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Evaluation Of Different Spacing on the Growth and Yield of Onion (Allium Cepa L.) Varieties Under Raining and Dry Seasons in Ogbomoso South Western Nigeria.

ATANDA TINUADE TOYIN[1], OLANIYI JOEL OYEKUNLE[2]
[1,2]*Department of Crop Production and Soil Sciences, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria.*

Abstract- Field experiment was conducted in order to investigate the impact of different spacing on the growth and yield of Onion varieties in the year 2017 under rainfed and irrigation facilities at Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. The treatments were four onion varieties (Local white, Texas grano, Local red and Red creolo) and six different spacing (0.3m by 0.2m, 0.3m by 0.3m, 0.3m by 0.4m, 0.3m by 0.5m, 0.3m by 0.6m, 0.3m by 0.7m). A recommended combined application of N and K fertilizers (60Kg N/ha x 120Kg K2O/ha) inform of Urea and Muriate of Potash (MOP) (Atanda and Olaniyi, 2016) was applied at 2 weeks after transplanting. Texas grano variety recorded the highest values in all the parameters observed and this was obtained when onion was planted at the spacing of 30cm x 40cm. the study showed that at 30cmx 40cm spacing, Texas grano variety of onion could be produced successfully at Ogbomoso agro-ecological zone.

Index Terms- Onion varieties, spacing, onion yield, LAUTECH, Nigeria.

I. INTRODUCTION

Onion (Allium cepa L.) ranks as one of the most important and economically valuable vegetable crops worldwide, second only to tomatoes in global significance (FAO, 2020), owing to its essential role in culinary traditions, nutritional contributions, medicinal applications, and extensive international trade (Food and Agriculture Organization [FAO], 2024a). In Nigeria, onion cultivation plays a vital part in supporting household food security, rural livelihoods, and income generation, particularly in the northern regions where it functions as both a staple condiment and a major cash crop. The crop is consumed at mature bulb and immature green stages, delivering key macronutrients including proteins (approximately 1.1%), carbohydrates (9–10%), and dietary fiber (1.7%) alongside micronutrients such as calcium, potassium, and vitamins C, B6, and E, complemented by bioactive organosulfur compounds and flavonoids (Gupta et al., 2025a). Botanically, onion is a biennial herb belonging to the Amaryllidaceous family, featuring a fleshy underground bulb, hollow tubular leaves, and a shallow fibrous root system that makes it particularly responsive to soil moisture, nutrient availability, and management practices (Sansan et al., 2024). In Nigeria, production concentrates during the dry season (September - April) in northern arid zones, enabling up to three cropping cycles per year, two rainfed and one irrigated and often incorporating intercropping with vegetables such as tomatoes, peppers, or lettuce to optimize land use and mitigate risks (NAERLS, 2025). Despite these advantages, the sector faces persistent challenges, including post-harvest losses exceeding 40%, price volatility linked to supply disruptions, and dependence on substandard inputs (BusinessDay, 2025).

Agronomic practices particularly plant spacing and varieties exert considerable influence on vegetative development (e.g., plant height and leaf number) and yield components (e.g., bulb diameter, weight, and marketable yield), thereby determining overall productivity and quality (Gelaye & Woldemariam, 2025; Getaneh et al., 2025). Effective management of these practices is essential to enhance resource-use efficiency and minimize inefficiencies arising from competition or nutrient imbalances (Gelaye et al., 2025b).Genotype–environment–management interactions are particularly pronounced in onion; hybrid varieties frequently outperform traditional ones, attaining marketable yields up to 57–58 tonnes per hectare under optimized N regimes of 82–138 kg/ha (Getaneh et al., 2025; Yeshiwas et al., 2024). Plant spacing modulates resource competition for light, water, and nutrients: narrower intra-row distances (5–10 cm) reduce inter-plant rivalry, improve marketable yield by 20–40%, suppress weeds, and enhance bulb quality, whereas excessive density can diminish individual bulb size and wider spacing reduce output per hectare (Belay et al., 2025; Gelaye, 2024; Omaria et al., 2023). These effects interact with genotype, favoring moderate densities for balanced performance in many hybrids (Gupta et al., 2025c; Yeshiwas et al., 2024).

Globally, dry onion production (including shallots) has shown substantial growth, reaching approximately 111 million metric tonnes from about 5.97 million hectares in recent years, with an average yield of around 18.5 tonnes per hectare; major producers include India, China, Egypt, the United States, and Türkiye (FAO, 2024b; Sansan et al., 2024; Gutiérrez-Benicio et al., 2025). In Nigeria, annual production is estimated at roughly 2.1 million metric tonnes valued at over N1.17 trillion positioning the country as Africa's second-largest producer after Egypt, although average yields remain at 14–17 tonnes per hectare due to constraints such as climatic variability, input quality issues, and post-harvest losses (National Onion Producers, Processors and Marketers Association of Nigeria [NOPPMAN], 2026; National Agricultural Extension and Research Liaison Services [NAERLS], 2025). The characteristic pungency derives from volatile organosulfur compounds (e.g., allyl propyl disulfide), while health-promoting effects including antioxidant, anti-inflammatory, antimicrobial, and cardioprotective properties are largely attributed to quercetin, phenolic acids, and saponins (Gupta et al., 2025a; Imran et al., 2025; Muscolo et al., 2025).

Demand for onion is increasing gradually in Nigeria and worldwide while its production technique has not been fully developed owing to significant difference in environmental conditions of the producing area (Northern, Nigeria) and the Southern parts of Nigeria. Northern part of Nigeria (Kano, Kaduna, Sokoto, Plateau, Jigawa etc) is the production area for onion whereas; farmers in the South western part of Nigeria encounter many difficulties due to insufficient information about its cultivation. Despite the ranking of onions as second most important vegetable in Nigeria, the present production levels do not meet the demand of the teeming populace (Gambo et al, 2008). The cost of purchasing onion is increasing at an alarming rate day by day. This is due to the fact that the production is localized or concentrated or limited to the far North and little or no effort is been made in Southwest, Nigeria. The cost of transportation, poor road and poor storage facilities which leads to increase in produce deterioration has contributed to the high cost and even unavailability of the onion in Southwest. Onion is a relatively new crop in terms of cultivation for this region and several aspects of their production need to be quantified and optimized.

II. OBJECTIVES

The objectives of this experiment were as follows: (1) to examine the suitable spacing for onion production in the study area (2) to study the best performing onion variety among the varieties tested (3) to examine the maximum growth and yield as related to the treatment tested

III. MATERIALS AND METHODS

Research description: Field experiment was conducted at Teaching and Research Farm Ladoke Akintola University of Technology, Ogbomoso (80 10'N and 40 10'E), a location in the Guunea Savannah zone of South-western Nigeria in 2017. The 4 x 6 factorial treatment combinations were arranged in a Randomized Complete Block Design (RCBD) with three replicates. The experimental site was manually cleared and 72 raised beds were made with the use of hoe. These were divided into three replicates with each replicate containing 24 beds. The size of each bed was 2 m x 2 m (4m2) with the spacing of 0.5 m within and 1m between replicates. The total area of the experimental plot was 53.5m x 8m (428m2) and this area was divided into three replicates each dimensioned 53.5m x 2m (107m2).

Four onion varieties (Local white, Texas Grano, Local red and Red creolo,) were sourced for at National Seed Centre, Kano and National Institute of Horticultural Research (NIHORT), Ibadan and used as test crop. The treatments were four onion varieties (Local white, Texas grano, Local red and Red creolo)

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and six different spacing (0.3m by 0.2m, 0.3m by 0.3m, 0.3m by 0.4m, 0.3m by 0.5m, 0.3m by 0.6m, 0.3m by 0.7m) with their various combinations.

Soil analysis of the experimental site: Soil samples were collected from the experimental plots prior to planting at depths 0 – 15cm. These was air-dried at room temperature, crushed and sieved through wire mesh of 0.02 mm sieve, to remove debris and other materials and kept in plastic containers with covers for routine analysis according to Anderson and Ingram (1993) procedure. Soil pH was measured in a 1:1 soil-water suspension using glass electrode pH meter. Exchange acidity (Al3+, H+) was extracted with KCL and determined by titration with 0.05 NaOH, using phenophthalin as indicator. Organic carbon was determined by wet bichromate acid oxidation method. Total nitrogen was determined by the micro-kjeldahl method. Available phosphorus was extracted with Bray-P1 solution and measured by the molybdenum blue method and read in the technical auto analyzer.

Exchangeable cations (Ca, Mg, Na and K) was extracted with 1N NH4OAc. (pH 7.0), K and Na was read in a flame emission photometer while Ca and Mg was determined with atomic absorption spectrometer. Effective cation exchange capacity (ECEC) was calculated by the summation of exchangeable bases and exchange acidity. Particle size distribution was determined by the hydrometer method. The soils were dispersed with sodium hexamethaphosphate solution. Bulk density was determined according to the method of Anderson and Ingram (1993). Particle density was determined by the expulsion of trapped air in the air-dried soil sample, using a graduated cylinder, and distilled water aggregate stability was determined by the wet sieving method, using a 0.02 mm sieve and distilled water in a bowl.

Statistical analysis: Data collected was analyzed using Standard Analysis System (SAS, 1990) for analysis of variance (ANOVA). Difference among treatments means was computed using least significance differences (LSD) at 0.05 probability level.

Physico-chemical properties of soil before sowing of Onion: the physic-chemical properties of composite soil sample is given (table 1).

IV. RESULTS AND DISCUSSIONS

Effect of variety on the Plant height of Onion: The varietal effect on the height of onion plant is shown in table 2. The plant height was significantly ($p \leq 0.05$) influenced by variety at all sampling periods. At both season, Texas grano variety (V2) recorded the highest height of (4.23cm and 4.11cm) respectively, this is followed by V4 with 3.97cm at early season but V4 gave 4.05cm at late season while V1 recorded the least height of 3.56cm and 3.77cm respectively for both seasons.

Effect of variety on the Number of leaves of Onion: The effect of variety on the mean number of leaves of onion is shown in table 3. The number of leaves was significantly (P□0.05) influenced by different varieties used. Onion plant produced from V4 recorded the highest number of leaves at both seasons with the value of 7.94 obtained at early season and 7.88 at late season while V1 recorded the least value of 6.72 and 7.27 respectively. The values obtained from V2 and V4 at early season with the one obtained at V2 and V3 at late season were not significantly different from one other.

Effects of variety on the yield of onion: The effect of varieties on the bulb yield, leaf yield and total marketable yield of onion is shown in figure 1. The bulb and leaf yield were highly significant at both season. Texas grano variety (V2) recorded the highest bulb yield of 80.62kg and 69.25kg respectively at both season, this was followed by V3 which recorded the value of 56.38kg for the early season and V4 which gave the value of 55.03kg for the late season while local white variety (V1) recorded the least value (37.64kg & 36.65kg) at both season respectively. Also, V2 produced the highest leaf yield of 37.06kg & 35.67kg respectively at both season while V1 recorded the least value of 17.64kg and 20.61kg respectively at both season. The total marketable yield of onion was significantly influenced by variety with highest yield (117.68kg & 104.92kg) obtained at V2 respectively.

Effects of spacing on the height of onion plant: The plant height of onion was significantly influenced by different spacing used. The plant height increased with increase in the spacing from 0.3m X 0.2m (S1) up till 0.3m X 0.4m (S3) before a slight decrease was observed from the plants treated with much bigger spacing. The highest height of 4.7m & 4.17m respectively was recorded from S3 (0.3m X 0.4m) at both seasons while the least height of 3.45m & 3.47m respectively was obtained from S1 (0.3m X 0.2m) at both seasons.

Effects of plant spacing on the number of leaves of onion plant: The number of leaves of onion plant was greatly influenced by the spacing used. The onion planted at spacing five (S5) which is 0.3m X 0.6m recorded the highest number of leaves (8.0) at the early season while spacing three (S3) which is 0.3m X 0.4m recorded the highest number of leaves (8.41) at late season but there was no significant difference in the values obtained at S3 and S5 meanwhile S2 gave the least number of leaves (6.75 & 6.58) at both seasons.

Effect of spacing on the yield of onion: The different spacing used to produce onion plant shows a significant ($p \leq 0.05$) effect on the yield of onion at both seasons. The highest bulb weight of 82.67kg and 81.67kg was obtained respectively at 0.3m X 0.4m (S3), this was followed by S4 (0.3m X 0.5m) with a little drop in value (78.70kg and 60.48kg) while the least value was obtained at S1 (0.3m X 0.2m). also, the leaf weight was significantly influenced by the spacing used and the highest leaf weight was obtained at S3 with the value of 42.68kg and 42.17kg for both seasons while the least value was obtained from spacing one (S1). The same was the result obtained from the total marketable yield at both seasons.

The experimental results demonstrated a progressive increase in onion plant growth parameters such as plant height, leaf number, and overall biomass as the plants matured over time. This incremental growth is likely attributable to the cumulative expansion of cellular structures and the proliferation of meristematic tissues, which facilitate enhanced resource acquisition and photosynthetic capacity as the plant ages. Comparable patterns have been observed in recent studies, where inoculated onion plants exhibited significantly greater height, weight, and leaf development compared to controls, with increases of up to 35% in height and 58% in weight by the end of the growth cycle, emphasizing the role of age-related physiological maturation in optimizing vegetative performance (Gutiérrez-Benicio et al., 2025). Furthermore, seedling age at transplanting has been shown to influence these parameters, with 60-day-old seedlings yielding superior stand counts, bulb diameters, and overall growth metrics, highlighting how developmental stage interacts with environmental factors to drive incremental improvements (Aragie, 2023). These observations align with the notion that onion growth follows a sigmoidal pattern, where early vegetative phases lay the foundation for later bulb formation, underscoring the importance of monitoring age-dependent changes to maximize yield potential.

The observed variations in growth parameters among the tested onion varieties can be primarily ascribed to inherent genetic differences, which govern traits such as growth habit, resource allocation, and adaptability to local edaphic and climatic conditions. Genotypes with superior genetic makeup, for example, demonstrate enhanced tolerance to stressors like waterlogging, resulting in minimal reductions in plant height (up to 17.1%), leaf number, and bulb yield (around 28.8-29.7%), while maintaining higher membrane stability and antioxidant activities (Pawar et al., 2025). Multi-environment trials further reveal that genetic variability influences yield stability, with certain hybrids exhibiting broad adaptability and higher marketable yields under diverse conditions, driven by polygenic traits like bulb weight and maturity period (Gupta et al., 2025). This genetic diversity extends to all measured parameters, including seed yield and quality, where differential responses to environmental cues lead to significant inter-varietal differences in protein content, biological yield, and component traits (Yeshiwas et al., 2024). Such findings reinforce the value of genetic selection in breeding programs aimed at tailoring varieties to specific agroecologies, thereby optimizing growth and minimizing yield penalties from suboptimal conditions.

Experimental observations indicate that onion growth and yield are profoundly shaped by varietal genetic potential, coupled with adopted cultural practices and prevailing environmental conditions. Varietal differences, for instance, interact with management strategies to influence traits like bulb firmness and total yield, with hybrid cultivars often outperforming open-pollinated types under varying humidity and temperature regimes (Romo-Pérez et al., 2026). Environmental factors, such as microclimates and soil properties, further modulate these outcomes; regions with optimal conditions, like those in South Korea, show that fluctuations in yield are tied to climate variability, while practices like biodegradable mulching enhance soil nutrients and root development, boosting overall productivity (Lee et al., 2025). Moreover, the integration of agronomic practices such as varieties, spacings, tillage methods, irrigation and fertilization with environmental considerations has been shown to sustain high yields, with hybrid varieties achieving up to 28.09 t ha^{-1} under dense planting, illustrating how genotype-environment-management interactions drive performance (Yeshiwas et al., 2024). These insights emphasize the necessity of holistic approaches that align varietal selection with site-specific practices to mitigate environmental constraints and maximize onion output.

The study revealed that varying plant spacings exerted significant influences on all evaluated growth and yield attributes of onion. Specifically, denser spacings, such as 0.3 m × 0.4 m, promoted higher population densities, leading to elevated growth parameters and yields due to reduced inter-plant competition for resources like light and nutrients. This configuration yielded the highest bulb production, followed by 0.3 m × 0.5 m, with declines noted at wider spacings, attributable to underutilization of space and increased weed pressure (Belay et al., 2025). Intra-row spacing further modulates these effects; narrower arrangements (e.g., 5 cm) optimize total and marketable yields, particularly for adaptable varieties, by balancing competition and resource access, though excessive density can reduce bulb size and increase unmarketable produce (Gelaye, 2024). These results corroborate findings that moderate spacings enhance water and nutrient efficiency, ultimately improving yield components like bulb diameter and weight (Omaria et al., 2023). Thus, spacing optimization is crucial for resource-efficient onion cultivation, with recommendations tailored to variety and soil fertility to achieve sustainable high yields.

V. CONCLUSIONS

Spacing and varieties significantly influenced the growth and yield of onion at both season. Effect of different spacing was significant on the bulb, leaf and total marketable yield where 30cm X 40cm spaced plants produced the highest values than all other spacing used. Texas grano variety produced better growth parameter (plant heights and number of leaves) and yield attributes compare to other varieties tested. The result obtained at both the early and late season is not significantly difference from one another.

VI. ACKNOWLEDGEMENT

This work was carried out under the supervision of Prof J.O Olaniyi, Crop Production and Soil Science Department, LAUTECH, Ogbomoso.

Table 1: Physico-chemical properties of the soil of the experimental site.

Parameters	Values
pH (H_20)	5.8
Organic carbon (g/kg)	2.53
Total N (mg/kg)	0.26
Available P (mg/kg)	6.00
Fe (mg/kg)	11.40
Cu (mg/kg)	2.70
Zn (mg/kg)	1.96
Exchangeable K (C mol/kg)	0.31
Exchangeable Na (C mol/kg)	0.26
Exchangeable Ca (C mol/kg)	3.42
Exchangeable Mg (C mol/kg)	0.70
Exchangeable acidity (C mol/kg)	0.32

Sand (%)	78
Silt (%)	20
Clay (%)	2
Textural class	Sandy loam

Table 2: Effect of varieties on the height of Onion plant

	Raining season				Dry season			
	Months after transplanting							
Variety	1	2	3	4	1	2	3	4
Local white	1.20c	1.80c	2.45d	3.56c	1.38c	1.98c	2.60d	3.77c
Texas grano	1.66a	2.33a	3.02a	4.23a	1.75a	2.45a	3.03a	4.11a
Local red	1.58a	2.16b	2.81b	3.39b	1.58b	2.20b	2.88b	3.96b
Red creolo	1.45b	2.16b	2.75c	3.97b	1.60b	2.21b	2.77c	4.05a

Note: V1=local white, V2=Texas grano, V3=Local red, V4=Red Creolo

Table 3: Effects of varieties on the number of leaves of Onion (cm) at both seasons

	Raining Season				Dry Season			
	Month after transplanting							
Variety	1	2	3	4	1	2	3	4
Local white	4.72c	5.77c	6.72c	7.11d	4.88b	6.16b	6.77c	7.27b
Texas grano	5.05b	6.27b	7.44a	7.77b	5.44a	6.44a	7.05b	7.88a
Local red	4.77bc	6.38ab	7.16b	7.55c	5.33a	6.66a	7.44a	7.66a
Red creolo	5.55a	6.61a	7.50a	7.94a	5.55a	6.66a	7.33a	7.61ab

Note: V1=local white, V2=Texas grano, V3=Local red, V4=Red Creolo

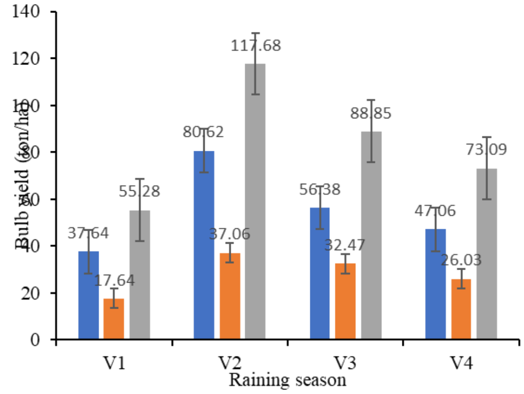

Figure 1: Effect of varieties on the yield of Onion during raining season

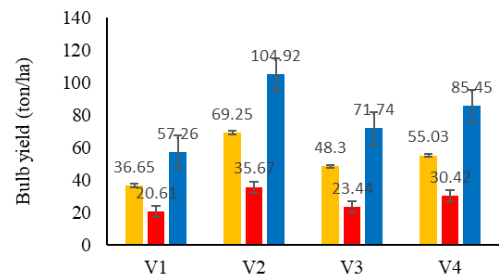

Figure 2: Effect of varieties on the yield of Onion during dry season

Table 4: Effects of spacing on the height (cm) of Onion plant at both seasons

	Raining season				Dry season			
	Months after transplanting							
Spacing	1	2	3	4	1	2	3	4
0.3 x 0.2	1.07d	1.67e	2.32d	3.45d	1.10d	1.75e	2.35d	3.47c
0.3 x 0.3	1.47bc	2.05d	2.72c	3.92c	1.51c	2.12d	2.75c	3.97b
0.3 x 0.4	1.90a	2.45a	3.02a	4.07a	2.02a	2.60a	3.06a	4.17a
0.3 x 0.5	1.55b	2.30b	2.86b	4.05ab	1.60b	2.25bc	2.93b	4.00b
0.3 x 0.6	1.45bc	2.15bc	2.80b	4.06ab	1.63b	2.23c	2.93b	4.16a
0.3 x 0.7	1.40c	2.12c	2.82b	4.00b	1.62b	2.32b	2.92b	4.06ab

Table 5: Effects of spacing on the number of leaves of Onion at both seasons

	Raining Season				Dry season			
	Months after transplanting							
Spacing	1	2	3	4	1	2	3	4
0.3 x 0.2	3.91d	5.5d	6.66c	7.16c	4.66c	5.75c	6.33d	6.91d
0.3 x 0.3	4.08d	5.41d	6.58c	6.75d	4.41c	5.66c	6.33d	6.58d
0.3 x 0.4	5.50b	7.08a	7.66a	8.01a	6.00a	7.16a	8.16a	8.41a
0.3 x 0.5	5.5b	6.5b	7.66a	7.91ab	5.66a	6.91a	7.58b	8.25ab
0.3 x 0.6	6.16a	7.00a	7.66a	8.00a	5.91a	7.16a	7.66b	7.66c
0.3 x 0.7	5.00a	6.08c	7.00b	7.75b	5.16b	6.25b	6.83c	7.83bc

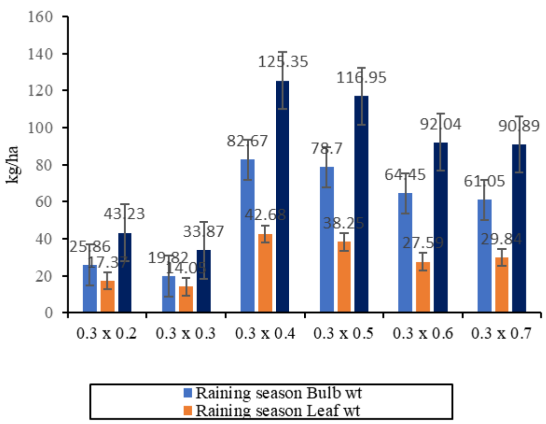

Figure 3: Effect of spacing on the yield of onion during raining season

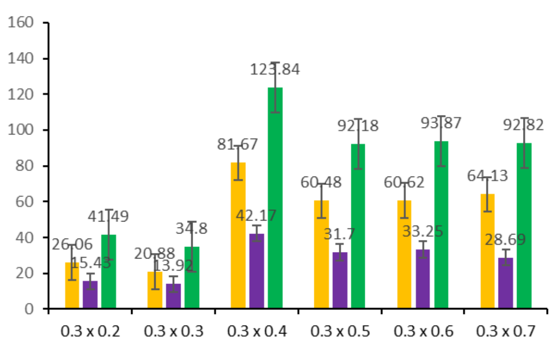

Figure 4: Effect of spacing on the yield of onion during dry season

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