



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

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ABSTRACT

Field experiment was conducted at the Teaching and Research Farm of Bauchi State 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 vegetative yield of onion. The treatments consisted of four levels of nitrogen (0, 45, 90 and 135kgN/ha) and intra row spacing (9, 13, 17 21cm), these were factorially combined to give 16 treatments combination and laid out in a randomized complete block design (RCBD) with three replications. Data were collected on number of leaves, plant height, leaf area index, crop growth rate and net assimilation rate. All data collected were subjected to analysis of variance (ANOVA) and duncan's multiple range test (DMRT) was adopted in separating the means. The results of the experiment revealed a significant ($P \leq 0.05$) difference among the treatments. The results further indicated that, nitrogen and intra row spacing as well as their interaction, significantly ($P \leq 0.01$) affected number of leaves, plant height, number of leaves, leaf area index, crop growth rate and net assimilation rate. The result also showed that, application of nitrogen at the rate of 90 kgN/ha and intra row spacing of 9cm significantly ($P \leq 0.05$) performed better than the other treatments and all the treatments were better than the control. Based on the findings of this experiment, application of 90 kgN/ha to onion spaced at 21cm intra row spacing is recommended for improved onion production in the study area.

Keywords: Growth, Vegetative, Intra, Row, Onion

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 (Mesfin *et al.*, 2009). 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 (Samaila *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 vegetative yield of onion and to ascertain the most suitable spacing for the performance of onion in the study area.

MATERIALS AND METHODS

Experimental Site

Field experiment was conducted at the Teaching and Research Farm of 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 the growth and vegetative yield 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 subjecting 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 factorial combination of four nitrogen levels (0, 45, 90 and 135kg N ha⁻¹) and four intra-row spacing (9, 13, 17 and 21 cm) 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 of the plots. The growth parameters recorded were plant height, number of leaves, leaf area, leaf area index, while net assimilation rate and crop growth rate were computed. 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

Plant Height

The results of effects of nitrogen and intra row spacing on plant height of onion is presented in Table 1. The results revealed a significant difference among the treatments throughout the study

period. The result further showed that, application of 90 kgN/ha significantly produced taller plants, followed by 135 kgN/ha. Control plot produced the shortest plants, this agrees with the finding of Ali *et al.*, (2007) who said that plant height increase with increased in nitrogen which could be attributed to the fact the nitrogen is an essential nutrient necessary for the stimulation of rapid vegetative growth because of importance in photosynthesis and formation of chlorophyll, amino acid and nucleic acid. Spacing on the other hand, 9cm intra row spacing produced taller plants while 21cm intra row spacing produced lower plants, this correlate positively with the finding of Mehla *et al.*, (2000) who reported that plant height showed an increase with decrease of spacing which could be due to intense competition between and within plants and their desire to reach for the essential of life (light energy). This result could be due to less available space in the narrowest spacing which discourage growth of lateral branches and favors plant to grow upward in competition for light. The interaction of nitrogen and spacing levels were significant at 6, 8, and 10 WAT in 2016 while in 2017 the interaction was significant at 6 and 10 WAT. 90kg/ha and 135kg/ha of nitrogen as well as 9cm and 13cm intra row spacing produced taller plants. This agrees with the finding of Moshileh (2001), who reported that abundant nitrogen assimilated by the plants result in rapid vegetative growth under increase competition.

Table 1: Effect of Nitrogen and Intra Row Spacing on Plant Height of Onion

Treatments	2016				2017			
	6WAT	8WAT	10WAT	AT HARVEST	6WAT	8WAT	10WAT	AT HARVEST
Plant height								
Nitrogen (kg/ha)								
0	22.71 ^d	25.33 ^d	33.73 ^d	40.37 ^d	25.09	34.76 ^b	39.46 ^b	43.95 ^c
45	27.13 ^b	30.90 ^c	46.43 ^c	46.43 ^c	24.54	39.43 ^a	41.11 ^a	47.20 ^b
90	28.10 ^a	33.27 ^a	61.69 ^a	66.84 ^a	24.67	41.94 ^a	41.94 ^a	51.37 ^a
135	25.99 ^c	33.01 ^b	58.88 ^b	60.34 ^b	24.18	40.93 ^a	40.98 ^a	49.79 ^a
LS	**	**	**	**	NS	**	*	**
SE (±)	0.110	0.073	0.842	1.879	0.618	1.286	0.478	0.673
Spacing (cm)								
9	30.31 ^a	34.50 ^a	53.42 ^a	56.45 ^a	28.07 ^a	44.18 ^a	44.18 ^a	52.45 ^a
13	26.66 ^b	31.92 ^b	52.24 ^a	52.24 ^{ab}	27.43 ^a	41.59 ^a	41.59 ^b	48.45 ^b
17	23.53 ^c	28.43 ^c	47.62 ^b	53.59 ^{ab}	21.48 ^b	36.02 ^b	39.37 ^c	46.29 ^c
21	23.42 ^c	27.67 ^d	47.44 ^b	49.19 ^b	21.51 ^b	37.27 ^b	38.28 ^c	45.11 ^c
LS	**	**	**	*	**	**	**	**
SE (±)	0.110	0.073	0.842	1.879	0.618	1.286	0.478	0.673
Interaction								
NXS	NS	NS	NS	NS	*	*	NS	*

Means followed by different letters within each column of the treatment are significantly different following Duncan Multiple Range Test (DMRT) * = Significant at 5% level of significance LS = Level of significance ** Significant at 1% level of significance. NS = Not significant

Number of Leaves

The results of effects of nitrogen and intra row spacing on number of leaves of onion is presented in Table 2. The results revealed a significant difference among the treatments throughout the study period. The result also showed that, application of nitrogen significantly increased the number of leaves of onion plants. Application of 135 kgN/ha and 90 kgN/ha gave the highest number of leaves, followed by 45kgN/ha, while 0kgN/ha gave the lowest number of leaves at all growth stages of the crop. This shows that nitrogen plays an important role in vegetative growth of onion and this corroborate with the finding of Muoneke (2003), who stated that the number of leaves increases with increase in nitrogen. Study on spacing indicated that, plant spacing had a significant effect on number of leaves of onion. Highest number of leaves were obtained in plant spaced at 21cm intra row spacing, followed by 17cm and 13cm intra row spacing. The minimal number of leaves were observed on plant spaced at 9cm intra row spacing which might be due to the competition among the plants to



achieve the required food for their growth. Ahmed *et al.*, (2013) reported that closed plant spacing produced minimum number of leaves of onion due to higher competition between the plants.

The interaction of nitrogen and spacing on number of leaves was not significant in 2016. In 2017, there was significant difference between the treatments at 8, 10WAT and at harvest. Nitrogen at the rate of 135kgN/ha and 90kgN/ha as well as spacing of 21cm and 17cm produced the highest number of leaves. Number of leaves per plant is an important parameter considering the highest performance of onion yield. The number of leaves produced by plants is directly proportional to the Photosynth ate produced, this is because leaves are the site photosynthetic activities of the crop

Table 2: Effect of Nitrogen and Intra Row Spacing on Number of Leaves of Onion

Treatments	2016				2017			
	6WAT	8WAT	10WAT	AT HARVEST	6WAT	8WAT	10WAT	AT HARVEST
Number of leaves								
Nitrogen (kg/ha)								
0	4.69 ^c	5.21 ^b	5.78 ^d	7.04 ^d	6.17	6.41 ^b	7.36 ^b	8.08 ^d
45	5.86 ^b	5.86 ^b	7.61 ^c	8.52 ^c	6.35	6.64 ^a	7.62 ^a	7.54 ^c
90	6.77 ^a	8.35 ^a	8.93 ^b	9.71 ^b	6.28	6.57 ^a	7.93 ^a	8.44 ^b
135	6.77 ^a	8.44 ^a	9.52 ^a	10.27 ^a	6.19	6.73 ^a	7.95 ^a	9.51 ^a
LS	**	**	**	**	NS	*	**	**
SE (±)	0.279	0.355	0.200	0.100	0.116	0.067	0.111	0.046
Spacing (cm)								
9	5.87	6.71	8.02	8.52 ^b	6.09 ^b	6.23 ^c	7.19 ^c	7.82 ^d
13	5.85	7.44	8.18	8.68 ^b	6.01 ^b	6.35 ^c	7.69 ^b	8.03 ^c
17	6.27	6.45	7.68	8.96 ^a	6.28 ^b	6.69 ^b	7.94 ^a	8.68 ^b
21	6.11	6.78	7.95	9.27 ^a	6.61 ^a	7.08 ^a	8.04 ^a	9.04 ^a
LS	NS	NS	NS	**	**	**	**	**
SE (±)	0.279	0.355	0.200	0.100	0.116	0.067	0.111	0.046
Interaction								
NXS	NS	NS	NS	NS	NS	**	**	**

Means followed by different letters within each column of the treatment are significantly different following Duncan Multiple Range Test (DMRT) * = Significant at 5% level of significance LS = Level of significance ** Significant at 1% level of significance. NS = Not significant.

Leaf Area Index

The results of effects of nitrogen and intra row spacing on leaf area index of onion is presented in Table 3. The results revealed a significant difference among the treatments throughout the study period. The result also showed that, application of 90 kgN/ha gave the highest leaf area index, followed by 135 kgN/ha and 45 kgN/ha while 0kgN/ha gave the lowest leaf area index. Nitrogen significantly increased leaf area index of onion both at 2016 and 2017. This agrees with the finding of Holvorson *et al.* (2002) who said that leaf area index increases with increasing nitrogen.

Spacing on the other hand, 9cm gave the highest leaf area index, followed by 13cm and 17cm intra row spacing while 21cm intra row spacing gave lowest leaf area index. Plant spacing significantly increased leaf index, this is in conformity with the finding of Hussaini *et al.*, (2000) who reported that closely spaced plants produced higher leaf area index than wider spaced plants. The result of interaction revealed that, 90kgN/ha and 9cm intra row spacing gave the highest leaf area index.

Table 3: Effect of Nitrogen and Intra RowSpacing on Leaf Area Index of Onion

Treatments	Leaf area index							
	2016				2017			
	6WAT	8WAT	10WAT	AT HARVEST	6WAT	8WAT	10WAT	AT HARVEST
Nitrogen (kg/ha)								
0	0.04 ^c	0.43 ^c	0.45 ^d	0.45 ^d	0.20	0.62 ^c	1.57 ^c	2.24 ^c
45	0.56 ^b	2.12 ^b	2.72 ^c	2.72 ^c	0.21	0.80 ^b	1.75 ^b	2.92 ^b
90	1.21 ^a	3.79 ^a	7.05 ^a	7.05 ^a	0.29	1.31 ^a	2.17 ^a	3.51 ^a
135	0.80 ^{ab}	3.74 ^a	5.47 ^b	5.47 ^b	0.29	1.20 ^a	1.83 ^b	2.92 ^b
LS	**	**	**	**	NS	**	**	**
SE (±)	0.141	0.195	0.344	0.344	0.052	0.050	0.062	0.049
Spacing (CM)								
9	1.13 ^a	4.01 ^a	5.64 ^a	5.64 ^a	0.85 ^a	1.56 ^a	2.82 ^a	4.14 ^a
13	0.88 ^a	2.70 ^b	4.38 ^b	4.38 ^b	0.66 ^b	1.03 ^b	2.07 ^b	3.87 ^b
17	0.38 ^b	1.92 ^c	3.44 ^b	3.44 ^b	0.43 ^b	0.56 ^d	1.33 ^c	2.18 ^c
21	0.22 ^b	1.45 ^c	2.23 ^c	2.23 ^c	0.40 ^b	0.77 ^c	1.11 ^d	1.90 ^d
LS	**	**	**	**	**	**	**	**
SE (±)	0.141	0.195	0.344	0.	0.052	0.050	0.062	0.049
Interaction								
NXS	**	**	**	**	**	**	**	**

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. NS = Not significant

Net assimilation rate

The results of effects of nitrogen and intra row spacing on net assimilation rate of onion is presented in Table 4. The results indicated a significant difference among the treatments throughout the study period. Application of 90kg N/kg/ha and 135 kgN/ha gave the highest net assimilation rate statistically followed by 45 kgN/ha, while control gave the minimal net assimilation rate, this agrees with the finding of Samaila *et al.*, (2000) who reported that net assimilation rate increases with increase in nitrogen.

Plant spacing on the other hand, significantly affected net assimilation rate. 21cm intra row spacing gave the highest net assimilation rate, followed by 17cm and 13cm intra row spacing. 9cm intra row spacing gave the lowest net assimilation rate, this correlate positively with the finding of *et al.*, (2007) who said that wider spacing gave the highest net assimilation while the narrower spacing gave the minimum net assimilation rate which could be due to competition among plants to achieve the required for their growth.

The interaction of nitrogen and intra row spacing levels were significant at 6 and 8 WAT in 2016. In 2017 the interaction effect was significant through the period of the experiment. 90kgN/ha and 21cm intra row spacing gave the highest net assimilation rate.

Table 4: Effect of Nitrogen and Intra Row Spacing on Net Assimilation Rate of Onion

Treatments	Net assimilation rate							
	2016				2017			
	6WAT	8WAT	10WAT	AT Harvest	6WAT	8WAT	10WAT	AT Harvest
Nitrogen (kg/ha)								
0	0.26 ^d	0.22 ^b	0.10 ^b	0.10 ^c	0.39 ^d	0.18 ^d	0.13 ^c	0.12 ^b
45	0.57 ^c	0.27 ^c	0.11 ^b	0.10 ^c	0.57 ^c	0.21 ^c	0.13 ^c	0.13 ^b
90	0.60 ^a	0.43 ^a	0.14 ^a	0.16 ^a	0.81 ^a	0.35 ^a	0.21 ^a	0.18 ^a
135	0.59 ^b	0.32 ^b	0.10 ^b	0.13 ^b	0.69 ^b	0.29 ^b	0.18 ^b	0.16 ^a
LS	**	**	**	**	**	**	**	**
SE (±)	0.001	0.001	0.005	0.004	0.004	0.008	0.002	0.002
Spacing (cm)								
9	0.42 ^d	0.24 ^d	0.11 ^{ab}	0.12	0.54 ^c	0.22 ^b	0.14 ^d	0.13 ^b
13	0.47 ^c	0.30 ^c	0.11 ^{ab}	0.12	0.66 ^a	0.28 ^a	0.16 ^b	0.14 ^{ab}
17	0.56 ^b	0.33 ^b	0.12 ^a	0.12	0.60 ^b	0.26 ^a	0.15 ^c	0.14 ^{ab}
21	0.57 ^a	0.37 ^a	0.12 ^a	0.13	0.66 ^a	0.28 ^a	0.17 ^a	0.17 ^a
LS	**	**	**	NS	**	**	**	*
SE (±)	0.001	0.001	0.005	0.004	0.004	0.008	0.002	0.002
Interaction								
NXS	**	**	NS	NS	**	**	**	**

Means followed by different letters within each column of the treatment are significantly different following Duncan Multiple Range Test (DMRT) * = Significant at 5% level of significance LS = Level of significance ** Significant at 1% level of significance. NS = Not significant

Crop growth rate

Table 5 presented results of the effects of nitrogen and intra row spacing on crop growth rate of onion. The results indicated a significant difference among the treatments throughout the study period. The result showed that, application of 90 kgN/kg/ha gave the highest crop growth rate, followed by 135 kgN/ha and 45 kgN/ha, while the least crop growth rate was obtained under control plot. The result of this findings agrees with the finding of Samaila *et al.*, (2000) who reported that crop growth rate increases with increase in nitrogen.

Plant spacing significantly affected crop growth rate where 21cm intra row spacing gave the highest crop growth rate, followed by 17cm and 13cm intra row spacing. 9cm intra row spacing gave the lowest crop growth rate, this correlate positively with the finding of Umar *et al.*, (2003) who said that wider spacing gave the highest crop growth rate while the narrower spacing gave the minimum crop growth rate which could be due to competition among plants to achieve the required food for their growth. Result of the interaction showed that, 90kgN/ha and 21cm intra row spacing gave the highest crop growth rate in both years under study.



Table 5: Effect of Nitrogen and Intra Row Spacing on Crop Growth Rate of Onion

Treatments	Crop growth rate							
	2016				2017			
Harvest	6WAT	8WAT	10WAT	AT HarvestT	6WAT	8WAT	10WAT	AT
Nitrogen (kg/ha)								
0	0.15 ^d	0.32 ^b	0.32 ^c	0.32 ^d	0.12 ^c	0.32 ^d	0.39 ^d	0.79 ^b
45	0.23 ^b	0.46 ^a	0.49 ^b	0.68 ^b	0.41 ^b	0.44 ^c	0.55 ^c	0.74 ^b
90	0.27 ^a	0.47 ^a	0.58 ^a	1.06 ^a	0.61 ^a	0.68 ^b	0.72 ^a	0.89 ^a
135	0.22 ^c	0.28 ^c	0.28 ^d	0.51 ^c	0.62 ^a	0.69 ^a	0.70 ^b	0.80 ^b
LS	**	**	**	**	**	**	**	**
SE (±)	0.001	0.004	0.001	0.001	0.029	0.001	0.003	0.022
Spacing (cm)								
9	0.19 ^d	0.33 ^d	0.32 ^d	0.53 ^d	0.36 ^b	0.40 ^c	0.42 ^d	0.55 ^d
13	0.20 ^c	0.40 ^b	0.39 ^c	0.62 ^c	0.36 ^b	0.42 ^c	0.47 ^c	0.64 ^c
17	0.23 ^b	0.37 ^c	0.42 ^b	0.64 ^b	0.54 ^a	0.61 ^b	0.68 ^b	0.85 ^b
21	0.25 ^a	0.42 ^a	0.49 ^a	0.85 ^a	0.60 ^a	0.76 ^a	0.80 ^a	1.18 ^a
LS	**	**	**	**	**	**	**	**
SE (±)	0.001	0.004	0.001	0.001	0.029	0.001	0.00	0.022
Interaction								
NXS	**	**	**	**	**	**	**	**

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 6: Effect of Nitrogen and Intra Row Spacing on Vegetative Yield of Onion

Treatments	Vegetative Yield (kg/ha)
Nitrogen (kg/ha)	
0	0.20 ^d
45	0.28 ^c
90	0.79 ^a
135	0.70 ^b
LS	**
SE (±)	0.070
Spacing (cm)	
9	0.28 ^d
13	0.33 ^c
17	0.67 ^b
21	0.75 ^a
LS	**
SE (±)	0.070
Year	
2016	0.43 ^a
2017	0.35 ^b
0.	
LS	**
SE (±)	0.016
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.



CONCLUSION AND RECOMMENDATION

In conclusion, the application 90kgN/ha of nitrogen and intra row spacing of 21cm significantly increased growth and vegetative yield of onion in the study area. Based on the results of this study, application of nitrogen at the rate of 90 kgN/ha to onion grown with 21cm intra row spacing is recommended and should be used by onion farmers in the study area.

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