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Efficacy of intra-row spacing on the growth and yield of groundnut (*Arachis hypogea* (L.)) cultivars on the Jos Plateau Nigeria

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ABSTRACT: The experiment was conducted at the Federal College of Forestry Demonstration Farm in Jos, Plateau State, Nigeria during the 2018 and 2019 growing seasons to determine the efficacy of intra-row spacing on the growth and yield of groundnut cultivars on the Jos, Plateau, Nigeria. A Randomized Complete Block Design (RCBD) was used involving four row spacings (15, 25, 35 and 45 cm) and three groundnut cultivars (SAMNUT 22, SAMNUT 23, and SAMNUT 24) arranged in 12 treatment combinations and replicated three (3) times on a 3 m x 3 m plot size with an alley of 0.5 m. Data were collected on plant height (cm), numbers of leaves, branches and pods plant^{-1}, canopy width (cm), 100 seeds weight (g), plant biomass (kg ha^{-1}) and yield (kg ha^{-1}). The data collected was subjected to analysis of variance (ANOVA) to test the significance between the treatment effects using F-test in XLSTAT 18 statistical package and where significance was observed, means were separated using Duncan's Multiple Range Test. The experiment showed that intra row spacing and cultivar significantly ($p \leq 0.001$) affected the growth and yield characters of the groundnuts. An intra-row spacing of 45 cm produced the highest growth characters of groundnut and 25 cm row spacing produced the highest yield characters while SAMNUT 24 out yielded the other cultivars producing the highest growth and yield. Based on the afore mentioned, it can be concluded and recommended that SAMNUT 24 is the most suitable cultivar and 25 cm intra row spacing is the optimal spacing for groundnut production in the study area.

Keywords: *Arachis hypogea*, cultivar, forestry, groundnut, growth, intra–row, SAMNUT, spacing, yield.

INTRODUCTION

Groundnut (*Arachis hypogea* (L)) is a self-pollinating annual legume that is widely cultivated in arid and semi-arid climates (40°N and 40°S), from warm temperate to equatorial climates (Aliyu, 2019). Groundnuts are grown on 26.4 million ha around the world, with a total production of 38.2 million metric tons (FAOSTAT, 2010). Developing countries account for 97 percent of groundnut area and 94 percent of the total production. Nigeria is the largest producer of groundnuts in Africa, producing 3.007 million tons on approximately 2.4 million hectares (FAO, 2012). According to Garba et al. (2006), groundnut is grown in all Northern Nigerian States, traditional commercial groundnut growing areas include Kano, Adamawa, Zamfara, Katsina, Jigawa, Yobe, Borno, Sokoto, Kaduna, Bauchi, Gombe, Taraba, Benue, Plateau, and Niger. Groundnut is an excellent food in Nigeria and other developing countries where the crop is grown, containing approximately 62% highly digestible protein, 22% carbohydrates, 6% minerals, and approximately 8% fat (Ibrahim et al., 2019).

Any crop's yield is a complicated phenomenon that is determined by environment, management and is a function of genetic factors. Thus, for the crop to grow properly, it must be properly managed. Crop yield is determined by the interaction of genetic and environmental factors such as soil type, sowing time and process, seed rate, fertilizers, and irrigation time, among which row spacing plays a critical role in achieving higher yields (Hussain et al., 2003). Proper spacing ensures adequate ventilation, reduces competition among plants for space and nutrients, reduces disease transmission, encourages weeding and movement in the farm, and also reduces overcrowding, allowing plant canopies to intercept radiation (Gutu et al., 2019). To maintain the necessary number of plants and to conduct intercultural operations for a higher yield, proper spacing in line sowing is recommended. The usual physiological processes of the crop as described by Awal and Lija (2015) are harmed by improper spacing and plant density. Inter-specific competition between plants is intense in densely populated crops. Wider spacing, once again, results in lower yield due to inefficient room use.

Despite its many advantages and applications, groundnut production is limited by a variety of biotic and abiotic factors. Weak acceptance of improved cultural practices is a major aspect of crop production and management that hinders or restricts productivity and yield increase among subsistence and peasant farmers. Usage of improved varieties, implementation of acceptable seeding rates and spacing, weed control, and fertilizer application are only a few examples of cultural practices. The majority of farmers depend on unimproved local varieties that produce low yields and are susceptible to pests and diseases (Ibrahim et al., 2019).

In Nigeria, recently published varieties are disease resistant/tolerant and mature early to prevent drought (NACGRAB, 2015). In Nigeria's dry savanna region, many programs are being introduced to promote these varieties (Shuaibu et al., 2019). Different groundnut cultivars necessitate different plant spacing. A successful cultivar sown at an incorrect spacing can produce a low yield. Increased groundnut production requires proper plant spacing and a suitable cultivar. Identifying a suitable cultivar and optimum plant spacing will significantly increase groundnut growers' production and profits. A large number of research projects have been carried out around the world in order to increase groundnut production. It was discovered that there is a certain planting spacing for groundnuts above which the crop would not achieve a higher yield (Gutu et al., 2019; Konlan et al., 2013). To fill this gap, this research was conducted to determine the efficacy of intra-row spacing on the growth and yield of groundnut cultivars on the Jos, Plateau.

MATERIALS AND METHODS

Experimental area

The experiment was conducted at the Federal College of Forestry Demonstration Farm on Jos, Plateau State, Nigeria. It is an area in Nigeria's Northern Guinea Savannah between latitude 9° 9' and longitude 8°.8', with an elevation of 1,200 meters above sea level and an average annual rainfall of 1200 mm. The rain usually starts from April and terminates between October and November with temperatures ranging from 20 to 30ºC.

Materials

The materials used for this experiment include groundnut cultivar seeds, NPK fertilizer, cutlass, shovel, rake, measuring tape, meter rule, rope, auger, wheelbarrow, tape and hoe. The cultivars (SAMNUT 22, 23 and 24) were sourced from International Crop Research Institute for Semi-Arid Tropics (ICRISAT) research station, Kano. The tools were obtained from Crop Production Technology Department store of the Federal College of Forestry Jos.

Experimental design

A Randomized Complete Block Design (RCBD) was used involving four (4) row spacing (15, 25, 35 and 45 cm) and three (3) groundnut cultivars (SAMNUT 22, 23, and 24) arranged in 12 treatment combinations replicated three (3) times on a 3 m x 3 m (9 m^2) plot size with an alley way of 0.5 m.

Agronomic practices

Land preparation

Preparation of land for planting was done during the July, 2018 and 2019 growing seasons. The land was cleared using a cutlass and hoe. The soil was thoroughly ploughed and the clumps were broken into fine soil particles using mechanical ploughs.

Sowing and spacing

Sowing of groundnut cultivars was carried out at a depth of 5 cm and at a spacing of 15, 25, 35 and 45 cm with two seeds per hole. The groundnut seeds were treated with seed dressing chemical in the form of Apron star 20% w/w thiamethoxam, 20% w/w metalaxyl-m and 2% w/w difenoconazole at the rate of 10 g per 5 kg of seed against fungal and insect infection. NPK fertilizer was applied after two weeks of sowing using the side placement method.

Weeding

Weeding was carried out two times at 4 and 6 weeks after sowing. This was carried out manually using a hoe.

Data collection and analysis

The following agronomic measurement were taken: Plant height (cm), number of leaves, leaf area (cm^2), number of branches, canopy width (cm), number of pods per plant, 100 seeds weight (g), shelling percentage (%), plant biomass (kg/ha) and yield (kg/ha). The data collected were subjected to statistical analysis of variance (ANOVA) to test the significance between the treatment effect using the F-test (Snedecor and Cochran, 1967) in XLSTAT 18 statistical package and where significance was declared, means were separated using Duncan Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Efficacy of intra – row spacing on the plant height of groundnut cultivars

The efficacy of intra – row spacing on the growth characters of groundnut cultivars is presented in Table 1. The result shows that during the 2018 and 2019 seasons, the intra – row spacing significantly ($p \leq 0.001$) affected the plant height, number of leaves, branches and canopy width. The intra – row spacing of 45 cm recorded the tallest plants (47.22 and 48.17 cm). This was followed by a spacing of 35 cm with plant heights (41.40 and 42.78 cm) and 25 cm with plant heights (38.64 and 39.17 cm) respectively. While the shortest plant height (36.61 and 36.50 cm) was however, recorded by 15 cm spacing. Therefore, 25 cm row spacing tended to produce the tallest plants during the different growth stages of groundnut. The efficacy of cultivar on the plant height of groundnut was significant ($p \leq 0.001$) in both growing seasons. SAMNUT 24 gave the highest plant heights (42.08 and 42.83 cm) followed by SAMNUT 23 (40.77 and 41.67 cm) and SAMNUT 22 (40.06 and 40.46 cm) in both seasons (Table 1) of the experiment.

There was no significant ($p > 0.05$) effect of interaction on the plant height in 2018 and 2019 seasons. This may be due to the spacing not close enough to cause competition between the cultivars. Plant height is a critical growth characteristic that has a direct impact on groundnut production potential. Over time, the taller plants obtained at 40 cm spacing could be due to less competition for growth factors such as light, nutrient, and water, allowing the groundnut plant to access these factors. The results of this study are consistent with those of Madisa et al. (2014), who found that taller plants were collected at wider spacing due to less competition for resources such as nutrients. Aliyu (2019) found out that the varieties behaved significantly ($p \leq 0.001$) differently at all stages of the crop's growth in terms of plant height. This may be attributed to the genetic differences between the respective cultivars. The result was in agreement with the findings of Aliyu and Ajala (2016).

Efficacy of intra – row spacing on the number of leaves of groundnut cultivars

Statistically, similar number of leaves (167.00, 166.00 and 166.00, 166.00) at a spacing of 45 and 35 cm at 2018 and 2019 growing seasons was measured (Table 1) which were statistically at par with 25 cm (161.56 and 162.78) and 15 cm (159.11 and 160.22) spacing. Numbers of leaves were found to significantly ($p \leq 0.001$) affected groundnut cultivar with SAMNUT 24 producing more leaves (165.92 and 165.58) as against SAMNUT 23 (162.08 and 163.33) and SAMNUT 22 (161.58 and 162.17) respectively. The interaction between intra-row spacing and groundnut cultivar was not significant on number of leaves in 2018 and 2019 seasons. The availability of sunlight and soil nutrients for better plant production could be attributed to the higher number of leaves recorded by 40 cm spacing. The presence of these factors aids photosynthesis, resulting in larger plants in terms of leaf count, branch count, and other characteristics. This is consistent with the findings of Mehla et al. (2000), who found that less competition led to an increase in the number of leaves and other growth parameters. The number of leaves has declined over time, most likely due to senescence. Similarly, cultivar differences play a significant role on the number of leaves of groundnut plant.

Efficacy of intra – row spacing on the number of branches of groundnut cultivars

Significant ($p \leq 0.001$) effect of intra – row spacing was measured on number of branches of the groundnut plants. An intra – row spacing of 45 cm was found to produce more branches (15.22 and 15.00) than spacing of 35 cm (14.11 and 14.44), 25 cm (12.22 and 12.89) and 15 cm (10.33 and 10.44) in 2018 and 2019 growing seasons. Also, cultivars significantly ($p \leq 0.001$) affect the number of branches of groundnut with SAMNUT 24 recording the highest branches (14.50 and 14.42) while SAMNUT 22 gave the least (11.42 and 12.00) number of branches of groundnut. No significant interaction between intra – row spacing and cultivars was observed. It is believed that wider row spacing helped the groundnut plant to utilize its energy properly in branching because there was no much competition for light nor an overlapping from adjacent groundnut plants within the row. Similarly, the number of branches produced may be as a result of the genetic makeup of the cultivars. The results may differ from those of Giayetto et al. (2011), who found that plant density has an effect on peanut growth parameters, they also found an increase in branches/plant with wider spacing (medium plant density) when they looked at fewer ranges of branches/plant due to the low plant spacing (45 x 15 cm). Increased row spacing allows for better light interception and solar energy harvesting.

Efficacy of intra – row spacing on the canopy width of groundnut cultivars

Canopy width was found to be significantly influenced by intra – row spacing and groundnut cultivar in 2018 and

Table 1. Efficacy of intra – row spacing on the growth characters of groundnut cultivar.

Treatment	Plant height (cm)		Number of leaves		Number of branches		Canopy width (cm)	
	2018	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**
Row Spacing (cm)								
15	36.61[d]	36.50[d]	159.11[b]	160.22[c]	10.33[d]	10.44[c]	48.44[d]	48.44[d]
25	38.64[c]	39.17[c]	161.56[b]	162.78[b]	12.22[c]	12.89[b]	51.44[c]	51.22[c]
35	41.40[b]	42.78[b]	165.56[a]	166.22[a]	14.11[b]	14.44[a]	53.39[b]	53.17[b]
45	47.22[a]	48.17[a]	166.56[a]	165.55[a]	15.22[a]	15.00[a]	54.67[a]	54.11[a]
SE±	0.29	0.41	1.29	0.51	0.33	0.29	0.32	0.33
p–value	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
Groundnut Cultivar								
SAMNUT 22	40.06[c]	40.46[c]	161.58[b]	162.17[b]	11.42[c]	12.00[c]	51.08[c]	51.08[b]
SAMNUT 23	40.77[b]	41.67[b]	162.08[b]	163.33[b]	13.00[b]	13.17[b]	51.87[b]	51.79[b]
SAMNUT 24	42.08[a]	42.83[a]	165.92[a]	165.58[a]	14.50[a]	14.42[a]	53.00[a]	52.33[a]
SE±	0.25	0.36	1.12	0.87	0.29	0.25	0.28	0.29
p–value	0.000***	0.000***	0.000***	0.002**	0.000***	0.000***	0.000***	0.001***
Interaction								
IRS x GC	NS	NS	NS	NS	NS	NS	NS	NS

Means that do not share the same letter(s) are significant, SE = Standard Error, NS = Not Significant at $p \geq 0.05$ ** = Significant at $p \leq 0.01$, *** = Significant at $p \leq 0.001$.

2019 growing seasons (Table 1). The main efficacy of intra – row spacing on canopy width shows that a row spacing of 45 cm gave the highest canopy width of 54.67 cm in 2018 and 54.11 cm in 2019 followed by a spacing of 35, 25 and 15 cm with 53.39 and 53.17 cm, 51.44 and 51.22 cm and 48.44 cm each in 2018 and 2019 seasons respectively. Similarly, the main efficacy of cultivar indicates that SAMNUT 24 gave the widest canopy (53.00 and 52.33 cm) and SAMNUT 22 gave the least canopy (51.08 cm apiece) in both years. No significant interaction was recorded between intra – row spacing and cultivar. This implies that canopy width was found to increase with increasing space while variety was affected by canopy width. In light of this, plants were forced to expand vertically to compete for room and light in both years, resulting in a reduction in canopy width as explained by Konlan et al. (2013). Broad spacing favored larger canopy sizes in both years, most likely because there was more usable space for horizontal growth than there was for closely spaced crops.

Efficacy ofintra – row spacing on the number of pods/plant of groundnut cultivars

Efficacy of intra – row spacing on the number of pods/plant of groundnut cultivar is presented in Table 2. The intra – row spacing was found to be significantly ($p \leq 0.001$) affected by number of pods/plant. In both 2018 and 2019 seasons, a 25 cm row spacing recorded higher number of pods/plant (56.89 and 56.11) followed by 35 cm (53.56 and 53.33) then 45 cm (45.67 and 46.44) and the least number of pods plant^{-1} at 15 cm (37.44 and 39.22). The main efficacy of cultivar on number of pods/plant was found to be significant. SAMNUT 24 gave more pods/plant while SAMNUT 23 and SAMNUT 22 were statistically similar with 46.67 and 48.08 and 45.33 and 47.17 pods/plant respectively in both seasons. The interaction was not significantly affected by number of pods/plant. The number of pods/plant decreases with increasing space and cultivar type affects the pods/palnt. According to Abdullah et al. (2007), as plant density increased, the number of pods per plant decreased, and as plant density decreased, the number of pods per plant increased. This finding contradicts Gutu et al. (2019) who reported that higher number of pods per plant recorded by wide spacing arrangements could be attributed to less intra-specific competition for growth resources among wide spacing crops compared to close spacing crops, which have lower plant density and more available growth resources. Variations in the number of pods observed were most likely due to genotypes of the groundnut variety. This finding is consistent with Konlan et al. (2013), who found that the number of pods per plant varied significantly between varieties.

Efficacy of intra – row spacing on 100 seeds weight of groundnut cultivars

100 seeds weight was found to be significantly ($p \leq 0.05$) affected by intra – row spacing (Table 2) in 2018 with a row spacing of 25 and 35 cm producing statistically similar 100 seeds weight. The least weight recorded for 15 cm

Table 2. Efficacy of intra – row spacing on the yield and yield characters of groundnut cultivar.

Treatments	Number of pods/plant		100 Seeds weight (g)		Plant biomass (kg/Ha)		Total yield (kg/Ha)	
	2018	2019	2018	2019	2018	2019	2018	2019
Row spacing (cm)								
15	37.44^{d}	39.22^{d}	47.89^{b}	48.44	1915.56^{bc}	1955.56	1549.44^{b}	1585.00^{c}
25	56.89^{a}	58.11^{a}	49.11^{a}	49.22	2014.44^{a}	1978.89	1626.88^{a}	1664.56^{a}
35	53.56^{b}	53.33^{b}	48.67^{a}	49.00	1941.56^{b}	1954.44	1625.56^{a}	1637.00^{ab}
45	45.67^{c}	46.44^{c}	48.44^{ab}	48.78	1900.67^{c}	1935.67	1605.22^{ab}	1620.56^{bc}
SE±	0.96	0.71	0.35	0.27	15.98	15.56	28.04	18.40
p–value	0.000***	0.000***	0.016*	0.52	0.000***	0.077	0.039*	0.002**
Groundnut cultivar								
SAMNUT 22	45.33^{b}	47.17^{b}	48.08^{b}	48.33^{b}	1849.25^{c}	1922.08^{b}	1544.83^{b}	1574.00^{b}
SAMNUT 23	46.67^{b}	48.08^{b}	48.33^{b}	48.92^{a}	1934.42^{b}	1945.00^{b}	1556.50^{b}	1589.42^{b}
SAMNUT 24	53.17^{a}	52.58^{a}	49.17^{a}	49.33^{a}	2045.50^{a}	2001.33^{a}	1704.00^{a}	1716.92^{a}
SE±	0.83	0.62	0.30	0.24	13.84	13.48	24.28	15.94
p–value	0.000***	0.000***	0.004**	0.001***	0.000***	0.000***	0.000***	0.000***
Interaction								
IRS x GC	NS	NS	NS	NS	0.000***	0.021*	NS	NS

Means that do not share the same letter(s) are significant, NS = Not Significant at p≥0.05, * = Significant at p≤0.05, ** = Significant at p≤0.01, *** = Significant at p≤0.001.

spacing. However, in 2019 season no significant effect of row spacing was measured on 100 seeds weight. The main effect of cultivar in 2018 on 100 seeds weight shows that SAMNUT 24 gave the highest (100 seeds) weight (52.58 g) while SAMNUT 23 and 22 are statistically similar. Also in 2019, SAMNUT 24 and 23 gave statistically similar 100 seeds weights which are at par with SAMNUT 22 with the least weight of 100 seeds of groundnut. No interaction effect was recorded. The differences in rainfall and other environmental conditions might be attributed to these variations.

Efficacy of intra – row spacing on biomass of groundnut cultivars

Plant biomass was found to be significantly ($p \leq 0.001$) affected by intra – row spacing (Table 2) in 2018 with a row spacing of 25 cm having the highest biomass weight of 2014.44 kg Ha^{-1} followed by 35 cm with 1941.56 kg Ha^{-1}, 45 cm spacing had the least (1900.67 kg Ha^{-1}) plant biomass. However, in 2019 no significant ($p>0.05$) effect of intra – row spacing was measured on plant biomass. Cultivar difference significantly affects plant biomass of groundnut both in 2018 and 2019. SAMNUT 24 consistently produced the highest biomass weight (2045.50 and 2001.33 kg Ha^{-1}) of groundnut while SAMNUT 22 gave the least (1849.25 and 1922.08 kg Ha^{-1}). No interaction effect between row spacing and cultivar was observed. The results are consistent with the findings of Patil et al. (2007) who found that most yield contributing characters were significantly affect the broad furrow spacing than that at closest one.

Efficacy of intra – row spacing on total yield of groundnut cultivar

Total pod yield was equally affected by the intra-row spacing during 2018 growing season as presented in Table 2. The maximum and minimum pod yield was recorded in 25 cm (1626.88kg/Ha) and 35 cm (1625.56kg/Ha) intra-row spacing, respectively. During 2019 season, intra-row spacing of 25 cm gave the highest pod yield (1664.56kg/Ha) that is statistically at par with 35 cm intra-row spacing and the lowest (1585.00kg/Ha) was recorded by 15 cm intra-row spacing. SAMNUT 24 cultivar had the highest pod yield (1704.00kg/Ha and 1716.92kg/Ha) for both 2018 and 2019 planting seasons. The cultivar SAMNUT 23 and 22 gave statistically similar pod weight. The interaction between spacing and cultivar on total yield were not significant as presented in Table 2. The result from this findings disagreed with Awal and Lija (2015) who stated that groundnut crop with the highest biological yield was grown with 15 or 20 cm row spacing, while the crop with the lowest biological yield was grown with 30 or 35 cm row spacing. The higher plant densities may have higher grain yields (Gutu et al., 2019) due to more efficient utilization of growth resources, whereas the lower plant densities may have lower grain yields due to more luxurious growth because the lower plant density initiated more pod thickness than grain yield. SAMNUT

24's good performance could be attributed to its relatively higher 100 seed weight, which is an important determinant of yield. The variations in grain yield of cultivars were probably attributable to genetic differences between them.

Conclusion

Planting density is one of the most important factors influencing groundnut growth, yield, and quality. To maximize yield, it is critical to plant the appropriate number of plants per unit area of land. The major findings from this experiment showed that intra row spacing and cultivar significantly affected the growth and yield characters of groundnut. An intra – row spacing of 45c m produced the highest growth characters of groundnut and 25 cm row spacing produced the highest yield characters while SAMNUT 24 out yielded the other cultivars producing the highest growth and yield. Based on the aforementioned, it can be concluded that SAMNUT 24 is the most suitable cultivar and 25 cm intra row spacing is the optimal spacing for groundnut production at the study area. Further research should be conducted on other row spacing and cultivars to establish a base line for optimum productivity of groundnut.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

Abdullah, T., Rahmianna, A. A., Hardaningsih, S., & Rozi, F. (2007). Increasing groundnut yield on dry land Alfisols in Indonesia. *Journal of Semi-Arid Tropics Agricultural Research,* 5(1), 84-96.

Aliyu, U. I. (2019). Response of groundnut (*Arachis hypogea* L.) to varying intra-row spacing and variety in Bagauda, a Sudan Savannah Agro-Ecological Zone of Nigeria. *Journal of Agriculture and Veterinary Science,* 12(1), 45-51.

Aliyu, U., & Ajala, A. A. (2016). Effect of variety and plant density on growth and yield of okra (*Abelmoschus esculentus* (L.) Moench). *Journal of Agriculture and Veterinary Science,* 9(2), 38-42.

Awal, M. A., & Lija, A. (2015) Effect of row spacing on the growth and yield of peanut (*Arachis hypogaea* L.) stands. *International Journal of Agriculture, Forestry and Fisheries*, 3(1), 7-11.

Duncan, D. B. (1955). Multiple range and multiple F tests. *Biometrics*, 11(1), 1-42.

FAOSTAT (2010). Groundnut world production. Retrieved 12th March, 2021 from http://www.faostat.fao.org

Food and Agriculture Organization (FAO) (2012). Production year book, Vol.6, Rome, Italy.

Garba, A., Auwalu, B. M., & Abdul, S. D. (2006). Effect of intra-row spacing and variability in seed size on the yield of ten groundnut varieties in Bauchi, Nigeria. *Savanna Journal of Agriculture*, 1(1), 46-51.

Giayetto, O., Cerioni, G. A., & Asnal, W. E. (1998). Effect of sowing spacing on vegetative growth, dry matter production, and peanut pod yield. *Peanut Science*, 25(2), 86-87.

Gutu, T., Abera, D., & Alemu, B. (2019). Evaluation of the Effects of Intra and Inter Row Spacing on the Growth and Yield of Ground Nut (Arachis Hypogaea L.) at Haro Sabu, Western Ethiopia. *Advances in Life Science and Technology*, 70, 19-24.

Hussain, I., Ayyaz Khan, M., & Ahmad, K. (2003). Effect of row spacing on grain yield and the yield components of wheat (Triticum aestivum L.). *Pakistan Journal of Agronomy,* 2(3), 153-159.

Ibrahim, I. I., Jameela, A., Ninani, K. N. (2019). Growth and yield components of groundnut (*Arachis hypogeal* L) as affected by phosphorous fertilizer application on the Jos Plateau. *Asian Journal of Research in Agriculture and Forestry*, 3(3), 1-8.

Konlan, S., Sarkodie-Addo, J., Asare, E., & Kombiok, M. J. (2013). Groundnut (*Arachis hypogaea* L.) varietal response to spacing in the Guinea savanna agro-ecological zone of Ghana: Growth and yield. *African Journal of Agricultural Research*, *8*(22), 2769-2777.

Madisa, E. M., Mathowa, T., Mpofu, C., & Oganne, T. A. (2014). Effect of plant spacing on the growth, yield and yield components of okra (*Abelmoschus esculuntus* L. Moench) in Botswana. *American Journal of Experimental Agriculture,* 6(1), 7-14.

Mehla, C. P., Srivastava, S. J., Mangat, R., Singh, J., & Ram, M. (2000). Response of tomato varieties to N and P fertilization and spacing. *Indian Journal of Agricultural Research*, 5(2), 67-71.

National Centre for Genetic Resources and Biotechnology (NACGRAB) (2015). Crop varieties released and registered in Nigeria.

Patil, H. M., Kolekar, P. T., & Shete, B. T. (2007). Effect of layouts and spacing on yield quality of bold seeded summer groundnut (*Arachis hypogaea* L.). *International Journal of Agricultural Science,* 3(2), 210-213.

Shuaibu, Y. M., Kawure, S., & Bala, R. A. (2019). Effect of season, variety and phosphorus fertilization on the growth and yield of groundnut (*Arachis hypogaea* L.) in Bauchi State Nigeria. *Journal of Horticulture and Plant Research*, 6, 20-26.

Snedecor, G. W., & Cochran, W. G. (1967). Statistical methods. 6th edition, Ames, Lowa, the Lowa State University.