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

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**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 subterranea* (L.) Verdc) in Jalingo. The experiments was laid out in split-plot design with three replications and three nitrogen rates, 20 kg N ha⁻¹, 25 kg N ha⁻¹ and 30 kg N ha⁻¹ as main plot treatment while four intra-row spacing, 20 cm, 25 cm, 30 cm and 35 cm as the sub plot treatment. The sub plot size was 3 m x 2 m (6 m²). 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, number of branches per plant and number of effective nodules per plant at 6 WAS with a mean value of 48.24 and 16.80 respectively. Intra-row spacing, 25 cm gave the highest mean number (3.14) of non-effective nodules per plant at 30 DAS while 25 cm 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 6 WAS. It is recommended that nitrogen rate of 20 kg N ha⁻¹ and intra-row spacing of 35 cm be adopted for Bambara groundnut in Jalingo.

**Keywords:** Nitrogen; Nodules; Plant Height and Yield.

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1. Introduction

Bambara groundnut (Vigna subterranea (L.) Verdc) is a crop belonging to the legume species 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
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 kg ha⁻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 (1 sachet) for 1-2 kg 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 9 WAS 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.
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:

\[
\text{Yield/ha} = \frac{\text{Grain yield per plot (kg)}}{\text{Plot size (6m}^2)} \times 10,000\text{m}^2
\]

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.
Table 2 presents the interaction between intra-row spacing and nitrogen rate on number of leaves per plant at 3 weeks after sowing (3 WAS) in the study area. Interaction between intra-row spacing and nitrogen rate had a significant (P≤ 0.05) effect on number of leaves per plant at 3 WAS. 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 30 kg N ha⁻¹ was applied at an intra-row spacing of 35 cm with a mean value of 6.67 number of leaves per plant. Furthermore, the least interaction was recorded when 25 kg N ha⁻¹ was applied to Bambara groundnut at a spacing of 25 cm recording a mean value of 5.53 number of leaves per 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 (kg ha⁻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)             | 0.686| 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≤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 influence 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≤0.05) on plant height in the study areas. This finding corroborated with Maunde et al. (2002) who conducted his research at Samarua in bambara groundnut that nitrogen had no significant effect on plant height. But intra-row spacing showed significant (P≤0.05) difference on number of branches per plant at 6 WAS with the highest mean value of 16.80 at 25 cm and the lowest mean value (14.93) at 20 cm. In the
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) |
|-----------|-------------------------------|------------------|
|           | 3                | 6                | 9                | 3                | 6                | 9                |
| Nitrogen Rates (kg ha⁻¹) |                           |                  |                  |                  |                  |                  |
| 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 (kg ha⁻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                    |
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≤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≤ 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≤0.05) of nitrogen rate and intra-row spacing on number of days to 95% maturity. Intra-row spacing had significant (P≤ 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 (kg ha⁻¹) | | | | |
| 20 | 42.50 | 110.25 | 27.13 | 27.38 |
| 25 | 42.00 | 109.67 | 22.45 | 22.65 |
### Effects of Intra-Row Spacing and Nitrogen Rate on Weight of 100 Seeds and Grain Yield ha⁻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≤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 kg ha⁻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 Chiezeey 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:

| Treatment | Weight of 100 Seeds (g) | Grain Yield ha⁻¹ (kg) |
|-----------|-------------------------|-----------------------|
| Nitrogen Rates (kg ha⁻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≤0.05)  | NS                      | NS                    |
| Interaction X (Nitrogen Spacing) | NS  | NS |

NS=Not significant
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.

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