



## Effect of irrigation frequency on growth and yield of onion (*Allium Cepa* L.) in Bunza Kebbi State

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### Abstract

Field trial was conducted at Kebbi Agricultural and Rural Development Fadama Farm Bunza, Kebbi State (Latitude 12<sup>00</sup> and Longitude 04<sup>00</sup>E and 177 m above sea level) during 2012/2013 dry season to study the effect of irrigation interval and nitrogen rates on growth and bulb yield of onion. The treatments consisted of four of irrigation intervals (3, 5, 7 and 9 days) and four levels of nitrogen rate (0, 50, 100 and 150 kgNha<sup>-1</sup>). The treatments were factorially combined and laid out in a randomized complete block design, replicated three times. Results obtained indicated that, 3 days irrigation interval consistently had the highest number of leaves, bulb weight, bulb diameter and bulb yield. While, the highest mean values for growth and yield components were recorded in plot treated with Nitrogen at 100 kgNha<sup>-1</sup> and the control had the least mean values. In conclusion the application of 100 kgNha<sup>-1</sup> along with days irrigation interval is suitable for onion production in the study area.

**Keywords:** Field trial, irrigation interval, nitrogen rates, onion growth, Kebbi state

### Introduction

Onion (*Allium Cepa* L.) belongs to Alliaceae family (Kocchar, 1986). It is believed to have originated in central Asia (Fritsch and Friesen, 2002) [6]. Onion plant is a biennial crop that is grown as an annual. It has a long hollow or cylindrical leaves with widening ring and overlapping base. On top of the long stalks, greenish white flowers are present in the form of solitary umbels growing to 2.5cm wide. It requires a land with optimum soil pH of 6.0-7.0 with good tilt and high moisture content. It is grown on a wide range of climatic conditions, but thrives best in a mild climate without excessive rainfall or extremes of temperature (Boukary *et al.*, 2012). Onion requires soils with mild acid to neutral reaction (pH 6-7) and high soil moisture content for good yield (Gambo *et al.*, 2008) [7]. Globally, it is estimated that, over 3.6 hectares are devoted to onion production with an annual production yield of about 82,851,732 metric tons, Food and Agriculture Organization Statistics (2022). China ranked first in onion production with production output of 22,600,000 metric tons followed by India (16,308, 990) and United States (3,277,460) respectively. In Africa, Niger is the largest onion producer with an annual output of 1,350,000 metric tons followed by Nigeria with 1,183,268 (FAOSTAT, 2012) [5]. Inadequate mineral nutrition has been reported as one of the major constraints for increased crop yield. The yield of onions in this agro ecology is not comparable with those obtained in other countries. This low yield could be attributed to depletion of soil fertility and multiple nutrient deficiencies in onion fields as stressed by Sharma *et al* (2003) [12]. Similarly, Haris (2006) [8] and Been *et al* (2012) [4] reported that poor soil fertility is the main constraint affecting the crop's production in tropical region and therefore result in low yield. Additional reasons for low yield may be attributed to other factors such as moisture stress and good knowledge of irrigation scheduling for the crop (Miko *et al.*, 2000) [10]. Nitrogen has to be judiciously applied to crop, as over fertilization leads to waste of resources and also enhances vegetative growth at the expense of reproductive

phase. Water (moisture) is another limiting factor necessary for onion production. Onion root are found within the first 20-25cm of the soil profile as a result of it having fibrous and shallow root system. The roots therefore do not go deeper in search of water. For this reason, the crop requires efficient irrigation scheduling so as to avoid water stress, there by leading to significant yield reduction (Ahmed, 2006) [2]. On the contrary however, too much irrigation may lead to leaching of nutrients and where adequate drainage is lacking this could cause water table to rise which can limit the potential productivity of the crop. As a result of these and other reasons, it is therefore necessary to determine appropriate irrigation interval or schedule for the crop.

### Materials and methods

Field trials were carried out during the 2019/2020 and 2020/2021 dry season under irrigation at Kebbi Agricultural and Rural Development Authority, Fadama Farm (latitude 1200041N longitude 040001E and 177m above sea level). To determine the effect of irrigation frequency and nitrogen levels on growth and yield of onion. The treatments consisted of factorial combinations of four irrigation intervals (3,5,7 and 9 days) and four nitrogen rates (0, 50,100 and 150kgNha-1). This were laid out in a Randomized Complete Block Design with three replications. The experimental area was harrowed to a fine tilth. After that, the land was divided into plots and replications. There was also 0.5m border spaces between plots and 1m between replicates. The onion seedlings were transplanted and a spacing of 15 cm x 20 cm. Weeding was done at 3 and 6 WAS. Harvesting was carried out by hand pulling. The plants were carefully removed at a time when over 50% of the plants turn yellow. Data on number of leaves, bulb diameter, bulb weight, and bulb yield were recorded. Data collected were subjected to Analysis of Variance (ANOVA) SAS software. The DNMT was used to compare the treatment means that are significant at (0.05%).

**Results**

**1. Number of leaves per plant**

Results on number of leaf of onion at 3, 6, 9 and 12 WAT as affected by irrigation interval and nitrogen rates during 2019/2020 and 2020/2021 dry season are presented in Table 1. Mean number of leaf per plant of onion was significantly ( $P<0.05$ ) affected by irrigation interval at various growth stages considered except at 3 and 12 WAT only in 2013/14. In 2019/2020 season, 3- and 5-days irrigation interval recorded the highest number of leaves per plant than 5- and 9-days irrigation interval and was at par with 7 days irrigation interval at 9 and 12 weeks after transplanting (WAT). In 2020/2021, 3-day irrigation interval recorded the highest number of leaves at 6 and 9 weeks after transplanting (WAT) and is per both 5 and 9 day irrigation intervals. The least is at 7 day irrigation interval. Nitrogen application did show any significant difference in 2019/2020 season. In the 2020/2021 however, significant difference was observed at 9 and 12 weeks after transplanting (WAT). Result showed that 100 kgNha-1 had significantly higher number of leaves than all other treatment. At 12WAT, however, the 100kgNha-1 was at par with 50kgNha-1 and the control. and differed significantly with 150 kgNha-1 in 2019/2020 season.

**2. Bulb weight (g)**

Bulb weight as influenced by irrigation interval and nitrogen during 2019/2020 and 2020/2021 and the combined was presented in table 3. The results of the study revealed that irrigation interval had significant effect on bulb weight in both seasons and the combined. Bulb weight decrease as irrigation interval increase in both seasons and the combined. In 2019/2020 season three-day irrigation interval resulted in significantly heavier bulb than 9-day irrigation interval. This also at par with 5 and 7 day irrigation interval. Similarly, in 2019/2020 season 3 day irrigation interval recorded heavier bulb weight than 5, 7 and 9 days irrigations interval all of which were statistically at par. Similar result was observed in the combined where 3 days irrigation interval recorded significantly heavier bulb weight than all other of the irrigation intervals (Table 3). Influence of nitrogen application on onion bulb weight was not significant in both seasons. However, in the combined, significant difference was observed. The results revealed that 100 kgNha-1 had heavier bulb weight than control, and was at par with 50 and 150 kgNha-1.

**3. Bulb diameter (cm)**

Bulb diameter as affected by irrigation interval and nitrogen rates in 2019/2020 and 2020/2021 and the combined season are presented in Table 3. Results revealed a significant effect of irrigation on bulb diameter in both season and the combined. In 2019/2020 season, 3 days irrigation interval resulted in larger bulb size than either 5 and 9 days irrigation intervals. This is at par 7 days irrigation interval. In the 2020/2021 season, 3 days irrigation interval still recorded the largest bulb diameter and is at par 5 with days irrigation interval. The least bulb diameter was obtained with 7 and 9 days irrigation intervals. All of which were statistical at par. In the combined season, the 3 day irrigation interval still recorded the largest bulb size than all other irrigation intervals. Nitrogen application had

influenced bulb diameter in 2019/2020 and 2020/2021 and the combined. The results revealed that largest bulb size were obtained with 100kgNha-1 in 2019/2020 season. This is also at par with 50 and 150 kgNha-1 treatment. The least bulb diameter was recorded with 0kgNha-1. Similar trend observed in 2020/2021 season. In the combined, however 100 kgNha-1 recorded the largest bulb diameter than all other treatments. The interaction was found to be not significant in the study.

**4. Bulb Yield (tha-1)**

Result on bulb yield of onion as affected by irrigation interval and nitrogen rates during 2019/2020 and 2020/2021 dry season and combined is presented in Table 4. Significant effect ( $p<0.05$ ) of irrigation interval on bulb yield was obtained in both seasons and combined. In 2019/2020 season, the highest yield was obtained in 3 days irrigation interval. This is followed by 7 days irrigation interval and is statistically at par 5 days irrigation interval. The least yield was obtained when onion was irrigated at 9 days interval. In 2020/2021 season, 3 and 5 days irrigation interval recorded the highest bulb yield. This is also at par with 7 days irrigation interval. The 9 days irrigation interval however recorded the least bulb yield. Similar trend were observed in the combined where 3 days irrigation interval recorded highest bulb yield than 5 and 7 days irrigation interval which were statistically similar. While the least yield was with 9 day irrigation interval. Effect of nitrogen on bulb yield of onion was found to be significant in both seasons and the combined. In 2019/2020 season, the 100 and 150 kgNha-1 treatment recorded the highest bulb yield. This is statistically at per 50 kgNha-1. The least yield was obtained from the control treatment. In 2020/2021 season, highest bulb yield were also obtained from 100 and 150 kgNha-1 treatment. This were followed by 0 and 50 kgNha-1 which were statistical. Similar trend was also observed in the combined. The control treatment produces the lowest bulb yield. There was no significant irrigation and Nitrogen interaction observed in this trial

**Table 1:** Number of leaves at 3, 6, 9 and 12 weak after transplanting (WAT) as affected by irrigation interval and Nitrogen rates during 2019/2020 and 2020/2021 dry season at Kebbi Agricultural and Rural Development Authority, Fadama Farm, Bunza

Weeks after transplanting (WAT)								
2019/2020 2020/2021								
Treatment	3	6	9	12	3	6	9	12
Irrigation Interval (days)								
3	6.79 <sup>a</sup>	7.36 <sup>a</sup>	8.17 <sup>a</sup>	8.63 <sup>a</sup>	6.40	8.92 <sup>a</sup>	10.24 <sup>a</sup>	10.50
5	6.21 <sup>b</sup>	6.81 <sup>b</sup>	7.50 <sup>b</sup>	7.90 <sup>b</sup>	6.25	8.29 <sup>ab</sup>	9.15 <sup>ab</sup>	9.73
7	5.88 <sup>bc</sup>	6.60 <sup>b</sup>	7.65 <sup>ab</sup>	8.04 <sup>ab</sup>	5.73	7.75 <sup>b</sup>	8.61 <sup>b</sup>	9.35
9	5.63 <sup>c</sup>	6.39 <sup>b</sup>	7.22 <sup>b</sup>	7.50 <sup>b</sup>	6.19	8.46 <sup>ab</sup>	9.38 <sup>ab</sup>	10.04
SE±	0.190	0.176	0.204	0.208	0.219	0.369	0.363	0.433
Nitrogen (kg ha <sup>-1</sup> )								
0	6.02	6.65	7.53	7.71	5.81	8.13	8.90 <sup>b</sup>	9.86 <sup>ab</sup>
50	6.27	6.81	7.81	8.15	6.31	8.27	9.16 <sup>b</sup>	9.71 <sup>ab</sup>
100	6.10	6.88	7.58	8.15	6.35	8.75	10.35 <sup>a</sup>	10.71 <sup>a</sup>
150	6.10	6.84	7.61	8.06	6.08	8.27	8.96 <sup>b</sup>	9.33 <sup>b</sup>
SE±	0.190	0.176	0.204	0.208	0.219	0.369	0.363	0.433

Means in a column followed by same letter(s) are not significantly different at 5% level of significance using New Multiple Range Test (DNMRT). ns= not significant

**Table 2:** Bulb weight (g) of onion as affected by irrigation interval and ni trogen rates during 2019/2020 and 2020/2021 dry season and combined at Kebbi Agricultural and Rural Development Fadama farm, Bunza

Treatment	2019/2020	2020/2021	Combined
<b>Irrigation Interval (days)</b>			
3	80.00 <sup>a</sup>	81.67 <sup>a</sup>	80.83 <sup>a</sup>
5	63.3 <sup>ab</sup>	63.33 <sup>ab</sup>	63.33 <sup>b</sup>
7	77.50 <sup>ab</sup>	52.50 <sup>b</sup>	65.00 <sup>b</sup>
9	50.83 <sup>b</sup>	61.67 <sup>b</sup>	54.20 <sup>b</sup>
SE±	9.206	6.279	5.690
<b>Nitrogen (kg ha<sup>-1</sup>)</b>			
0	55.83	54.17	55.00 <sup>b</sup>
50	60.83	65.83	63.33 <sup>ab</sup>
100	83.33	70.83	77.08 <sup>a</sup>
150	71.67	63.33	67.95 <sup>ab</sup>
SE±	9.206	6.279	5.690

Mean in a column followed by same letter(s) are not significantly different at 5% level of significance using Duncan New Multiple Range Test (DNMRT). ns= not significant

**Table 3:** Bulb diameter as affected by irrigation interval and nitrogen rate in 2019/2020 and 2020/2021 dry season and combined at Kebbi Agricultural and Rural Development Fadama farm, Bunza

<b>Bulb diameter (cm)</b>			
Treatment	2019/2020	2020/2021	Combined
<b>Irrigation Interval (days)</b>			
3	6.53 <sup>a</sup>	5.48 <sup>a</sup>	6.00 <sup>a</sup>
5	5.48 <sup>b</sup>	5.12 <sup>ab</sup>	5.29 <sup>b</sup>
7	5.86 <sup>ab</sup>	4.58 <sup>c</sup>	5.22 <sup>b</sup>
9	4.93 <sup>b</sup>	4.71 <sup>bc</sup>	4.82 <sup>b</sup>
SE±	0.313	0.144	0.175
<b>Nitrogen (kg ha<sup>-1</sup>)</b>			
0	5.14 <sup>b</sup>	4.66 <sup>b</sup>	4.89 <sup>b</sup>
50	5.61 <sup>ab</sup>	5.09 <sup>ab</sup>	5.35 <sup>b</sup>
100	6.40 <sup>a</sup>	5.28 <sup>a</sup>	5.84 <sup>a</sup>
150	5.66 <sup>ab</sup>	4.87 <sup>ab</sup>	5.26 <sup>b</sup>
SE±	0.313	0.144	0.175

Means in column followed by same letter(s) are not significantly different at 5% level of probability using Duncan New Multiple Range Test (DNMRT)

**Table 4:** Bulb yield as affected by irrigation interval and nitrogen rate in 2019/2020 and 2020/2021 dry season and combined at Kebbi Agricultural and Rural Development Fadama farm, Bunza

<b>Yield (t / (ha<sup>-1</sup>))</b>			
Treatment	2019/2020	2020/2021	Combined
<b>Irrigation Interval (days)</b>			
3	24.54 <sup>a</sup>	22.39 <sup>a</sup>	23.35 <sup>a</sup>
5	18.72 <sup>bc</sup>	21.39 <sup>a</sup>	20.05 <sup>b</sup>
7	19.08 <sup>b</sup>	18.27 <sup>ab</sup>	18.67 <sup>b</sup>
9	15.66 <sup>c</sup>	14.98 <sup>b</sup>	15.32 <sup>c</sup>
SE±	1.095	1.319	0.869
<b>Nitrogen (kg ha<sup>-1</sup>)</b>			
0	16.89 <sup>b</sup>	14.54 <sup>b</sup>	15.67 <sup>c</sup>
50	18.83 <sup>ab</sup>	17.45 <sup>b</sup>	18.14 <sup>b</sup>
100	21.20 <sup>a</sup>	21.92 <sup>a</sup>	21.56 <sup>a</sup>
150	21.16 <sup>a</sup>	22.88 <sup>a</sup>	22.02 <sup>a</sup>
SE±	1.095	1.319	0.869

Means in columns followed by same letter(s) are not statistically different at 5% level of probability using Duncan New Multiple Range Test (DNMRT)

**Discussion**

Effect of irrigation interval on growth and yield of onion  
 The significant effect of 3 and 5 days’ irrigation intervals in both seasons in having onion with higher number of leaves is largely due to the fact that 3 and 5 days’ irrigation interval had positive effect on onion production in this agro ecology. The soil of the area where onion is grown is sandy loam, high temperature coupled with high wind speed during the vegetative growth led to high evaporative demand on soil leading to high capillary rise of soil moisture which result in moisture loss on upper soil horizon where onion roots are found. This affects nutrients and available moisture in the root zone. The nutrients availability is high and plant does not suffer from moisture stress these period of growth and development. This result corroborates with findings of Abby and Joyce (2004) [1], in which they reported significantly high number of leaves with irrigation near field capacity. Ahmed *et al.*, (2007) also reported that 3 days irrigation interval had significantly more number of leaves compared to other irrigation intervals in garlic. Bulb weight were observed to be highest with 3 days irrigation interval. This was directly connected with positive effect of adequate water supply essential for vital plant processes such as cell division, enlargement, photosynthesis and nutrients absorption. Thus affecting growth characters and yields. This result was in conformity with what was reported by Bagali *et al.*, (2012). They reported that increase in bulb weight and yield were attributed to shorter irrigation interval. Onion bulb yield were highest in with 3 day irrigation interval in both seasons and the combined. Increase in bulb size (diameter) and yield of onion could be mainly the result of positive association between yield and yield contributing factors like bulb weight and size as reported by Bagali *et al.*, (2012). The lowest yield observed with 9 days irrigation interval could be the result of long period of water stress which negatively affected nutrient supply for the crop to maintain growth and yield attributes.

**Effect of Nitrogen on growth and yield of onion**

Number of leaves per plants at different growth stages were investigated in these trials. In both seasons the number of leaves per plant increase with nitrogen fertilization. Increase in number of leaves by nitrogen fertilization may be due to the fact that nitrogen is a constituent of many fundamental cell components and it play a vital role in all living tissue of the plant. Many researchers reported significant increase in number of leaves with nitrogen application. This result is in agreement with the findings of Aliyu *et al.*, (2007) [3] reported significant increase in number of leaves (12.52) with application of 100kgNha-1. The significant Increase in bulb weight of onion in the combined data by nitrogen fertilization could be attributed to general increase in vegetative growth parameters of onion plant which affect yield attribute. This finding was in conformity with what was reported by Yaso *et al.*, (2007) [13], they reported that increase mineral nitrogen level led to significant increase in bulb weight and total bulb yield. Bulb size (diameter) evaluated for this studies were highest with application of 100 kgNha-1in both seasons and combined data. On the other hand, smaller bulb diameter was obtained where no nitrogen (control) was applied. This could be linked to the fact that nitrogen generally increase all vegetable growth parameters of onion which significantly increase the yield attribute such as bulb weight and size. This is in conformity

with Ghaffooret *al* (2003) and Aliyu (2006) where they reported that largest bulb size was obtained with application of 100 and 150 kgNha-1. Bulb yield investigated in this study were highest with 100 and 150 kgNha-1 in both season and the combined. Increased in bulb yield with the application of N fertilizer could be due to the fact that nitrogen increase the rate of metabolism where more carbohydrate is synthesized which increase the bulb weight and then yield. This result was in agreement with findings of Agumas *et al.*, (2014) and Meen *et al.*, (2014) <sup>[9]</sup> who reported, that onion is associated with efficient source and sink relationship leading to higher productivity.

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