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Research Article

Effect of Intra-row Spacing on the Growth and Yield of Onion (*Allium cepa L*) in Guinea Savannah, the Gambia

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Abstract

The field experiment was conducted at the National Agricultural Research Institute (NARI), a horticulture research field in Yundum (Latitude: - 13.35903 ° N longitude: - 16. 72244 ° W) from January to April 2020 cold-dry season in The Gambia to study the effects of intra-row spacing on the growth and yield of onion. The experiment consists of four intra-row spaces (10, 15, 20 and 25cm). The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications. Data collected on the growth; yield component and yield were subjected to analysis of variance. Significant differences mean were separated using the least significant differences (LSD) test at the 5% level of probability. There were significant differences between the intra-row spacing of plant height at harvest, total bulbs, bulb yield, average bulb diameter and individual bulb weight. There were no significant differences observed in the number of leaves per plant. Intra-row spacing of 10cm obtained the highest yield (30.76 t ha^{-1}), while wider intra-row spacing of 25cm recorded the lowest yield (18.85 t ha^{-1}). Based on the findings of this study, it could be concluded that intra-row spacing of 10 and 15cm can be suggested for onion production during the cold-dry season in The Gambia.

Keywords

Inter-row, Growth, Yield and Onion

1. Introduction

1.1. Background Information

The onion (Allium cepa L.) crop belongs to the genus Allium under the family Alliaceae, which is one of the most significant vegetable crops cultivated in the world commercially as well as at smallholder levels. It is one of the oldest bulb vegetables in constant production since 4000 BC, and it originated from Central Asia between Turkmenistan and Afghanistan, South Asia, and the Mediterranean region [1, 7, 11]. Many studies have revealed that there are at least 750 species in the Allium genus. Onions are cultivated in almost 170 countries of the world [5, 12]. The production of the onion crop is worldwide because it has a wide benefit in our daily food requirements; medicinal/health benefits that fight diseases such as cancer, asthmatic, heart, and diabetic diseases due to the presence of vitamins, minerals, and chemical compounds [8].

The onion is a high-value vegetable crop in the Gambia, which contributes to GDP, providing employment and playing a role in food security within the household. It is cultivated in almost all the agro-ecological zones, especially during the cold dry season from November to March each year, when the

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temperature (20-30 ℃) is favourable for production. Onions thrive best in well-drained sandy-loam soil with a PH of 5.5 to 6.0. The United Nations Industrial Development Organization (UNIDO) reported [14] that Gambia's consumption of onion was estimated at 17,000 metric tons per annum (importation is 12,500 MT). Kharafi Farm produces 2000 MT and other locally onion production is estimated at 2500 MT.

There are production constraints that farmer face in the country, like inappropriate agronomic practices, such as recommended plant spacing in onion production, which causes low productivity. Spacing influences the plant growth, size of bulbs, yields as well as the quality of the onion bulb.

1.2. Objectives of the Study

1) To evaluate the effects of intra-row spacing on the growth and yield of onion.
2) To recommend the suitable spacing for onion production in the Gambia.

2. Materials and Methods

2.1. Experimental Site

The field Experiment was carried out in National Agricultural Research Institute, Horticulture unit research field from January to April 2020. The horticulture Research Field is located at western Region of the Gambia at (Latitude: - 13.35903 ° N longitude: - 16. 72244 °W). The annual rainfall is about 900 to 1200mm per annum with minimum and maximum temperatures of 18 ℃ and 35 ℃ respectively. The soil is sandy loam with a PH of 6.0 and 0.60% organic matter content [10].

2.2. Soil Sampling and Analysis

Soil samples were collected from four different points at 0.30cm depth by use of soil auger from experimental site before land preparation. The soil samples were bulked, dried, ground, sieved and composite samples was collected and subjected to physical and chemical analysis using standard procedure.

2.3. Treatments and Experimental Design

Experiment consists of four intra-row spacings (10, 15, 20 and 25cm). The experiment was laid in a Randomized Completely Block Design (RCBD) with four replications. A space of 1 meter between replication and 0.5 meter (footpath) between the plots.

2.4. Plant and Fertilizer Material

Onion (Galmi de violet) seed was purchased from Jobe Kunda seed shop at Brikama west coast region. Galmi de violet was cultivated throughout the country and it potential yield was (25-30 tons) per hectare. Ten (10 tons) of organic manure (poultry dung) and 50 kilograms bag compound fertilizer (NPK 15:15:15) was used.

2.5. Cultural Practices

Onion seeds were sown in a nursery bed (10 x 1 meter). The seeds were drilled at 5cm depth and 20cm between the rows. Seedlings were nursed for 4 weeks before transplanting.

The land area for the experiment was cleared, harrowed, then demarcated into plots as per treatments and the plot size was 5 x 1 m^2. The number of plants transplanted per plot depends on intra spacing. At 10cm (200 plants), 15cm (132 plants), 20cm (100 plants) and 25cm (80 plants). The total number of plants transplanted was 20,48 plants.

Irrigation was done once a day and weeds were removed at different intervals. 10 tons per hectare of well-decomposed poultry manure was incorporated into the soil 2 days before transplanting and 200 kg/ha NPK 15:15:15 at 2 weeks after transplanting. Curing and harvesting were done within 90 days of transplanting.

2.6. Data Collection

Growth and yield data were collected from ten randomly selected tagged plants in each plot.

Plant height, number of leaves, total bulb, total bulb yield per hectare, average bulb weight and average bulb diameter.

Figure 1. *Field Layout of The Onion Trial.*

Figure 2. *Onion Bulb Harvested from the Trial.*

2.7. Data Analysis

Data collected were analyzed using Analysis of Variance (ANOVA) for randomized complete block design and the treatment means were compared using Least significance difference (LSD) at (P = 0.05) while the residual effects of treatments were also tested using Genstat edition 12.

3. Results and Discussion

3.1. Results

Table 1. *Physical and Chemical Properties of the Soil of the Experimental Site During 2020 Dry Season.*

Soil Properties	Replication 1	Replication 2	Replication 3	Replication 4
Physical Properties				
Organic matter (%)	0.46	0.31	0.24	0.46
Sand (%)	22.4	42.4	40.4	52.4
Clay (%)	12.68	10.68	12.68	8.68
Silt (%)	64.9	46.9	46.9	38.9
Chemical properties				
Soil pH (water)	5.9	5.6	5.0	5.0
Soil PH ($CaC1_2$)	3.6	3.8	4.0	3.7
EC (mmhos/cm)	0.08	0.04	0.03	0.03

Source: Soil laboratory National Agricultural Research Institute, Ministry of Agriculture, The Gambia.

Table 2. *Effect of Intra Row Spacing on Plant Height (cm) at Maturity, Number of Leaf Per Plant During 2020 Dry Season.*

Treatments	Plant Height (cm)	Number of Leaf
10	66.9a	10
15	62.6b	9
20	60.5b	9
25	62.9b	9
P. Value	0.004	0.308
Lsd	2.848	0.854
Cv%	2.82%	5.58%

Means followed by the same letter in each column are not significantly different according to Lsd Multiple Range Test at 5% level.

Table 3. Effect of Intra Row Spacing on Total Number of bulbs, Total Bulb Yield (t ha^{-1}), Average Bulb Diameter and Bulb Weight Per Plant During 2020 Dry Season.

Treatments	Total Bulb Yield (t/ha)	Average Bulb Diameter (cm)	Bulb Weight Per Plant (g)
10	30.76a	5.5b	82b
15	24.76b	6.5ab	132ab
20	21.4bc	6.6ab	147ab
25	18.85c	7.3a	167a
P. Value	<.001	<.001	<.001
Lsd	1.831	0.595	35.569
Cv%	9.56%	5.76%	16.78%

Means followed by the same letter in each column are not significantly different according to Lsd Multiple Range Test at 5% level.

3.2. Discussion

Soil physical and chemical properties of the experimental site before planting show that the soil pH of the area is generally acid (5.4); the organic matter content (0.37%), calcium (cmol kg^{-1})) is moderate while the percentage of sand, clay and silt is high (52.4%, 12.68%, 64.9%) and varies within the different replications as in Table 1 [10].

3.2.1. Plant Height

Plant height at maturity 2 ranged from 60.5 to 66.9 centimeters. There were significant (P=0.004) differences between intra-row spacing. The intra-row spacing of 10cm was significantly taller than the other spacing. While 15cm, 20cm and 25cm were statistically at par. This variation with regard to plant height was due to competition between plants for sunlight in closer spacing. Similar finding was reported by [3, 4, 7, 9].

3.2.2. Number of Leaf per Plant

The number of leaves per plant shows no significant differences between the intra-row spacing. Similar research was conducted by [3], who also reported that intra-row spacing had no significant effect on the number of onion leaves. This may be attributed to the environment and soil condition of the study area.

3.2.3. Total Bulb Yield (t/ha)

Bulb Yield varied from 18.85 to 30.76 tons per plot. Closer spacing of 10cm had significantly (P=0.001) maximum total bulb yield (30.76 t/ha) followed by 15cm (24.76 t/ha) and 21.4 t/ha was obtained at 20cm, which was statistically at par (Table 3). Similar results were obtained by [2, 6, 13] in his finding that 15cm recorded the higher bulb yield. The lowest bulb yield was recorded at 25cm, which was statistically similar to 20cm. This may be attributed to the quantity of the bulb per plot in closer spacing, which is reflected in the yield.

3.2.4. Average Bulb Diameter (cm)

The average bulb diameter per plant was significant (P=0.001) differences between intra-row spacing during the 2020 dry season. This finding agrees with the results of [6, 9, 13]. The maximum bulb diameter was recorded at a wider spacing of 25cm (7.3cm). This may be due to little or no competition between the plants in wider spacing. While 20cm produced a bulb size of (6. 7cm) and a medium intra-row spacing of 15cm recorded (6.5cm), a similar report was confirmed by Hailu (2019). The smallest bulb diameters were recorded by closer spacing (5.5cm.).

3.2.5. Bulb Weight per Plant (g)

Results presented in Table 3 revealed that there were significant (P=0.001) differences observed amongst intra-row spacing in total bulb yield per hectare. This current finding was in connection with the findings of [3, 4, 13, 15]. However, intra-row spacing is 25cm, significantly higher than other intra-row spacing. The lowest bulb weight was recorded at a closer spacing of 10cm, which is statistically similar to 20 and 15cm respectively. This may be attributed to the high competition taken between the plants at a closer spacing of 10cm than the wider spacing of 15cm, 20cm and 25cm respectively.

4. Conclusion

Based on the findings of this study, it can be concluded that intra-row spacing of 10cm produced a higher total onion bulb yield per hectare during the 2020 dry season compared to intra-row spacing of 15cm, 20cm, and 25cm respectively. The major constraint of onion production in the study area during the dry season is the absence of optimum intra-row spacing which, as a result of low yield, related to yield and yield

component 10cm and 15cm is the best intra-row spacing in the way of produced higher yield while the 25cm obtained larger bulb size. It can be recommended that 10cm and 15cm respectively are the best option.

Abbreviations

NARI	National Agricultural Research Institute
LSD	Least Significant Differences
ANOVA	Analysis of Variance
UNIDO	United Nation Industrial Development Organization
FAOSTAT	Food and Agriculture Organization Statistic
MT	Metric Tone
CV	Coefficient of Variation
T/H	Tons per Hectare
P VALUE	Probability Value

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Author Contributions

Adama M. Jallow: Conceptualization, Data Curation, Formal data analysis, Investigation, Methodology, Validation, Visualization, Writing- Original draft, Writing- review and Editing

Musa Janneh: Conceptualization, Data curation, Methodology, Investigation and Visualization

Ebou Sonko: Conceptualization, Data Curation, Methodology and Investigation

Conflicts of Interest

The authors declare no conflicts of interest.

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