



**EFFECT OF NITROGEN AND INTRA ROW SPACING ON YIELD AND
YIELD COMPONENTS OF ONION (*Allium cepa* L.) IN BAUCHI STATE NIGERIA**

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ABSTRACT

Field experiment was conducted at the Teaching and Research Farm, College of Agriculture Bauchi during the 2016 and 2017 dry seasons to determine the effect of different levels of nitrogen and intra row spacing on the growth and yield of onion. The treatments consisted of four different levels of nitrogen (0, 45, 90 and 135 kgN/ha) and intra row spacing (9, 13, 17 and 21cm) which were factorially combined and laid out in a randomized complete block design (RCBD) and replicated three times. The results of the experiment revealed that, nitrogen and intra row spacing as well as their interaction, significantly ($P < 0.01$) affected bulb diameter, individual bulb weight and total bulb yield per hectare. The application of nitrogen at 90 kgN/ha and 21cm intra row spacing significantly ($P < 0.01$) produced higher bulb diameter, individual bulb weight, bulb yield and cured bulb of onion in the study area. Therefore, based on the findings of this experiment, application of 90 kgN/ha with plants spaced at 21cm intra row spacing is recommended for the growers to improve onion production in the study area.

Keywords: Onion, Nitrogen, Spacing, Yield

INTRODUCTION

Onion (*Allium cepa* L.) is a bulb crop belonging to the genus *Allium* of the family *Alliaceae* (Singh *et al.*, 1998). To increase the yield of onion, emphasis must be given on adopting improved varieties, plant spacing, nutrients, proper irrigation scheduling and other cultural measures, (Hussaini *et al.*, 2000). Onion bulb consist of mainly thickened end bases of leaves attached to the bulb basal plate and varies in shape from flat to round. The leaves are long, cylindrical and hollow, often bluish or green in color with an average height from 20 – 60cm, it has a hollow root system. It is an important vegetable crop grown in most countries of the world (FAO, 2003). Onion is the most important bulb crop cultivated commercially in most parts of the world. The crop is grown for consumption both as green vegetable as well as matured bulb. Onion is considered as one of the most important vegetable crops produced on large scale in Nigeria and is of immense benefit due to its dieting and medicinal values (FAO, 2005). Generally, all plant parts of onion can be consumed by humans except perhaps the seed. Onion production is greatly influenced by cultivars and agronomic practices. Onion vary in size (small, medium, and large), color (white, yellow and red) and texture (fine or coarse). (Denton *et al.*, 1990). Varieties that are cultivated in the world include early grano, red globe which are found in India and granex in Philippines. Prema, Dayo, Adama red, Bombay red and Super yali red in West Africa. Yet the yield obtained by the farmers is low 15 t ha⁻¹ compared to Niger Republic 36 t ha⁻¹, South Africa 26 t ha⁻¹ Morocco 24.9 t ha⁻¹ and Egypt 30.5 t ha⁻¹ (FAO, 2006). Bombay red is the most widely grown onion variety under irrigation in the country due to its higher bulb yield and earliness. This variety is not suitable for production under rain fed as it easily rots in the field if encounters rain during maturity stage (Asif *et al.*, 1976). Yields up to 400 tons/ha for Bombay red were observed on farmer's fields in Nigeria. On the other hand, Adama red can produce good size bulbs only at plant spacing greater than 6cm. Most of the onion varieties are adapted to low and mid altitude areas. The ideal temperature for mother bulb production is 18°C - 24°C day and 10°C - 12°C night temperature. Inadequate N has been reported as major constraints to increased onion production in Nigeria (Samailla *et al.*, 2000). Nitrogen is essential to growth and yield of onion but excessively high doses cause delay in bulb maturity and encourages bolting, which is an undesirable characteristic. Application of 80-90 kg ha⁻¹ of Nitrogen has been reported to be adequate



for onion production (Halvorson *et al.*, 2002). Nitrogen nutrition can influence onion bulb development, flavor and bulb quality (Mesfin *et al.*, 2009). Spacing has effect on different varieties as their root and leaf growth habits differ (Ahmad *et al.*, 2002). Onion is one of the richest sources of flavonoids in the human diet and flavonoid consumption has been associated with a reduced risk of cancer, heart disease and diabetes. In addition, it is known for antibacterial, antiviral, anti-allergenic and anti-inflammatory potential (Muhammad *et al.*, 2001). The study was therefore carried out to determine the best nitrogen rate for the growth and yield of onion and to ascertain the most suitable spacing for the performance of onion in the study area.

MATERIALS AND METHODS

The Study Area

Field experiment was conducted at the Teaching and Research Farm, Bauchi State College of Agriculture Bauchi during the 2016 and 2017 dry season to determine the effect of different levels of nitrogen and intra row spacing on yield and yield components of onion. The site is located at 10° 17'N, 9° 47' E and 609.3m above sea level in the Northern Guinea Savanna Zone of Nigeria.

Land Preparation, Soil Sample Collection and Analysis

The land was cleared, ploughed to obtain a fine tilt. Basins were constructed to as plot. The soil sample were randomly taken from three different sampling points at each of the experimental site at the depth of 0 – 30cm using soil auger before and after the trial. The collected soil samples were air dried, ground and passed through 2mm mesh before subjected to laboratory analysis. Physical and chemical properties of the soil samples were determined using standard procedure as described by A.E.S. (1998), at the soil science laboratory of the Abubakar Tafawa Balewa University Bauchi.

Experimental Materials

The following material and farm implements were used during the period of the experiment which includes Urea (46%N), hoe, rope, measuring tape, Vernier caliper, meter rule, manual scale, and electronic compact scale, model BL 200.

Treatments and Experimental Design

The treatments consisted of four nitrogen levels (0, 45, 90 and 135 kg N ha⁻¹) and four intra-row spacing (9, 13, 17 and 21 cm) these were factorially combination and laid out in a randomized complete block design (RCBD) and replicated three times. Each replicate contained sixteen (16) plots, keeping the total number of plots to 48 and inter-row distance was maintained at 20cm. There were 20 rows in each plot respectively. There were 22, 15, 12 and 10 plants in each row with intra row spacing of 9, 13, 17 and 21 cm giving a total number of fourteen thousand one hundred and sixty plants (14160) plants in the experiment. Each plot size was 8m² (4m x 2m). Distance of 1m was allowed between replicates (Blocks) and 0.5m between plots which also served as drainage channel for irrigation.

Data Collection and Analysis

The first data was observed and recorded at 4 weeks after planting and subsequent were recorded at fortnight interval. Ten sampled plants were selected at random and tagged for data collection from each net plot area. The parameters recorded were fresh bulb yield, cured bulb yield, individual bulb weight and bulb diameter. All the Data collected were subjected to analysis of variance (ANOVA) to test the treatment effect for significance using SPSS version 23. Means were separated using Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Bulb Diameter

The result of the effects of nitrogen and intra row spacing on bulb diameter is presented in Table 1. The result indicated a significant difference among the treatments used throughout the study period. The also revealed that, application of 90 kg N/ha gave the highest bulb diameter of onion, followed by 135 kgN/ha and 45 kgN/ha of nitrogen. 0 kgN/ha of nitrogen gave the lowest bulb diameter of onion. The increase in bulb diameter is as a result of the role of nitrogen in promoting



vegetative growth which enable the plants to absorb other nutrients, water and photosynthesized more food resulting in formation of bigger bulbs. This agrees with the finding of Islam *et al.*, (1999).

Spacing significantly affected bulb diameter of onion. Highest bulb diameter was obtained by plants spaced at 21cm, followed by 17cm intra row spacing. This is because of the adequate space available that reduced plants competition over nutrients, water and light. 9cm intra row spacing produced the lowest bulb diameter which may be due to high rate of competition over nutrient, water and light as well as unavailability of space required by the plants to expand their bulbs (kolata *et al.*, 1994). On year effect, 2016 gave the highest bulb diameter of onion than 2017.

The result of interaction (Table 4) revealed that, application of 90 kgN/ha and 21cm intra row spacing gave the highest bulb diameter of onion while 0 kgN/ha and 9cm gave the lowest bulb diameter of onion. When intra row spacing and years were compared, 21cm at 2016 dry season gave the highest bulb diameter, 9cm at 2017 dry season gave the lowest bulb diameter. When nitrogen and years were compared, 90kgN/ha at 2016 dry season gave the highest bulb diameter of onion while 0kgN/ha at 2016 dry season gave the lowest bulb diameter of onion. When nitrogen, intra row spacing and years were compared, 21cm intra row spacing and 90kgN/ha at 2016 dry season gave the highest bulb diameter, followed by 90kgN/ha and 17cm intra row spacing at 2016 and 2017. 9cm intra row spacing and 0 kgN/ha at 2016 gave the lowest bulb diameter of onion.

Individual Bulb Weight

The result of the effects of nitrogen and intra row spacing on individual bulb weight is also presented in Table 1. The result revealed a significant difference among the treatments used throughout the study period. The result further showed that heavier bulbs were produced by the application of 90 kgN/ha, followed by 135kg N/ha and 45kgN/ha of nitrogen. 0 kgN/ha of nitrogen produced minimum individual bulb weight of onion. The significant increase in bulb diameter observed in this study could be due to the role of nitrogen in promoting vegetative growth which enable the plants to absorb other nutrients, water and photosynthesized more food resulting in formation of bigger bulbs. This agrees with the finding of Islam *et al.*, (1999).

Spacing on the other hand, significantly affected bulb diameter of onion. Highest individual bulb weight was obtained by plants spaced at 21cm, followed by 17cm intra row spacing. The highest bulb weight was produced by the wider spaced plants while the lowest was obtained from the narrowest spacing which could be attributed to the fact that plants had sufficient space to absorb nutrient and water from the soil and also expand their bulbs which also enable them to spread their leaves and capture sunlight resulting in vigorous and subsequent bigger bulbs. This result is in agreement with the finding of Denton *et al.*, (1990) who reported that percentage weight of small bulbs increased as intra row spacing decreased. On year effect, 2016 gave the highest individual bulb weight of onion than 2017.

The interactions (Table 5) were significant on individual bulb weight of onion. When nitrogen and intra row spacing levels were compared, Application of 90kgN/ha and 21cm intra row spacing gave the highest individual bulb weight of onion while 0kgN/ha and 9cm gave the lowest individual bulb weight of onion. When intra row spacing and years were compared, 21cm at 2016 dry season gave the highest individual bulb weight of onion, 9cm at 2017 dry season gave the lowest individual bulb weight. When nitrogen and years were compared, 90kgN/ha at 2016 dry season gave the highest individual bulb weight of onion while 0kgN/ha at 2016 dry season gave the lowest individual bulb weight of onion. When nitrogen, intra row spacing and years were compared, 21cm intra row spacing and 90kgN/ha at 2016 dry season gave the highest individual bulb weight of onion, followed by 90kgN/ha and 17cm intra row spacing at 2016 and 2017. 9cm intra row spacing and 0kgN/ha at 2016 gave the lowest individual bulb weight of onion.

Yield

Table 1 also presented result of the effects of nitrogen and intra row spacing on yield of onion. The result revealed a significant difference among the treatments used throughout the study period. The result further indicated that, yield of onion was significantly influenced by nitrogen. The yield of onion increased with increasing nitrogen up to 90 kgN/ha and 135 kgN/ha while the lowest yield was



recorded from 0 kgN/ha. The increased in yield of onion is due to the fact that nitrogen promote strong early vegetative growth, bulb formation and maintain bulb development (Shimelis *et al.*, 2003). The result also showed that, highest yield was obtained by plants spaced at 21cm, followed by 17cm intra row spacing, while the lowest yield was obtained from the narrowest spacing of 9cm. High planting densities usually results in less availability of soil nutrient, light and water which affect the bulb size, thereby reducing yield. This is in agreement with the finding of Tzeng *et al.*, (1992). On year effect, 2016 gave the highest yield of onion than 2017.

The result of interaction (Table 2) revealed that, application of 90 kgN/ha and 21cm intra row spacing gave the highest yield of onion while 0kgN/ha and 9cm gave the lowest yield of onion. When intra row spacing and years were compared, 21cm at 2016 dry season gave the highest yield of onion, 9cm at 2017 dry season gave the lowest yield of onion. When nitrogen and years were compared, 90kgN/ha at 2016 dry season gave the highest yield of onion while 0kgN/ha at 2016 dry season gave the lowest yield of onion. When nitrogen, intra row spacing and years were compared, 21cm intra row spacing and 90kgN/ha at 2016 dry season gave the highest yield of onion, followed by 90kgN/ha and 17cm intra row spacing at 2016 and 2017. 9cm intra row spacing and 0kgN/ha at 2016 and 2017 produced the minimum yield of onion.

Cured Bulb Yield

The result of the effects of nitrogen and intra row spacing on cured bulb yield is presented in Table 1. The result revealed a significant difference among the treatments used throughout the study period. The result further showed that, 90 kgN/ha gave the highest cured bulb yield of onion, followed by 135 kgN/ha and 45 kgN/ha. Control on the other hand, gave the lowest cured bulb yield of onion.

In terms of spacing however, highest cured bulb yield was obtained by plants spaced at 21cm, followed by 17cm intra row spacing. 9cm intra row spacing produced the lowest cured bulb yield of onion. On year effect, 2016 gave the highest cured bulb of onion than 2017.

The interactions result (Table 3) indicated that, 90 kgN/ha and 21cm intra row spacing gave the highest cured bulb of onion while 0kgN/ha and 9cm gave the lowest cured bulb of onion. When intra row spacing and years were compared, 21cm at 2016 dry season gave the highest cured bulb while 9cm at 2017 dry season gave the lowest cured bulb of onion. When nitrogen and years were compared, 90kgN/ha at 2016 dry season gave the highest cured bulb of onion while 0kgN/ha at 2016 dry season gave the lowest cured bulb of onion. When nitrogen, intra row spacing and years were compared, 21cm intra row spacing and 90kgN/ha at 2016 dry season gave the highest cured bulb, followed by 90kgN/ha and 17cm intra row spacing at 2016. 9cm intra row spacing and 0kgN/ha at 2016 gave the lowest cured bulb of onion.



Table 1. Effect of Nitrogen and Intra Row Spacing on Yield and Yield Components of Onion

Parameters				
Treatments	Bulb Diameter (cm)	Individual Bulb Weight (g)	Yield (kg/ha)	Cured Bulb(kg/ha)
Nitrogen (kg/ha)				
0	2.76 ^d	55.25 ^d	1.66 ^d	1.19 ^d
45	5.23 ^c	102.14 ^c	5.56 ^c	4.34 ^c
90	6.75 ^a	157.99 ^a	10.44 ^a	8.05 ^a
135	6.55 ^b	148.06 ^b	7.30 ^b	5.68 ^b
LS	**	**	**	**
SE	0.036	0.023	0.015	0.012
Spacing (cm)				
9	3.70 ^c	82.05 ^d	3.84 ^d	2.98 ^d
13	4.71 ^c	100.83 ^c	5.42 ^c	4.01 ^c
17	6.28 ^b	136.15 ^b	7.76 ^b	5.94 ^b
21	6.59 ^a	144.42 ^a	7.93 ^a	6.34 ^a
LS	**	**	**	**
SE	0.036	0.023	0.015	0.012
Year				
2017	5.90 ^a	128.63 ^a	7.07 ^a	5.04 ^a
2018	4.74 ^b	103.09 ^b	5.40 ^b	4.60 ^b
LS	**	**	**	**
SE	0.026	0.016	0.011	0.009
Interaction				
N x S	**	**	**	**
N x YEARS	**	**	**	**
S x YEARS	**	**	**	**
N x S x YEARS	**	**	**	**

Means followed by different letters within each column of the treatment are significantly different following Duncan Multiple Range Test (DMRT) LS = Level of significance ** = Significant at 1% level of significance.

Table 2. Interaction of Nitrogen and Intra Row Spacing on Yield of Onion

Spacing (cm)	Nitrogen (kg/ha)			
	0	45	90	135
9	1.15 ⁿ	3.86 ^k	4.21 ^j	6.15 ⁱ
13	1.42 ^m	4.14 ^j	9.60 ^c	6.53 ^h
17	2.04 ^l	6.83 ^g	14.25 ^a	7.90 ^c
21	2.00 ^l	7.40 ^f	13.70 ^b	8.63 ^d
LS		**		
SE		0.031		

Means followed by different letters within each column of the treatment are significantly different following Duncan Multiple Range Test (DMRT) LS = Level of significance ** Significant at 1% level of significance.

Table 3. Interaction of Nitrogen and Intra Row Spacing on Cured Bulb Yield of Onion

Spacing (cm)	Nitrogen (kg/ha)			
	0	45	90	135
9	0.81 ^m	2.65 ^k	3.76 ⁱ	4.68 ^h
13	0.93 ^m	3.00 ^j	6.85 ^d	5.27 ^g
17	1.50 ^l	5.68 ^f	10.83 ^a	5.74 ^f
21	1.53 ^l	6.02 ^e	10.75 ^b	7.05 ^c
LS		**		
SE		0.024		

Means followed by different letters within each column of the treatment are significantly different following Duncan Multiple Range Test (DMRT) LS = Level of significance ** Significant at 1% level of significance.

Table 4. Interaction of Nitrogen and Intra Row Spacing on Individual Bulb Weight of Onion

Spacing (cm)	Nitrogen (kg/ha)			
	0	45	90	135
9	42.13 ^p	71.81 ^l	101.14 ⁱ	113.18 ⁱ
13	49.08 ^o	88.03 ^k	139.56 ^c	126.63 ^g
17	63.42 ⁿ	115.03 ^h	196.10 ^a	170.05 ^d
21	66.36 ^m	133.68 ^f	195.19 ^b	182.44 ^c
LS		**		
SE		0.047		

Means followed by different letters within each column of the treatment are significantly different following Duncan Multiple Range Test (DMRT) LS = Level of significance ** Significant at 1% level of significance.

Table 5. Interaction of Nitrogen and Intra Row Spacing on Bulb Diameter of Onion

Spacing (cm)	Nitrogen (kg/ha)			
	0	45	90	135
9	1.96 ⁱ	3.63 ^h	4.44 ^j	4.78 ^f
13	2.16 ⁱ	4.44 ^g	6.22 ^c	6.01 ^c
17	3.45 ^h	6.08 ^e	8.09 ^a	7.50 ^c
21	3.47 ^h	6.75 ^d	8.23 ^a	7.92 ^b
LS		**		
SE		0.072		

Means followed by different letters within each column of the treatment are significantly different following Duncan Multiple Range Test (DMRT) LS = Level of significance ** Significant at 1% level of significance.

CONCLUSION AND RECOMMENDATION

In conclusion however, the application of 90 kgN/ha and intra row spacing of 21cm significantly increased yield and yield components of onion in the study area. Their interaction on the other hand gave better values for all the characters measured. Based on the result of this study, application of nitrogen at the rate of 90kgN/ha to onion spaced at 21cm intra row spacing should be used by onion farmers in the study area for increased yield.

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