of the Fabaceae family (Bamshaiye *et al.*, 2011). It is a herbaceous, intermediate (0.3-0.35m in height) annual plant with creeping stem at ground level (spreading) to compact type. It is conventionally classified as a bean but its seeds are actually dug from the ground like pea nut (Belel *et al.*, 2014). Bambara groundnut will grow on soils ranging from sandy loamy to clay loam with good drainage but prefers light sandy loams with pH of 5.0 to 6.5. It does well on poor soil which is low in nutrients. However, it can be successfully grown on a wide variety of soils with appropriate soil management, fertilization and appropriate moisture control practices (Anonymous, 2011 and Swanevelder, 1998). With the inconsistency in the plant spacing as essential factor for optimum yield couple with the status of the soil on which Bambara groundnut is grown in Jalingo, warrants the study on the effect of nitrogen rate on the growth and yield of Bambara groundnut. (*Vigna subterranea* (L) verdc.) in Jalingo Taraba State.

Fertilizer application: Although Stanto (1968) suggested that high level of fertilizer can be profitable, Akombo and Asema (2013) reported that Bambara groundnut need fertilizer for high seed yield, the use of mineral fertilizer for the production of this crop has rarely been practiced. Nitrogen requirement is met by natural N2 fixation, seed should be inoculated. When nitrogen content is high in the soil, Bambara groundnut usually produces mostly only a few pods of seed on the top surface. It is always advisable to conduct soil test and apply fertilizer according to the recommended rates. Akpalu et al. (2013) reported that the crop does not require much fertilizer for its growth. This supports the reports on the ability of the crop to grow on poor soils that could not support the growth of other legumes (Akpalu, 2010).

Effects of Nitrogen on Growth and Yield of Bambara groundnut and other Legumes:
Nitrogen plays a vital role in plant nutrition. It is essential for growth and a constituent of various organic compounds such as protein, nucleic acid and hence part of protoplasm. It encourages rapid vegetative growth and regulates the utilization of P and K nutrients from the soil (Brady and Weil, 1999; Moses et al., 2013). It is a critical limiting element for plant growth and production; it is the nutrient that is most commonly deficient in soils, contributing to reduced agricultural yields throughout the world (Adriana, 2000). Adequate supply of nitrogen is beneficial for carbohydrate and protein metabolism, promoting cell division and cell enlargement (Wamba et al., 2012). Nitrogen deficiencies result in decreased crop leaf area, photosynthetic assimilation and seed growth. Much of the variation in leaf photosynthetic capacity for different cultivars, age of leaves and growth conditions can be attributed directly to differences in leaf N content (Moses et al., 2013).

2. Materials and Methods

Experimental Site
The experiment was conducted during the 2015 cropping seasons at Teaching and Research Farm of Department of Crop Science, Taraba State College of Agriculture, Jalingo which is located within latitude 80 56″N and longitude 110 50″E at altitude 1600m above sea level in Southern Guinea Savanna. Jalingo experience wet and dry tropical climate with rainy season from May to

 ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3595287

October with mean annual rainfall of 750 to 1000mm while the dry season commences in November and ends in March or April (TADP, 2012).

Treatment and Experimental Design

The treatments consisted of four (4) intra-row spacing (20, 25, 30 and 35cm) and three (3) Nitrogen (urea) rates (20, 25 and 30 kgha-1).The treatments were laid out in a split plot design with nitrogen rate assigned to the main plot whereas intro-row spacing at the sub plot. The treatments were replicated three times. The keys for the main plot treatments, N1, N2, N3 and the sub plot treatments, S1, S2, S3 and S4 were written on pieces of papers, squeezed, put in a container and shook-up. The papers were picked at random and used to design the plots. The sub-plot size was 3x2m (6m2).

Agronomic Practices:

Land preparation: The field was cleared to remove stubbles at the onset of the rainy season. A tractor was used to plough, disc harrowed and the field was leveled manually by the use of hand hoe to produce fine seedbed for good germination and crop establishment. The plots were laid out using rope, pegs, hoes and measuring tape for demarcation accuracy.

Seed selections: A local cultivar Yar Shelleng was used for the experiment which was obtained from Jalingo market. The seeds were visually examined for purity and seeds of uniform sizes and color were selected which were later tested in the laboratory to determine the viability using the germinator.

Seed dressing: Prior to planting, seeds were dressed using seed dressing chemical, Apron plus 50DS at the rate of 10g (1sachet) for 1- 2kg in order to protect the crop from infestation of soil-borne pests and diseases.

Sowing date: The sowing date was on 30th June, 2015 in Jalingo when the rain was well established in the location.

Sowing method: Seeds were dibbled in the soil with the use of a hand hoe.

Sowing rate and depth: The seeds were sown at the rate of 2 to 3 seeds per hole and later thinned to 1 plant per hill. The seeds were sown 2.5 to 3.0 cm deep.

Number of leaves per plant: Five (5) plants were randomly tagged per plot and the number of leaves per plant was counted at 3, 6 and 9 weeks after sowing and the mean number was recorded per plant.

Number of branches per plant: Five (5) plants were randomly tagged per plot and the number of branches per plant was counted at 3, 6 and 9WAS and the mean number was recorded per plant.

Plant height: Five (5) plants were randomly tagged in each plot and their heights were measured from ground level to tip of the plant at 3, 6 and 9 WAS and the mean was recorded.

Total Number of nodules per plant: The number of nodules was counted at 15 and 30 days after sowing (DAS). Three plants were randomly dug out (root out together with boll of earth) in order not to lose the nodules. These were carefully washed for the nodules to be seen clearly. The nodules were counted and the mean number was recorded.

Number of effective and non-effective nodules: The number of effective nodules was determined by slicing the nodules into two by the use of a new Razor blade. A pinkish color indicated that the nodules were effective while, whitish color indicated non-effectiveness of the nodules and the means were recorded.

Days to 50% flowering: This was done by examining each plot periodically to note when 50% of the plants formed flowers.

 ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3595287

Number of pods per plant: Five (5) plants were randomly harvested in each plot at maturity and the number of pods were counted and divided by five to obtain the mean number of seeds per plant.
Number of seeds per plant: The pods of the five randomly harvested plants in each plot were shelled and the seeds were divided by five to obtain the mean number of seeds per plant.
100 Seeds weight (grams): 100 seeds were randomly taken from each plot and their weight measured using electric top loading balance and their values recorded.
Grain yield per ha: The seeds obtained from the dried pods of the plots were weighed on an Electric Top loading balance to determine the yield per each plot, which was then converted to yield per hectare in kilogram as follows:

$$\text{Yield/ha} = \frac{\text{Grain yield per plot (kg)}}{\text{Plot size (6m2)}} \text{ x } 10{,}000\text{m2}$$

Statistical Analysis: All the data collected from the experiments were subjected to Analysis of Variance (ANOVA) appropriate to Split plot design and means were separated using Least Significance Difference (LSD) at 5% level of significance as described by Gomez and Gomez (1984). The package used was GENSTAT, 4th Edition.

3. Results and Discussion

Effects of Intra-Row Spacing and Nitrogen Rate on Percentage Seedling Emergence of Bambara Groundnut in Jalingo During 2015 Cropping Season

The effect of intra-row spacing and nitrogen rate on percentage seedlings emergence is presented on Table 1. There was no significant (P≤0.05) difference between nitrogen rates on percentage seedlings, however differences were observed in terms of seedlings strength and vigor. This may be due to the application of nitrogen a week after emergence which could not have influence on it. This suggests that when conditions for germination are favorable, seeds would germinate and emerge even if the nutrient status of the soil is poor. This agrees with the report of Madukwe et al. (2010) that nitrogen fertilizer had no significant effect on germinability of bambara groundnut seeds.

There were no significant (P≤0.05) effects of nitrogen rate and intra-row spacing on number of leaves per plant at 3 WAS. Highly significant (P≤0.01) difference on number of leaves/plant were recorded in intra-row spacing with 35cm having the highest mean value (48.24) while 20cm gave the lowest mean (41.96) number of leaves per plant at 6WAS as presented on the table.

Table 1: Effects of Intra-row Spacing and Nitrogen Rate on Percentage Emergence of Seedlings and number of leaves per plant in Bambara groundnut during 2015 Cropping season.

Treatment	**% Seedlings Emergence**	**Number of Leaves 3WAS**	**Number of Leaves 6WAS**	**Number of Leaves 9WAS**
Nitrogen Rates ($kgha^{-1}$)	99.54	6.22	50.13	120.30
20	99.28	5.90	45.28	117.60
25	99.09	6.20	43.07	108.90

 ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3595287

30	0.48	0.29	9.29	17.25
LSD	Ns	NS	NS	NS
Significance				
Spacing (cm)				
20	93.43	6.20	41.96	111.20
25	93.30	6.02	43.31	109.30
30	99.17	5.96	47.13	119.10
35	99.31	6.22	48.24	122.90
LSD	1.13	6.43	2.84	14.78
Significance	Ns	NS	**	NS
Interaction (NXS)	Ns	*	**	NS

Key: NS = Non-significant. * = significant ($P \leq 0.05$). ** = (highly significant ($P \leq 0.05$)

Interaction Between Intra-Row Spacing and Nitrogen Rate on Number of Leaves Per Plants At 3weeks After Sowing

Table 2 presents the interaction between intra-row spacing and nitrogen rate on number of leaves per plant at 3 WAS in the study area. Interaction between intra-row spacing and nitrogen rate had a significant ($P \leq 0.05$) effect on number of leaves per plant at 3WAS. The response of different levels of nitrogen with increasing intra-row spacing was similar. However, within each intra-row spacing, the response of nitrogen levels gave different trends. The best interaction was registered when 30kgNha-1 was applied at an intra-row spacing of 35cm with a mean value of 6.67 number of leaves per plant. Furthermore, the least interaction was recorded when 25kgNha-1 was applied to Bambara groundnut at a spacing of 25cm recording a mean value of 5.53 number of leaves/plant.

Table 2: Interaction between Intra-row Spacing and Nitrogen Rates on Number of Leaves per Plant at 3 Weeks after Sowing (3 WAS).

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 ($P \leq 0.05$)	0.686 0.03				

Table 3 shows the effect of Intra-row spacing and nitrogen rate on number of branches of Bambara groundnut during the 2015 cropping season, there was no significant and ($P \leq 0.05$) effect of nitrogen rate and intra-row spacing on number of branches at 3 and 9 WAS. No significant difference was observed on influenced of nitrogen rate on number of leaves per plant, number of branches per plant is in line with the findings of Madukwe et al. (2010), Iliya (2010) and Kamithi et al. (2009) who conducted their research on Bambara groundnut and chickpea in Owerri, Mubi and Kenya respectively. Nitrogen rate showed no significant difference ($P \leq 0.05$) on plant height in the study areas. This finding corroborated with Maunde et al. (2002) who conducted his research at Samaru on bambara groundnut that nitrogen had no significant effect on plant height. But intra-row spacing showed significant ($P \leq 0.05$) difference on number of branches per plant at 6 WAS with the highest mean value of 16.80 at 25cm and the lowest mean value (14.93) at 20cm. In the

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3595287

same vein the effect of intra-row spacing and nitrogen rate on plant height at 3, 6 and 9 WAS is also presented on Table 3. The same trends follows as in number of branches, there was no significant (P≤0.05) difference between nitrogen rate and intra-row spacing on plant height at 3, 6 and 9 WAS.

Table 3: Effects of Intra-row Spacing and Nitrogen Rates on Number of Branches per Plant and Plant height of Bambara groundnut

Treatment	**Number of branches per plant**			**Plant height (cm)**		
Nitrogen Rates (kgha^{-1})	3	6	9	3	6	9
20	3.77	15.87	22.90	22.87	23.71	24.10
25	3.68	16.38	21.00	22.29	23.62	23.65
30	3.78	15.62	20.57	22.50	23.43	23.50
LSD	0.51	3.18	2.72	0.86	3.41	1.88
Significance	NS	NS	NS	NS	NS	NS
Spacing (cm)						
20	3.69	14.93	20.69	22.79	23.64	23.74
25	3.73	15.51	21.33	22.33	23.10	23.53
30	3.76	16.58	22.09	22.36	23.90	23.95
35	3.81	16.80	21.84	22.69	23.70	23.78
LSD	0.36	1.51	2.54	0.94	1.33	1.17
Significance	NS	*	NS	NS	NS	NS
Interaction (N x S)	NS	NS	NS	NS	NS	NS

Key: WAS = Weeks after sowing. * = significant (P≤ 0.05). NS = Non-significant.

Effects of Intra-Row Spacing and Nitrogen Rate on Number of Non-Effective Nodules at 15 and 30das in 2015 Cropping Season

The effect of intra-row spacing and nitrogen rate on the number of non-effective nodules is presented on Table 4. Results showed there was significant (P≤0.05) influence of intra-row spacing on number of non-effective nodules at 30DAS with 25cm producing the highest mean value (3.14) of number of non-effective nodules while 35cm gave the lowest mean value (1.36) number of non-effective nodules per plant, while highly significant difference (P≤0.05) were observed in interactions between Nitrogen and spacing as can be seen on table 4. But there were no significant (P≤0.05) difference on number of effective nodules at 15 DAS. The interaction between intra-row spacing and nitrogen rate on number of nodules per plant at 30 DAS.

Table 4: Effects of Intra-row Spacing and Nitrogen Rates on Total Number of Nodules per plant, non - effective nodules per plant and effective nodules.

Treatment	**Number of nodules/Plant**		**Non-effective nodules/plant**		**Effective nodules/plant**	
Nitrogen Rates (kgha^{-1})	15	30	15	30	15	30
20	1.03	5.50	0.97	1.62	0.07	3.90
25	0.57	7.34	0.58	3.42	0.00	3.85
30	1.01	5.62	0.97	1.36	0.05	4.26

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3595287

LSD	0.94	4.30	0.84	1.99	0.11	3.35
Significance	NS	NS	NS	NS	NS	NS
Spacing (cm)						
20	1.13	5.62	1.11	1.39	0.02	4.23
25	0.75	8.20	0.71	3.14	0.04	5.06
30	0.98	6.50	0.56	2.66	0.02	3.77
35	0.62	4.29	0.84	1.36	0.07	2.96
LSD	0.66	4.23	0.69	1.41	0.07	3.15
Significance	NS	NS	NS	*	NS	NS
Interaction (N x S)	NS	*	NS	**	NS	NS

DAS = Days after sowing. * = Significant ($P \leq 0.05$) ** = highly significant ($P \leq 0.05$).

Effects of Intra-Row Spacing and Nitrogen Rate on Days To 50% Flowering, Number of Days 95% Maturity of Bambara Groundnut in Jalingo And Yola in 2015 Cropping Season

The effects of intra-row spacing and nitrogen rate on days to 50% flowering is presented in table 5. Application of nitrogen rates had no significant ($P \leq 0.05$) effect on days to 50% flowering and days to 95% maturity. Days to 50% flowering were significantly influenced by spacing. This disagrees with Ibudiola et al. (2013) and Jalal (2008) findings. There was no significant effect of spacing on days to 95% maturity. This result may be due to environmental influence on the crop. Number of pods per plant and number of seeds per plant did not respond significantly to the application of nitrogen. This could be attributed to low amount of rainfall during pod formation and seed filling. Vurayai et al. (2011) stated that bambara groundnut is more sensitive to water stress during reproductive growth stage as compared to vegetative growth stage. This result agreed with Rizwan, et al. (2014) who also recorded no significant difference of nitrogen application on number of pods of groundnut.

Intra-row spacing had significant ($P \leq 0.05$) effect on number of days to 50% flowering. The highest mean value (43.00) of days was recorded with intra-row spacing of 25cm and the lowest mean value (41.47) of days was recorded with intra-row spacing of 35cm.

The table shows the effects of intra-row spacing and nitrogen rate on number of days to 95% maturity, the results indicated no significant effect at ($P \leq 0.05$) of nitrogen rate and intra-row spacing on number of days to 95% maturity. Intra-row spacing had significant ($P \leq 0.05$) effect on number of days to 50% flowering at Jalingo location only. The highest mean value (43.00) of days was recorded with intra-row spacing of 25cm and the lowest mean value (41.47) of days was recorded with intra-row spacing of 35cm.

Table 5: Mean Effects of Intra-row Spacing and Nitrogen Rates on Days to 50% Flowering, Days to 95% Maturity, Number of Pods per Plant and Number of Seeds per Plant of Bambara groundnut.

Treatment	**Days to 50% flowering**	**Days to 95% maturity.**	**Number of pods/plant**	**Number of seeds/plant.**
Nitrogen Rates ($kgha^{-1}$)				
20	42.50	110.25	27.13	27.38
25	42.00	109.67	22.45	22.65

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3595287

30	42.50	106.08	17.10	17.25
LSD	1.30	7.87	10.16	9.97
Significance	NS	NS	NS	NS
Spacing (cm)				
20	42.78	108.33	23.24	23.49
25	43.00	108.78	23.09	23.47
30	41.89	109.44	22.27	22.44
35	41.47	108.11	20.31	20.51
LSD	0.95	0.69	3.27	3.24
Significance	*	*NS*	*NS*	*NS*
Interaction (NXS)	NS	NS	NS	NS

NS = Non-significant * Significant.

Effects of Intra-Row Spacing and Nitrogen Rate on Weight of 100 Seeds and Grain Yieldha-1 of Bambara Groundnut in Jalingo And Yola Locations in 2015 Cropping Season

The effects of intra-row spacing and nitrogen rate on 100-seed weight of Bambara groundnut in 2015 cropping season is presented in Table 6. There was no significant ($P \leq 0.05$) difference between nitrogen rates and intra-row spacings on weight of 100 seeds weight. Also, 100-seed weight was not significantly influenced by nitrogen rates in the trial area. This agrees with the findings of Olukayode and Kolapo (2014) who reported that 100-seed weight of soybean was not significantly affected by nitrogen rates. They revealed that nitrogen application favored vegetative growth and by extension, seems to hinder seed yield. 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 of nitrogen starter dose on the grain yield.

Table 6: Effects of Intra-row Spacing and Nitrogen Rate on Weight of 100 Seeds (g), Grain Yield ha-1 (kg) of Bambara groundnut:

	Weight of 100 Seeds (g)	**Grain Yield ha^{-1} (kg)**
Treatment		
Nitrogen Rates (kgha^{-1})		
20	83.19	1033
25	82.54	868
30	86.01	607
LSD	9.64	485
Significance	NS	NS
Spacing(cm)		
20	83.57	959
25	84.20	826
30	83.71	798
35	84.18	761
LSD	4.93	192
($P \leq 0.05$)	NS	NS
Interaction X (Nitrogen Spacing)	NS	NS

NS=Not significant

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3595287

4. Summary, Conclusion and Recommendation

Field experiments was conducted during the rainy season of 2015. The trial location was at the Research Farm of Department of Crop Science, Taraba State College of Agriculture, Jalingo which is located within latitude 80 56″ N and longitude 110 50″ E, in the Southern Guinea Savanna ecological zone of Nigeria. The effect of nitrogen rate on growth and yield of bambara groundnut (Vigna subterranea (L.) Verdc) in Jalingo. The cultivar used for the experiment was Ex-shelleng.
The experiment was laid out in a Split Plot Design consisting of three nitrogen rate as the main plot treatment and four intra-row spacing as sub plot treatment replicated three times. The parameters measured included percentage seedlings emergence, number of leaves per plant, number of branches per plant, plant height, total number of nodules per plant, number of non-effective nodules per plant, number of effective nodules per plant, days to 50% flowering, days to 95% maturity, number of pods per plant, number of seeds per plant, 100-seed weight and grain yield per kgha-1. All the data collected were subjected to analysis of variance (ANOVA) appropriate to Split Plot Design. The means were separated using Least Significant difference. The results showed that nitrogen rate did not significantly affect all the studied parameters. The effect of intra-row spacing treatment showed significant influence on number of leaves per plant and number of branches per plant with wider spacing of 35cm resulting in higher number of leaves and branches per plant. The use of 25cm intra-row produced more non-effective nodules per plant and increase days to 50% flowering. There was significant interaction between nitrogen rate and intra-row spacing on number of leaves per plant, number of nodules per plant and number of non-effective nodules per plant. The least nitrogen rate of 20kgNha-1 should be used for the growth of Bambara groundnut in the study area to minimize cost of fertilizer and to boost yield for the farmers. Intra-row Spacing of 35cm is also recommended for the growth of Bambara groundnut to minimize seeds waste.

References

[1] Adriana M, (2000). Overview and Case studies on Biological Nitrogen Fixation. An FAO/IAEA Co-ordinated Research Programme to Investigate the Nitrogen Fixing Potential of Cultivars and Breeding Lines of Common bean (Phaseolus vulgaris L.). Case Study B2; 1-11
[2] Akombo, R.A and Asema, U.S. (2013). “Effect of Different Levels of Phosphorus and Potassium Combinations on the Growth and Yiled of Bambara nut (Vigna subteranea (L.) Verdc.) in Yandev. International Journal of Development and Sustainability 2(3);1744-1748.
[3] Akpalu M.M, Atubilla, I.A. and Oppong-Sekyere, D. (2013). Assessing the Level of Cultivation and Utilization of Bambara groundnut in the Sumbrungu Community of Bolgatanga (Vigna subterrenea (L.) Vredc), Upper East Region, Ghana. International Journal of Plant, Animal & Environmental Sciences 3, Issue. 3 July-Sept. 2013. Accessed. 3. 12.2014.
[4] Akpalu, M.M. (2010) “Growth, Yield and Nutritional Quality of Five Bambara groundnut (Vigna subterrenea (L.) Verdc.). Landraces to Different Plant Population Densities” Thesis (Master of Science), Kwame Nkrumah University of Science and technology, Kumasi, Ghana.
[5] Anonymous (2011). Production Guidelines for Bambara groundnut. Agriculture Forestry and Fishery. Republic of South Africa. Available At http://www.daff.gov.za/docs/Bronchures/Bambara.pdf. (Accessed on 8/11/2014).
[6] Bamshaiye, O.M., Adegbola J.A and Bamishaiye E.I. (2011). Bambara groundnut: an Under-Utilized Nut in Africa. Advances in Agricultural Biotechnology 1; 60-72

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
Index Copernicus Value (ICV 2018): 86.20
DOI: 10.5281/zenodo.3595287

[7] Belel, M.D, Helim, R.A. Rafii, M.Y & Saud, H.M. (2014). Intercropping of Corn with Some Selected Legumes for Improved Forage Products: A Review. Journal of Agricultural Science 6(3); 48. Retrieved.3.12.2014.
[8] Brady,N.C and Ray R.Weil (1999) Nature and Properties of Soils. 12th edition U.S.A 460-666.
[9] Gomez, K.A and Gomez, A.D (1984). Statistical Procedures for Agricultural Research 2nd Ed. John Wiley and Sons Singapore. 680.
[10] Ibudialo, A.N., Ezema, R.A., andUgwu,I.E (2013). Efffect of Different Plant Spacing on the Growth and Yield of Soybeans (Glycine max) in Enugu South Eastern Nigeria. 1st National Annual Conference on the Role of Crop Science in the Agricultural Transformation Agenda (2013) at University of Nigeria, Nsukka Nigeria. 15-19 September, 2013.
[11] Iliya Daniel (2010). Effects of Nitrogen and Phosphorus Fertilizer on the Growth, Yield and Yield Components of Bambara-groundnut (Vigna subterrane (L.) Verdc.) Unpublished M.Tech Thesis, Department of Crop Production and Horticulture, Modibbo Adama University of Technology, Yola, Nigeria.
[12] Kamithi, D.K, Kibe, A.M and Akuja, T.E (2009). Effects of Nitrogen Fertilizer Application and Plant Density on Growth, Yield and Harvesting Index (HI) of Chickpea (Cicer arietinum L) Under Dry Land Conditions, Kenya. African Crop Science Socity conference on Science and Technology Supporting Food Security in Africa (2009) at Cape town. 28 September to 1 October, 2009. 47.
[13] Madukwe, D.K., Nwaigbo, I.C. and Anele V.M. (2010). Response of Bambara groundnut (Vigna subterranean (L.) to Organic & Inorganic Fertilizer Applicatoin. International Science Research Journal (online) 2; 78-81
[14] Maunde, S.M.; B. Tanimu; M. Mahmud and P.D Katung (2002). Growth and nodulation of bambara groundnut (vigna subterranea (L.) verdcourt) as affected by nitrogen and Phosphorus fertilizer application in Samaru. Promotion of Bambara groundnut, Institute of Tropical Agricultural research, A.B.U. Zaria.50-57
[15] Moses, O.E, Godwin, A.A and Michael Ijoyah (2013). Nodulation, Nitrogen Yield and Fixation by Bambara groundnut (Vigna. subterrenea (L.) verdc). Landraces Intercropped with cowpea & Maize in Southern Guinea savanna of Nigeria.
[16] Rizwan, L, Muhammad, I, Rizwan, K, Abid, S, Madeeha, K, Muhammad, S. I (2014). Significance of Groundnut Inoculation and N P Fertilizer Application on Yield, Nitrogen Uptake, Fixation and Soil N Balance Sheet under Rain fed Conditions. Journal of Biology and Medical Sciences 2; 7-14
[17] Swanevelder,C.J.(1998). Bambara-food for Africa. Available at http:||www.daff.gov. Zaldocs/Bronchures/bambara. Pdf (accessed 18/11/2014).
[18] Stanton, W.R (1968). Grain Legumes in Africa. FAO Rome, 183.
[19] Tanimu, B. Ogunlela, V.B, Olufajo, O.O and Iwuafor, E.N.O (1991). Effect of Fertilizer Elements on the Yield and Yield Characters of Bambara groundnut (Vigna subterranean (L.) Verdc.) Proceedings of the Second International Workshop of International Bambara Network (BAMNET) 23-25th September. Accra, Ghana. 1988. 66-73.
[20] TADP (2012). Annual Report, Taraba Agricultural Development Programme Jalingo, Nigeria.
[21] Vurayai, R., Emongor, V., Moseki, B. 2011. Physiological Responses of Bambaragroundnut (Vigna subterranean L. Verdc) to Short Periods of Water Stress During Different Developmental Stages. Asian Journal of Agriculture Science, 3: 37-43.
[22] Wamba, O.F., Taffouo, V.D., Youmbi, E., Ngwene B. and Amougou, A. (2012). Effects of Organic and Inorganic Nutrient Sources on the Growth, Total Chlorophyll and Yield of Three Bambara groundnut Landraces in the Coastal Region of Cameroon. Journal of Agronomy, 11 (2):31-42.

*Corresponding author.
E-mail address: toungosm@ mautech.edu.ng/dahiru.toungos@ gmail.com