International Academic Research Consortium Journals (IARCJ)
International Journal of Agricultural Science and Technology
ISSN: 2360-9888. Volume 9, Number 1
Pages 8 - 23 (February, 2021)
www.iarcj.org, www.arcnjournals.org

Response of Poultry Manure and Irrigation Intervals on Yield Parameters of Onion (*Allium cepa* L.) in Maiduguri

I.S. Dalatu, Usman I.M and Baba G.S.
Department of Agricultural Engineering and Technology, Ramat Polytechnic, Maiduguri. Nigeria | Email: dalatu.ibrahim@gmail.com | Tel: 08032503291, 08025799204

Abstract: *Field trial was carried out during the 2016/2017 and 2017/2018 cold dry seasons in Maiduguri Sudan Savanna, Nigeria (Latitude 11 05' N and Longitude 13 05' E and at about 350 meters above sea level) to determine the response of onion (Allium cepa L.) to varying levels of poultry manure fertilization and irrigation interval. The treatment consisted of four levels of poultry manure (0, 20, 25, and 30 kg/ha) and three levels of irrigation intervals (2, 4 and 6 days) which were laid out in a Randomized complete block design (RCBD) and replicated three times. Parameters studied were establishment count, plant height, number of leaves per plant, fresh bulb yield, fresh bulb weight, cured bulb weight, bulb diameter and percentage marketable weight. During the both seasons 2016/2017 and 2017/2018 and the combined years, there was significant effects of poultry manure and irrigation interval on the both growth and yield parameters studied. Application of poultry manure at 30 t/ha and irrigation interval at 6 days had significantly (P>0.05) recorded the highest effects on all the parameters examined. The interaction between poultry manure and irrigation interval was significant (P>0.05) in both seasons and the combined years.*

Keywords: *Poultry manure, Irrigation intervals, Yield parameters and Onion*

INTRODUCTION

Onion (*Allium cepa* L.) belongs to the family *Alliaceae* and is believed to have originated in South West Asia or the Mediterranean (Tindal, 1983). Onion is biennial crop that is the most important for the bulb crops because it is widely grown and consumed worldwide. It is ranked second to tomatoes in importance in soup making. It can be grown on a wide range of climatic conditions, but thrives best in a mild climate without excessive rain fall or extreme of temperature. It requires soils with mild acid to neutral reaction (pH 6.0 – 7.0) and high soil moisture content for good yields. Onion is a thermo-photoperiodic crop; temperature has a marked influence on bulbing. Under short days, they form leaves without bulbing. Photoperiod also controls bulbing, the critical day length varies from 11-16 hours (Raemarkers, 2001). World production of onion is estimated at over 61.6 million metric tons of bulb annually, with 18.45 tonnes average yield per hectare, 14.8 tons/ha is obtained as an average yield in Nigeria. Onion can be eaten raw in salad, fried, boiled or roasted and used as flavours in soups, stew, canned food products and other savory dishes. It is used in every home virtually on daily basis (Hussaini *et al*., 2000). The bulb is used traditionally as medicinal herb for the treatment of measles, pneumonia, cold and catarrh. Recent studies have confirmed that onion helps in fighting Osteoporosis or bone loss (Biochemist, 2005).

Statement of the Problem

Despite the place of onion as the second most important vegetable in Nigeria, its production is limited to the northern part of the country, even there, it can only be grown in flood plains under irrigation during the dry season.

Onion is a shallow rooted high input crop that demands adequate fertilization and irrigation water. In recognition of the increased cost of fertilizer and growing concern for other prospective effect of excess fertilizer use, fertilizer efficiency has become more important in cropping system for environmental as well as economic reasons (Alhassan, 2004). The shallow roots system of onion also made it more sensitive to weeds and yield reduction of up to 70% has been reported (Akobundu, 1989). These constraints call for a well-planned irrigation strategy and judicious application of fertilizer that will ensure optimum crop yield at the same time reducing farmer's unnecessary expenses and drudgery.

There is a fierce competition for *fadama* land between urban dwellers for habitation and farmers for the growing of crops; more land is lost to habitation (Dankani, 2005). Similarly, global warning through climate change has resulted in drier areas due to temperature changes, siltation and land degradation, (NIMET, 2008). Part of *fadama* have been overtaken through the construction of dams, drainages and waterways, and the water table has gone down making the *fadama* areas too dry for onion cultivation.

Justification of the Study

The use of organic fertilizer on crop production is encouraged due to its numerous advantages like; cheapness, availability and environment friendliness, most farmers who have traditionally used chemical fertilizers can no longer afford them (Biswas *et al*., 2010). Thus an alternative to the use of inorganic fertilizers is the application of organic manure which according to Gambo (2010), are locally available and cheaper sources of maintaining soil fertility.

In view of increasing demand of food due to human population pressure, dwindling land for onion production, its production has to be intensified. This could be achieved by using superior onion genotypes, better plant nutrition and application of efficient and timely weeding methods (Alasiri, 2002). The present production levels do not meet the demand of the teeming populace. Accurate and reliable production figures are not readily available, but an estimate import figure of 12,000 metric tons was reported in 2010 **(**FAO, 2017). Similarly, limited changes in the traditional production practices may still be lagging behind the national demand (Denton and Ojeifo, 1990).

Farmers do not know the correct dosage of fertilizers, the critical phenological stage of the crop at which to apply and the correct mode of application for optimum yield (Umar *et al*, 2004; Akoun, 2004).

Significance of the Study

The research will provide appropriate rate of poultry manure and the most suitable irrigation interval for onion production. The result of the study will further boost food security, serve as reference for future studies and contribute to entrepreneur skill development, in line with the present agricultural drive of the Federal Government, under President Muhammadu Buhari.

Objectives of the Study

The objectives of the study are to determine:

i. the response of poultry manure on the growth and yield of onion,
ii. the effect of different irrigation intervals on the growth and yield of onion,
iii. cost benefit

MATERIALS AND METHODS

Experimental Site

Field trials were conducted at Teaching and Research Farm, Faculty of Agriculture, University of Maiduguri, Maiduguri (11^{o} 50'N; 13^{o}10E and 319m above sea level) during the cool dry harmattan seasons of 2016 and 2017.

Source of Planting Materials

Bama red variety of onion was obtained from Borno State Agricultural Development Programme (BOSADP), Maiduguri office. The variety has a large bulb, red outer skin and is highly pungent: it is known to be the best variety of onion in Borno State. It is highly preferred in the market because of its high pungency, with yield of about 25t/ha when grown in cool season in Borno State (BOSADP, 1993).

Source of Manure

Poultry Manure was obtained from the University of Maiduguri Poultry Farm. The organic manure collected was analyzed in Soil Science Department laboratory, University of Maiduguri for nutrient compositions. Table 1 show the table of the nutrient composition analyzed

Source of Irrigation Water

Gasoline- powered water pumping machine was used for irrigation during the trials. The experimental plots were irrigated at 2,4 and 6day irrigation interval using gasoline powered pumping machine, the source of water was bore-hole.

Treatments and Experimental Design

The experimental design used for the field experiment was a Randomized Complete Block Design (RCBD) replicated 3 times as shown in Figure 1. The treatments consist of four levels of organic manure (0, 20, 25, and 30 t/ha) and three levels of irrigation intervals (2, 4, and 6 days).

Management Practices

Land preparation and management

A well-tilled seedbed raised at 1.0 x 2m with a fine loose surface was marked out. Poultry manure was incorporated during land preparation as required per plot (t/ha). The land was harrowed by a tractor and leveled manually; using a hoe then pegged and laid out into plot size of 2 x 2 ($4m^2$) with their accompanying water channels for irrigation.

Transplanting

The prepared land was supplied with water to field capacity two hours before transplanting. Seedlings were transplanted at spacing of 15cm inter row and 25cm intra row spacing. Seedlings were transplanted at the 5^{th} weeks after sowing. The nursery bed was irrigated to ease up-rooting of the seedlings.

Irrigation

Irrigation method used was surface furrow, using gasoline powered water pumping machine till first leaf stage were emerged The crop was irrigated daily for four days to avoid transplanting shocks, after that it continued in respective plots according to sub- plot treatments during evenings and maintained until two weeks to harvest.

Weeding

Weeding was done manually with specialized onion hoe to reduce the effect of competition and to maintain weed free environment at 4 and 8 weeks after transplanting.

Manure application

Poultry manure at the rates of 0, 20 t/ha, 25 t/ha, and 30 t/ha respectively were incorporated into the soil at land preparation as proposed.

Data Collection

Soil samples and organic manure analysis

Soil samples were randomly taken from different spots across the experimental field at 0-15cm and 15-30cm prior to planting using Auger. At each depth, samples were taken from ten points on a diagonal transect of the experimental field. Samples from each site and depth were bulked, mixed, air dried and analyzed at the laboratory of Soil Science Department, Faculty of Agriculture, University of Maiduguri. A composite soil sample was formed, air-dried, sieved through 2 mm sieve and was used for physical and chemical analysis. (Table 1. The initial physical and chemical characteristics of soil of the study area).

Plant height (cm)

Plant height were first measured at four weeks after transplanting (WAT) and then at every two weeks until harvest. Five plants were randomly selected from the stands in the plots and tagged for data collection. The height was measured from ground level to the apex of the terminal bud using meter tape. The mean plant height was thereafter, determined and recorded.

Number of leaves per plant

The numbers of leaves from five randomly selected plants from each plot were counted at 4 WAT and at every two weeks until harvest. The mean number of leaves per plant was thereafter, determined and recorded for each plot.

Bulb diameter (cm)

This were obtained by up-rooting three randomly selected plants per plot and measured using pair of Vernier calipers, this were done at 6th weeks after transplanting and continued at every 2week interval. The mean bulb diameter was thereafter determined and recorded.

Individual fresh bulb weight (g)

This were obtained by weighing twenty freshly harvested onion bulbs from each net plot after detaching the leaves at harvest using a sensitive weighing balance, average weight was thereafter determined and data obtained were recorded.

Individual cured bulb weight (g)

This were obtained by weighing twenty randomly harvested onion bulbs after curing for two weeks using a sensitive balance and average determined. Data were recorded as cured bulb weight in gramme.

Percentage of marketable and non-marketable bulb (%)

The randomly selected twenty (20) cured bulbs from each plot were sorted out. Bulbs from each plot were counted and divided by the total number of bulbs and thereafter multiplied by 100 which represent the percent of marketable or non-marketable bulb (Andre, 1991)

Percentage missing stands at harvest

This was determined by dividing the number of missing stand by the expected total number of stand per plot and multiplying by 100.

Cost Benefit Analysis

In each location cost benefit assessment was done after selling and the economic assessment was based on the bulb yield obtained. Partial budgets involving the analysis of variable input costs and benefits were drawn for all the treatments. Items considered were the gross return (₦/ha) calculated as yield of onion (kg/ha) multiplied by market price (₦/ha), total cost (₦/ha) of all inputs and labour used.

Gross profit = Gross Revenue — Gross Cost

Statistical Analysis
Data collected were subjected to Statistical Analysis of Variance (ANOVA) using the Statistix 8.0 Statistical Package, the means were separated using New Duncan's Multiple Range Test (NDMRT) as outlined by Gomez and Gomez (1984).

RESULTS AND DISCUSSIONS

Fresh bulb yield (t/ha)

Table 1 indicates the effect of poultry manure and irrigation interval on fresh bulb yield of onion for 2016/2017 and 2017/2018 dry seasons and the years combined. Fresh bulb yields significantly ($p>0.05$) responded to poultry manure rates in the both season and two years combined. The result revealed that increase in poultry in poultry manure rate from 0 – 30kg/ha significantly increased bulb yield in both seasons and the combined. The lowest fresh bulb yield was obtained from the control treatment where no poultry was applied. Jitendra *et al.* (1991) reported that higher yield was obtained by the application of higher farm yard manure. The result is also in agreement with Sing and Dhankar (1998). Irrigation interval had significant ($p>0.05$) on fresh bulb yield of onion in the both seasons and the combined. In both trials and the combined, 6 days irrigation interval gave the highest fresh bulb yield. The interaction between poultry manure and irrigation interval on fresh bulb yield was significant for the both seasons and the combined.

The result in table 1 shows the interactive effect of poultry manure rates and irrigation interval on fresh bulb yield of onion during 2016/2017 and 2017/2018 dry season and the two years combined. There was significant interactive effect between poultry manure rates and irrigation interval for both the seasons and the combined analysis. In the first season, application of 30kg/ha poultry manure level and 6 days irrigation interval produce the highest fresh bulb yield while the least was obtained with the control treatment. The same trend was obtained in the second season and the combined analysis.

Table 1: Effect of different levels of poultry manure and irrigation interval on fresh bulb yield (t/ha) during 2016/2017 and 2017/2018 dry seasons and the two years combined at Sudan Savanah of Borno State

	2016/2017	2017/2018	Combined
Treatment			
Poultry Manure			
0 kg/ha	6.6^{d}	5.7^{d}	6.2^{d}
20 kg/ha	11.8^{c}	10.5^{c}	11.2^{c}
25 kg/ha	17.5^{b}	15.9^{b}	16.7^{b}
30 kg/ha	19.9^{a}	18.3^{a}	19.1^{a}
Significance	*	*	*

SE ±	0.1277	0.1742	0.2821
Irrigation interval			
2 day	12.8[c]	11.3[c]	12.1[c]
4 day	13.8[b]	12.6[b]	13.2[b]
6 day	15.3[a]	13.9[a]	14.6[a]
Significance	*	*	*
SE ±	0.1106	0.1508	0.2443
Interaction PM x I I	*	*	*

Means followed by similar letter(s) are not significantly different at 5% probability level according to Duncan's Multiple Range Test (DMRT)., II = Irrigation Interval

* = Significant at 5% probability level, WAP = Weeks after planting, PM = Poultry Manure

Table 2: Interaction effects of different level of poultry manure and irrigation interval on fresh bulb yield (t/ha) during 2016/2017 and 2017/2018 dry seasons and the two years combine at Sudan Savannah of Borno State

	Fresh bulb yield 2016/2017		
Irrigation Interval	2 days	4 days	6 day
Treatment			
Poultry Manure			
0 kg/ha	5.3[k]	6.3[j]	8.2[i]
20 kg/ha	10.2[h]	12.1[g]	13.3[f]
25 kg/ha	16.4[e]	17.3[d]	18.8[c]
30 kg/ha	19.3[b]	19.6[b]	20.8[a]
SE ±		0.2212*	
	Fresh bulb yield 2017/2018		
0 kg/ha	4.4[i]	5.3h	7.5[g]
20 kg/ha	8.7[f]	11.2[e]	11.7[e]
25 kg/ha	14.6[d]	16.4[c]	16.6[c]

30 kg/ha	17.7[b]	17.6[b]	19.6[a]
SE ±		0.3017*	
	Fresh bulb yield Combined		
0 kg/ha	4.8[h]	5.8[h]	7.8[g]
20 kg/ha	9.5[f]	11.6[e]	12.5[e]
25 kg/ha	15.5[d]	16.6[c]	17.7b[c]
30 kg/ha	18.5[b]	18.6[b]	20.2[a]
SE ±		0.4886*	

Means followed by similar letter(s) are not significantly different at 5% probability level according to Duncan's Multiple Range Test (DMRT).
* = Significant at 5% probability level.
WAP = Weeks after planting
PM = Poultry Manure
II = Irrigation Interval

Fresh Bulb Weight (g)

Table 3 shows the effect of poultry manure rates and irrigation interval on fresh bulb weight of onion during the 2016/2017 and 2017/2018 dry seasons and the 2 years combined. Significant ($p>0.05$) effect of poultry manure and irrigation interval on fresh bulb weight of onion during the both seasons and the combined was observed. The results revealed that increase in poultry manure rate from 0 – 20 kg/ha and further increase to 25 – 30kg/ha lead to the significant ($p>0.05$) improvement in fresh bulb weight in both seasons and the combined. The highest fresh bulb weight was recorded with the application of 30kg/ha of poultry manure in both seasons and the combined and the least with the control treatment. Varying the periods of irrigation from 2 – 6 days, resulted to a significant ($p>0.05$) increase in fresh bulb yield of onion in the both seasons, but had not significantly ($p<0.05$) influenced the fresh bulb weight in the combined analysis. The increases on fresh bulb weight with corresponding increase in level of poultry manure applied noticed in the results are conformity with Gambo *et al.,* (2008), who reported that an increase in farm yard manure translate to increase in bulb yield of onions.

The interaction between poultry manure and irrigation interval had significant ($p>0.05$) effect on the fresh bulbs weight in both season but negative effect on the combined results.

Table 3: Effect of different levels of poultry manure and irrigation interval on fresh bulb weight (g)during 2016/2017 and 2017/2018 dry seasons and the two years combined at Sudan Savanah of Borno State

	2016/2017	2017/2018	Combined

Treatment			
Poultry Manure			
0 kg/ha	51.8[d]	45.8[d]	48.8[d]
20 kg/ha	60.9[c]	50.8[c]	55.8[c]
25 kg/ha	70.0[b]	61.1[b]	65.5[b]
30 kg/ha	71.1[a]	72.3[a]	71.7[a]
Significance	*	*	*
SE ±	0.2752	0.4860	1.5072
Irrigation interval			
2 day	63.2[b]	56.1[b]	59.6
4 day	62.6[c]	57.9[a]	60.2
6 day	64.5[a]	58.5[a]	61.5
Significance	*	*	*
SE ±	0.2383	0.4209	1.3053
Interaction PM x I I	*	*	NS

Means followed by similar letter(s) are not significantly different at 5% probability level according to Duncan's Multiple Range Test (DMRT)., II = Irrigation Interval
* = Significant at 5% probability level., WAP = Weeks after planting, PM = Poultry Manure

Table 4 present the significant ($p>0.05$) effect of poultry manure rates and irrigation interval of fresh bulb weight of onion during the 2016/2017 and 2017/2018 dry season. During the both seasons 30kg/ha poultry manure rates in combination with 6 days irrigation interval recorded the highest fresh bulb weight whereas the lowest was observed with the control treatment

Table 4: Interaction effects of different level of poultry manure and irrigation interval on fresh bulb weight (g) during 2016/2017 and 2017/2018 dry seasons at Sudan Savannah of Borno State

	Fresh bulb weight 2016/2017		
Irrigation Interval	2 days	4 days	6 day
Treatment			

Poultry Manure

0 kg/ha	49.4[i]	50.4[h]	55.4[g]
20 kg/ha	60.7[j]	60.7[f]	61.2[f]
25 kg/ha	71.9[ab]	69.0[e]	69.3[de]
30 kg/ha	70.9[bc]	70.1[cd]	72.1[a]
SE ±		0.4767*	
	Fresh bulb weight 2017/2018		
0 kg/ha	47.5[h]	45.7[i]	44.2[i]
20 kg/ha	50.5[g]	52.4[f]	49.4[g]
25 kg/ha	58.6[e]	61.5[d]	63.1[d]
30 kg/ha	68.0[c]	72.0[b]	77.0[a]
SE ±		0.8418*	

Means followed by similar letter(s) are not significantly different at 5% probability level according to Duncan's Multiple Range Test (DMRT).
* = Significant at 5% probability level.
WAP = Weeks after planting
PM = Poultry Manure
II = Irrigation Interval

Cured Bulb weight (g)

The result in Table 5 shows the effect of different levels of poultry manure and irrigation interval on cured bulb weight of onion for 2016/2017 and 2017/2017 dry seasons and the two years combined analysis. Poultry manure rates and irrigation interval has significantly ($p>0.05$) affected the cured bulb weight of onion in the both seasons and the two years combined. Increasing poultry manure rate from 0 – 30kg/ha had resulted in a corresponding increase in cured bulb weight of onion in both season and as well as the combined analysis. According to Rana and Sharma (1994) reported that dry bulbs weight per plant and other growth and yield parameters show a positive correlation with the frequency of irrigation, also Jones and Man (1963) reported that delay in irrigation results in lower onion bulb yields. Irrigation interval was not significantly ($p<0.05$) influenced the cured bulb weight of onion during the first season and the combined analysis but, had significant ($p>0.05$) effect on cured bulb weight in the second season. The interaction between poultry manure and irrigation interval on cured bulb weight was significant ($p>0.05$) only during the 2017/2018 dry season.

Table 6 shows the interactive effect of poultry manure rates and irrigation interval on cured bulb weight of onion during 2017/2018 dry season. Significant ($p>0.05$) interactive

effect was observed on cured bulb weight where 30kg/ha poultry manure rate with 6 days irrigation interval produced the highest (71.8g) cured bulb weight and the least (38.9g) was noticed with the control treatment in combination with 6 days irrigation interval.

Table 4: Effect of different levels of poultry manure and irrigation interval on cured bulb weight (g) during 2016/2017 and 2017/2018 dry seasons and the two years combined at Sudan Savanah of Borno State

	2016/2017	2017/2018	Combined
Treatment			
Poultry Manure			
0 kg/ha	46.4[c]	40.5[d]	43.4[d]
20 kg/ha	55.7[b]	45.4[c]	50.5[c]
25 kg/ha	64.7[a]	55.8[b]	60.2[b]
30 kg/ha	65.7[a]	67.1[a]	66.4[a]
Significance	*	*	*
SE ±	0.9053	0.4899	1.5371
Irrigation interval			
2 day	57.4	50.8[b]	54.1
4 day	58.2	52.6[a]	55.4
6 day	58.7	53.2[a]	55.9
Significance	NS	*	NS
SE ±	0.7840	0.4243	1.3312
Interaction PM x I I	NS	*	NS

Means followed by similar letter(s) are not significantly different at 5% probability level according to Duncan's Multiple Range Test (DMRT).
* = Significant at 5% probability level.
WAP = Weeks after planting
PM = Poultry Manure
II = Irrigation Interval

Table 5: Interaction effects of different level of poultry manure and irrigation interval on cured bulb weight (g) during 2017/2018 dry season at Sudan Savannah of Borno State

	Cured bulb weight 2017/2018		
Irrigation Interval	2 days	4 days	6 day
Treatment			
Poultry Manure			
0 kg/ha	42.1^{h}	40.4^{c}	38.9^{i}
20 kg/ha	45.1^{g}	47.1^{f}	44.1^{g}
25 kg/ha	53.2^{e}	56.2^{d}	57.9^{d}
30 kg/ha	62.7^{c}	66.7^{b}	71.8^{a}
SE ±		0.8486*	

Means followed by similar letter(s) are not significantly different at 5% probability level according to Duncan's Multiple Range Test (DMRT).
* = Significant at 5% probability level.
WAP = Weeks after planting
PM = Poultry Manure
II = Irrigation Interval

Bulb diameter (cm)

Effect of different levels of poultry manure and irrigation interval on bulb diameter of onion during 2016/2017 and 2017/2018 dry seasons and the two years combined were represented in table 6. Bulb diameter of onion was significantly ($p>0.05$) influenced by the application of poultry manure rates during the 2016/2017, but was not significantly ($p<0.05$) affected by poultry manure levels during the second trial and the combined, poultry manure rate of 30kg/ha produced the largest bulb diameter in the second trial, while the least bulb diameter was recorded with the control treatment. The trend was the same with the combined analysis. The positive response of onion bulb diameter to organic poultry manure obtained in the study is in conformity with the findings of Dalatu *et al*., (2018), where higher bulb diameter was recorded due to higher level of organic fertilizer in his research on influence of agriboom and bionim organic fertilizer rates on growth and yield parameters of onion in Sokoto Nigeria. Bulb diameter was not significantly ($p>0.05$) influenced by irrigation interval in the both seasons and the combined.

Table 6: Effect of different levels of poultry manure and irrigation interval on bulb diameter (cm) of onions during 2016/2017 and 2017/2018 dry seasons and the two years combined at Sudan Savanah of Borno_State

	2016/2017	2017/2018	Combined
Treatment			

Poultry Manure			
0 kg/ha	5.2	5.6[c]	5.4[b]
20 kg/ha	5.5	5.5[c]	5.5[b]
25 kg/ha	7.6	7.0[b]	7.3[ab]
30 kg/ha	6.5	8.5[a]	7.5[a]
Significance	NS	*	*
SE ±	0.8395	0.2728	2.9151
Irrigation interval			
2 day	6.6	6.7	6.6
4 day	6.8	6.6	6.7
6 day	6.4	6.6	6.5
Significance	NS	NS	NS
SE ±	5.0571	0.2362	2.5246
Interaction PM x I I	NS	NS	NS

Means followed by similar letter(s) are not significantly different at 5% probability level according to Duncan's Multiple Range Test (DMRT).
* = Significant at 5% probability level.
WAP = Weeks after planting
PM = Poultry Manure
II = Irrigation Interval.

Percentage marketable weight (%)

Table 7 indicates the effect of poultry manure rates and irrigation interval on percentage marketable weight of onion during the 2016/2017 and 2017/2018 dry seasons and the two years combined. Poultry manure rates significantly ($p>0.05$) influenced the percentage marketable weight of onion. In first trial 30kg/ha poultry manure rate produced the highest percentage marketable weight (79%) followed by 25kg/ha of poultry manure level (73.6%) these shows that increasing the rates of poultry manure has corresponding effect on larger percentage marketable weight. Irrigation interval had significantly ($p>0.05$) affected the percentage marketable weight of onion only in the second trial, where 4 days irrigation interval recording higher percentage marketable weight of onion bulb (72%). This was in conformity with work of Mohammed *et al* (2004), who reported that the application of poultry manure at higher dose of 30 kg/ha resulted in higher percentage marketable weight of onions.

The result in table 8 shows the interactive effect of poultry manure rate and irrigation

interval of onion on percentage marketable weight during the second trial (2017/2018). Poultry manure and irrigation interval interaction has significantly affected the percentage marketable weight. Maximum percentage marketable weight (78.6%) was recorded with 30kg/ha poultry manure in combination with 6 days irrigation interval, while the control treatment (0kg/ha) poultry manure and two days irrigation interval gave the least percentage marketable weight (64.5%).

Table 7: Effect of different levels of poultry manure and irrigation interval on percentage marketable weight (%) of onions during 2016/2017 and 2017/2018 dry seasons and the two years combined at Sudan Savanah of Borno State

	2016/2017	2017/2018	Combined
Treatment			
Poultry Manure			
0 kg/ha	64.3[c]	65.1[d]	64.7[d]
20 kg/ha	66.0[c]	67.9[c]	67.0[c]
25 kg/ha	73.6[b]	75.1[b]	74.3[b]
30 kg/ha	79.0[a]	78.3[a]	78.7[a]
Significance	*	*	*
SE ±	1.5565	0.5809	0.8412
Irrigation interval			
2 day	70.7	70.5[b]	70.6
4 day	71.3	72.2[a]	71.7
6 day	70.2	72.1[a]	71.2
Significance	NS	*	NS
SE ±	1.3479	0.5031	0.7285
Interaction PM x I I	NS	*	NS

Means followed by similar letter(s) are not significantly different at 5% probability level according to Duncan's Multiple Range Test (DMRT).

* = Significant at 5% probability level.

WAP = Weeks after planting

PM = Poultry Manure. II = Irrigation Interval

Table 8: Interaction effects of different level of poultry manure and irrigation interval on percentage marketable weight (%) during 2016/2017 and 2017/2018 dry seasons at Sudan Savannah of Borno State

	2017/2018		
Irrigation Interval	2 days	4 days	6 day
Treatment			
Poultry Manure			
0 kg/ha	64.5^{e}	65.8^{de}	65.0^{e}
20 kg/ha	67.8^{cd}	68.1^{c}	68.0^{c}
25 kg/ha	71.5^{b}	76.8^{a}	76.9^{a}
30 kg/ha	78.2^{a}	78.1^{a}	78.6^{a}
SE ±		1.0062*	

Means followed by similar letter(s) are not significantly different at 5% probability level according to Duncan's Multiple Range Test (DMRT).
* = Significant at 5% probability level.
WAP = Weeks after planting
PM = Poultry Manure
II = Irrigation Interval

CONCLUSION AND RECOMMENDATIONS

From the finding of this research work, it was concluded that poultry manure and irrigation interval had significantly affected growth and yield components of onion in Maiduguri Sudan Savannah during the 2016/2017 and 2017/2018 dry seasons and the combined years. Therefore, application of poultry manure at 30 kg/ha and irrigation interval at 6 days produced the highest effects on all the parameters examined in the Sudan Savannah.

From the finding of the study, the following recommendations could be made.

i. From the results of the experiments, it is recommended that for optimum onion production in Maiduguri Sudan Savannah, a combination of 30 kg/ha poultry manure and 6 days irrigation interval be adopted.
ii. Further study should be carried out to determine the effect of onion to different rates of poultry manure and irrigation interval levels in the study area.

REFERENCES

Akobundi, I.O. (1989). Weed Science in the tropics, principles and practices. A wiley inter-science publication. John Wiley and Sons. New York 2nd Edition.

Akoun, J. (2004). Effect of Plant density and manure on the yield and yield components of the common onion (*Allium cepa* L.) Var Nsukka Red NJAS Vol. 9-pp 43-48.

Alasiri, K.O. (2002). Effect of combined use of poultry manure and NPK Fertilizer on seed yield of (Abelmoschus Cepa L.) Var Nsukka Red NJHS Vol. 9 pp 43 – 48

Alhassan, J. (2004). Effects of fertilizer rate and time of weeding on the growth yield components and yield of two potato (*Solanum tuberosum* L) varieties in Sokoto. Unpublished M.Sc. Thesis Usman Danfodiyo University Sokoto.

Andres, E.B. and Kadams, A. M. (1995). Yield, bottling and storage losses of selected onion cultivars in Nigeria. *Onion newsletter for the tropics 2:14-17*

Biochemist (2005): http://www.biochemist.com *News item 12325*

Biswas, S.K., Khair, A., Sarker, P.K and Alom, M.S. (2010). Yield and storability of onion (Allium cepa L.) as affected by varying levels of irrigation, Bangladesh Journal of Agricultural research 2:1:22

BOSADP, (1993). Borno State agricultural Development Programmed package of cropping Recommendation for Borno State, Nigeria 76pp.

Dankani M., (2005). Spacing and nitrogen fertilizer on growth and yield of onion (Allium cepa L. Var net globe) *Indian Journal of Agricultural* Research 6:45-50.

Dalatu I. S., Abdullahi, A. and Mustapha, A. (2018). Influence of agriboom and bionim organic fertilizer rates on growth and yield parameters of onion (*Allium cepa L*) in Sokoto, Nigeria. Multidisciplinary interactional conference organized by Mediterranean publication and Research international, 15th February 2018 at Nassarawa state university, Nigeria.

Denton, L. and Ojiefo, I.M. (1990). Onion production practices and their improvement in Nigeria. *Onion newsletter for the Tropics. 2:10-13*

FAO (2017). Food and Agricultural Organization of the United Nations. Statistics of dry onion production, FAOSTAT Database Rome.

Gambo, B.A., Magaji M.D., Yakubu, A.I. and Dikko, A.U. (2008). Effects of farmland manure, nitrogen and weed interference on the growth and yield of onion (Allium cepa L.) at the Sokoto Valley, Journal of sustainable development in agriculture and Environment 3(2): 87-92

Gomez, K.A and Gomez, A.A (1984). Statistic procedure for agricultural research, 2nd edition. John Willey and sons. 655pp

Hassan, M.S. (2004). Effect of frequency of irrigation and fertilizer nitrogen on yield and quality of onions (A. cepa) in the Arid tropics. Acta Horticulture 143:341-346.

Hussaini, U.A., Rahaman, A.A, Aliyu, L. Ahmed, A. and Amans, E.B. (2004). Yields Bulb size distribution and storability of onion (Allium cepa L.) under different levels of N. fertilization and soil moisture regimes *Nigerian Journal of Horticultural Science vol. 5 (2) 436-439*

Jitendra, S. Dhankharr, B.S. and Sungh, J. (1991). Effect of nitrogen, potash and zinc on storage loss of onion bulbs (*Allium cepa L*) Vegetable science 18(1); 16-23.

Jones, H. A and Man, L.K. (1963). Onion and their allies. Leonard Hill, London.

Mohammed, A.K. and Gamie, A.A. (2004). Studies on some Egyptian onion varieties under Upper Egypt conditions 11-effect of irrigation regimes on yield and some bulb quality characters of onion varieties. Assiut Journal of agriculture science 31(5) 115-127.

NIMET, (2008): National Metrological Agency. Press Release . Daily Trust Newspaper, Monday, March 10 2008, Vol. 18, No. 61 P.1

Umar, M.E.M. (2004). Effect of the frequency of irrigation as related to stag growth on the performance and yield of onion. Ann. Rept. Gezira Res station and substation 1778/78 254-255.

Raemaker, H.R. (2001). Crop production in tropical African Ministry of Foreign Affairs – External trade and International Cooperation, Brussels, Belgium pp 221.

Rana, D. S, and Sharma, R. P. (1994). Effect of irrigation regime and nitrogen fertilization on bulb yield and water use of onion (*Allium cepa L)* Indian journal of agric science (4); 223 – 226.

Sing R., and Dhankar M., (1998). Effect of different soil moisture regime on the yield and yield components of onion. *Bangladesh Journal of sciences, India* Research 41 (1-2) 109-112, 2006.

Tindal, H.D. (1983). Vegetable in the tropics Macmillan Education Ltd. Houndmills, Basingstoke, Hampshire, RG21.25 pp. 20 – 23.