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EFFECT OF IRRIGATION INTERVALS ON THE GROWTH AND YIELD OF ONION (*Allium cepa L.*) IN MAIDUGURI SUDAN SAVANNA OF NIGERIA

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Abstract
Field experiment was conducted during dry season of 2018/2019 at the Teaching and Research Farm Faculty of Agriculture, University of Maiduguri to determine the effect of irrigation intervals on growth and yield of onion (Allium cepa). The experiment was laid out in a Randomized Complete Block Design (RCBD), with treatments allocated to the plots as 1, 2, 3 and 4 days irrigation intervals replicated three times. Agronomic parametrs collected includes; plant height, number of leaves per plant, bulb diameter, bulb weight and total yield respectively. Results showed that, two days irrigation interval produced the taller plant and number of leaves at 2, 4, 6 and 8 weeks after transplanting (WAT). Similarly, greater bulb diameter and bulb weight were higher at 2 days irrigation interval. 4 days irrigation intervals produced the lower growth, development and yield components than 1 or 3 days irrigation interval.

***Key words**: Irrigation, Interval, Onion, Days, Allium*

Introduction
The onion (*Allium cepa L.*) was derived from the Latin word ('cepa'=onion). It belong to the kingdom; plantae, Family; Amaryllidaceae, Sub family; Allioidae, Order; Asparagales, Genus; *Allium.* The onion plant also known as bulb is the most widely cultivated species of the genus *Allium*. It was first officially described by Carl Linnaeus in his 1753 work speaks plantarum. Based on the level of consumption, onion is the major spice in the diet, ranking 5th most important vegetable in Nigeria (Denton and Ejeifo, 1990).The main production period of onion in Nigeria is during the dry season between Septembers to April. The crop is produced in dry areas in the northern part of the country, and three crops are

possible in a year, two rain fed and irrigated (Anonymous, 1993). The most important limiting factors determining onion growth and yield in the drier areas is the time of irrigation are the amount to applied is the major constants to onion production in the Sudan savanna of Maiduguri (Brown, 1984). On irrigated land, the onion crop is regarded as a fairly large consumer of water. Onion under water deficiency decreases in its evapotranspiration and consequently reduced growth yield components (Sammis *et al*., 2000). The objective of this study is to determined suitable irrigation intervals for better growth, development, yield and yield components of onion in Maiduguri.

All plants need water to grow and produce good yields. According to (Brown,1984), When plants are water stressed they close their stomata and cannot photosynthesize effectively. Best growth can be achieved only if plants have a suitable balance of water and air in their root zones. Bakele and Tilahun (2007), some stages in the growth of crop are particularly sensitive to moisture stress. Water shortages sufficient to hinder crop growth can occur without producing obvious wilting of foliage, while water logging can cause large yield reduction too. (Hedge,1986),The grower must therefore rely on some other method determining the water needs of the crops to avoid production or quality losses. This requires an understanding of the movement and storage of water in the root zone of the crop and the rate of water use by the crop.

Therefore keeping irrigation interval above six days has greatly deprived the plant the available water for optimum photosynthesis, hence less dry matter was partitioned to bulbs, which might have resulted in size of the bulbs (Brown, 1984). Thabet *et al*. (1994) indicated that the number of leaves increased by increasing irrigation. Al-Moshileh (2003), reported that soil water quantity improved plant growth parameters and total yield while marketable yield was reduced. Olalla *et al.,* (2004) in drip irrigation experiment reported that lower volume of water received, the higher the efficiency obtained. Kadayifci *et al*., (2005) reported that bulb and dry matter production were highly dependent on appropriate water supply.

Bekele and Tilahun (2007) observed that, water deficit at first and fourth stages had insignificantly effect on yield as compared to optimum application. If the water deficit is in the second and third growth stages, or during all stages as 25% Etc, and 75% Etc water deficit, the yield were significantly different from optimal irrigation. All deficit levels increased the water use efficiency of onion from a Minimum of 6% by stressing the crop. Irrigation scheduling involves preventing the soil water deficit from falling below some threshold level for a particular crop and soil condition. This may involve estimating the earliest date to permit

efficient irrigation or the latest date to avoid the detrimental effects of water stress on the crop. Scheduling water application is very critical to make the most of efficient use of drip irrigation system, as excessive irrigation reduces yield, while inadequate irrigation causes water stress and reduces production. In onion, water is the main limiting factor for low productivity. Hence, judicious use of water is very essential. One aim of irrigation is to replace the daily crop evapotranspiration. Different combination of intensity, frequency and flow rates can be customized to meet varying irrigation needs within a field (Shock *et al.,* 2005). As drip irrigation is going to save 39-62 per cent of water over flood irrigation, more area can be brought under irrigation with better yield and quality which may compensate the cost of drip installation. Irrigation scheduling is one of the most important tools for developing best management practices for irrigated areas (Vucic, 1976; Hedge, 1986; Olalla *et al*., 1994; Al-Jamal *et al.,* 1999). If shortage of readily available soil water is eliminated and the technological and biological characteristics of the
crop are taken in to account, it is possible to achieve high and stable yields of irrigated onions, at the level of 40 t/ha or higher. Kanton *et al.,* 2003; Pejic *et al*., 2008).

Onion is a shallow rooted plant that requires frequent irrigation to achieve good yield. Accordingly, excessive amount of water is generally applied to fields. On irrigated land the onion crop is regarded as a fairly large consumer of water. Onions under water deficiency decrease in its evapotranspiration and consequently yield (sammis *et al.,* 2000). Mermoud *et al*., (2005) showed that irrigation frequency plays an important role on the development and yield of the onion crop. Irrigating twice a week instead of once a day (and thus increasing the irrigation depth) was found to cause an increase of the water storage through the whole root zone, a better crop water availability and higher yield. Many growers obtain much lower yields, primarily because of inadequate scheduling (Mermoud *et al*., 2005).

Amans and Kadams (1995) reported a significant increase in onion bulbs yield by increasing the frequency of irrigation. This is also in line with kadayifci *et al.* (2005) who observed that irrigation twice a week was found to cause better and high onions yield. Sen *et al*., (2006) reported that the bulb yield /ha increase in soil moisture regime. Nourai (2008) confirmed that irrigation every five days resulted to markedly increase in onions yield, this is also in line with Khan *et al* .(2005) who reported maximum yield obtained (tons/ha) with five days irrigation intervals.

Materials and Methods

The experiment was conducted at Teaching and Research Farm Faculty of Agriculture University of Maiduguri during 2018/2019 dry season to determine the effects of irrigation intervals on the growth, development and yield component of onion. The experimental site is located between latitude 11^{o}N, 4^{o}N and longitude13^{o}E and13^{o}E in the semi arid region above sea level

The experiment consists of four treatments as follows: T1= One irrigation interval, T2=Two days irrigation intervals, T3=Three days irrigation intervals and T4=Four days irrigation intervals. The experiment was laid out in a randomized complete block design (RCBD) and replicated three times. Plot size measured 4 meters square with an alley (path way) of 1 meter between block. The plots were sunken bed in 2 x 2 m with 0.5 m within rows and 1m between rows. Onion variety (Monguno white) was obtainted at the college of Agriculture Maiduguri Borno state. The experiment plot was prepared before planting, stumps, straws, weeds, weeds trash, stones and other unwanted materials were cleared and removed. The experimental plot was then prepared in to fine tilt to ensure uniform distribution of water and nutrients.

One week before transplanting, farm yard manure (poultry dung) was collected at the university poultry farm at the rate of 2 kg for each plot by broadcasting method. Then 3 weeks after transplanting compound fertilizer (NPK 15:15:15) was applied using broadcasting method. All the fertilizer was carefully incorporated in to the soil to minimize losses. The seedlings were transplanted one per stand at spacing of 25 x 25cm. Weeding was done at two and four weeks after transplanting using hand hoe. Parameter collected includes;

Plant height (cm), number of leaves per plant, bulb diameter (cm), bulb weight (kg) and yield (t/ha). All data collected were subjected to analysis of variance (ANOVA) and the difference among means were separated using Duncan Multiple Range Test (DMRT) at 5% levels of probability.

Results

The effect of irrigation interval on onion plant height showed that, there was significant difference observed among the treatment (Table 1). The results revealed that, onion produce significantly taller plants height at 2 days irrigation interval produce the taller plants height at 2, 4, 6, and 8 WAT when compared to 3 days irrigation interval at 2 WAT. The shorter plant was significantly produced under 1 day irrigation interval compared to the other treatments. Similar trends was observed at 6 and 8 WAT when 2 days irrigation interval significantly produced the taller plants when compared to 3 days irrigation interval (Table 1).

Although, there was no significant different observed at 3 and 4 days irrigation interval, the shorter plant height were significantly produce at 1 day irrigation interval at 6 WAT and also at 4 days irrigation interval at 8 WAT.

Table1. Effect of irrigation interval on onion plant height at 2, 4, 6, and 8 weeks after transplanting 2018/2019 dry seasons.

Irrigation Intervals	2 WAT	4 WAT	6 WAT	8 WAT
1Day	15.50b	26.42b	31.50c	41.50b
2 Days	27.50a	36.25a	41.83a	58.83a
3 Days	19.83b	29.58b	36.42b	48.67ab
4 Days	16.92b	27.50b	32.40b	37.0b
SE (±)	2.05	1.51	1.35	4.31

Means followed by the same letter(s) in a column are not significantly different using Duncan's Multiple Range Test ($p<0.05$)

Reasult revealed here was significant effect of irrigation interval on onion number of leaves per plant (Table2)., onion produce significantly higher number of leaves at 2 days at 2, 4, 6, and 8 WAT when compared to 3 days irrigation interval at 6 WAT (table 2). There was no significant different observed at 1 and 4 days irrigation interval at 4 and 6 WAT, the least being obtained from 1 day irrigation interval at 2 WAT and also at 4 days irrigation interval at 8 WAT. Irrigation at 2 and 3 days intervals supplied adequate moisture which favors the increase in number of leaves per plant, while irrigation at wider range must have supplied insufficient amount of moisture required for leaves development. The result of this work also shows that a new leaf is produced each week. This is in agreement with the work of Thabet *et al*, (1994) who indicated that the number of leaves is increased by increasing irrigation.

Table 2. Effect of Irrigation Interval on Number of Leaves at 2, 4, 6, and 8 Week after Transplanting 2018/2019 dry season

Irrigation Interval	2 WAT	4 WAT	6 WAT	8 WAT
1 Day	3.58c	6.67b	8.50c	9.75bc
2 Days	6.25a	9.42a	12.17a	13.16a
3 Days	5.91a	8.33ab	10.67b	11.58ab
4 Days	4.58b	7.58ab	8.42c	8.75c
SE (±)	0.29	0.78	0.56	0.93

Means followed by the same letter(s) in the same column are not statistically different using Duncan's Multiple Range Test (DMRT).

The effect of irrigation interval was significant on onion bulb diameter and total bulb weight. In both parameters, 2 days irrigation interval produced the widest bulb diameter (cm) as well as the highest bulb yield (Table 3) compared to other irrigation interval treatment. This trend could be linked to adequate supply of moisture. This does not tally with the work of Mermoud *et al.,* (2005) who showed that irrigating twice a week instead of once a day and thus increasing the irrigation depth) was found to cause an increase of water storage through the root zone, a better crop water availability and higher yield.

Table 3. Effect of irrigation intervel on onion bulb weight and bulb diameter 2018/2019 dry season

Irrigation interval	Bulb diameter (cm)	Bulb weight (kg/p)
1 Day	7.40d	1.57c
2 Days	15.58a	3.87a
3 Days	14.58b	2.88ab
4 Days	12.73c	1.83bc
SE (±)	0.12	0.45

Means followed by the same letter(s) in the same column are not statistically different according to Duncan's Multiple Range Test (DMRT).

The effects of different irrigation interval on yield of onion were statistically significant, among the treatments observed 2 days irrigation interval produced the higher yield compared to other treatments while the lower was obtained at 1 day irrigation interval (Table 4).

Table 4 Effect of Irrigation Internal on Yield of Onion in 2018/2019 dry season

Irrigation interval	Yield (t/ha)
1 Day	5.40d
2 Days	12.71a
3 Days	10.41b
4 Days	7.19c
SE (±)	58.21

Means followed by the same letter(s) in the same column are not statistically different according to Duncan's Multiple Range Test (DMRT).

Conclusion

Based on the results obtained from the study effect of different irrigation intervals on growth and yield component of onion it can be concluded that irrigation at 2 days interval enhanced better growth and development as well as yield and yield component of onion in Maiduguri, Sudan savannah of Nigeria.

Farmers can adopt 2 days irrigation interval as the best irrigation practice for onion production in Agro ecological zone of Sudan savannah of Nigeria. However, further studies could be conducted on onion crop with different irrigation intervals to certain their effects.

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