Effect of organic manures and irrigation intervals on the growth and yield of onion (Allium cepa L.) in Central and Southern Borno State, Nigeria

Ezekiel Yakubu Gwari*, Gambo, B. A. and Kabura, B. H.

Department of Crop Production, Faculty of Agriculture, University of Maiduguri, Borno State, Nigeria.

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**ABSTRACT**

Two field trials were conducted during dry season of 2012/2013 in Lake Alau near Maiduguri and Pelachiroma in Hawul Local Government Area in Borno State. The objective was to study the effect of organic manures and irrigation intervals on the growth and yield of onion (Allium cepa L.). The treatments consisted of factorial combination of four organic manures (cow dung at rate of 20 t/ha, goat dung at rate of 20 t/ha, poultry litter at rate of 15 t/ha and no manure) and five levels of irrigation intervals (3, 6, 9, 12 and 15 days). The treatments were laid out in a split plot design with three replications. Organic manure was allocated to the main plot and irrigation intervals to sub-plots. Parameters studied includes bulb diameter, cured bulb weight, percentage of marketable yield/non-marketable bulb and total yield in tons/ha. The results obtained show significant (P<0.05) effect of organic manure and irrigation intervals on the yield of onion. The highest bulb yield was obtained in plots of poultry litter at rate of 15 t/ha with 6 days irrigation interval in both location and in the combined, similar to the interactions. The control (no manure) with all irrigation intervals gave poor yield. Based on the findings, it was concluded that, for optimum production of onion bulbs in Lake Alau and Pelachiroma, a combination of poultry litter at rate of 15 t/ha and 6 days irrigation interval is the best farm practice.

INTRODUCTION

Onion (Allium cepa L.) is a member of the Alliaceae family and its one of the most important vegetables in the world, whose utility is ranked second to tomatoes (Brice et al., 1997). According to Purseglove (1985), onion can be grown on a wide range of climatic conditions. It is an important vegetable crop valued for its pungent or mild flavour and for being the essential ingredient of the cuisine of many regions (Anonymous, 1993). World production of onion is estimated at over 61.6 million metric tons of bulb; and yield per hectare average 18.45 tons with Nigeria’s average yield put at 14.8 tons (FAOSTAT, 2006). Based on the level of consumption, onion is a major spice in diets, ranking the second (after tomatoes) most important vegetable in Nigeria. The main production period of onion in Nigeria is during the dry season between September and April. The crop is produced in dry areas in the northern parts of the country, and three crops are possible in a year, two rainfed and one irrigated (Anonymous, 1993). Farmers’ production practice of onion involve complex mixture of cropping with other vegetables such as lettuce, tomato and pepper among others. Onion is consumed in different ways by different people and forms an essential part of the traditional daily diet. It is a major spice item and ranks among the top 5 vegetables in Nigeria (NIHORT, 1986). It can be eaten raw, in salad, fried, boiled or roasted, and is also used in flavouring soups, canned food products and other savory dishes. It is used in every home virtually on

*Corresponding author. E-mail: talk2gwari@gmail.com.
daily basis (Hussaini et al., 2000). The bulb is used traditionally as a 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). Onion production is a viable industry that employs plenty of labour and the bulbs are traded in large quantities within and between countries of the world (Currah and Proctor, 1990). Despite the ranking of onions as second most important vegetable in Nigeria, the present production levels do not meet the demand of the teeming populace (Gambo et al., 2008). Several factors are responsible for this discrepancy, among which are irrigation intervals, fertilizer application. Most farmers do not know the correct dosage of fertilizer; and when and how to apply it for optimum onion production (Magaji et al., 2004). The use of organic manure to meet the nutrient requirement of crops would be an inevitable practice in the years to come for sustainable agriculture since organic manure generally improves the soil’s physical, chemical and biological properties along with conserving the moisture-holding capacity of the soil, and thus resulting in an unenhanced crop productivity. The high cost and scarcity of inorganic fertilizer makes it not reliable.

Water as a natural resource is inadequate in most areas where onion production is prevalent (Muhammad et al., 2011). Water shortage facing onion production, is one of the problems over the last few years (Metwally, 2011). Onions are extremely sensitive to water stress regardless of the type of irrigation system used. Both yield and quality are usually below expectation, if irrigation is delayed. Biswas et al. (2010) observed that onion bulb yield and storage losses where increased gradually with increase in irrigation frequencies; so that application must be done efficiently to ensure profitability, while at the same time maximizing yield.

Therefore, this research conducted was to study the effect of organic manures and irrigation intervals on the growth and yield of onion (A. cepa L.) in Lake Alau near Maiduguri and Pelachiroma in Hawul Local Government Area in Borno State.

MATERIALS AND METHODS

Site description

Field trials were conducted in two locations of Borno State from November, 2012 to March, 2013 (multi-locations). The first location was at Lake Alau in Konduga Local Government Area (11°44 N, 13° 10’ E) which fall under the Sudan savannah agro-ecological vegetation zone with an altitude of 354m above sea level. The second location was at Pelachiroma (Hill Hawul) of Hawul Local Government Area of Borno State (10°35’ N, 12°27’E) which fall under Northern Guinea savanna agro-

Ecological zone of Borno State, with an altitude of 574 m above sea level. The soil from the study area were Loamy sand, pH=7.28 at Lake Alau and Sandy loam, pH=6.10 at Pelachiroma (Table 1). A mean monthly temperature of 28.6–42°C at Lake Alau and 20.7–35.2°C at Pelachiroma was recorded from October, 2012 to April, 2013 (Table 2).

Experimental design and treatments

The treatment consisted of factorial combination of four organic manures (cow dung, goat dung, poultry litter and no manure) and five levels of irrigation intervals (3, 6,9,12 and 15 days) laid out in a split-plot design with three replications. Organic manure was allocated to the main plot while irrigation intervals to the sub-plot, this gave a total of 60 net plots in each location, measuring 4 m with 1 m inter-row path and watering channels. The total area was 305 m²; seed of Bama red variety obtained from local farmers of Bama village. Nursery bed of 1.0×2.0 m were marked out and cleared, and then seeds drilled into row were 15 cm apart. The field was cleared, ploughed and harrowed manually using hoe, then 60 plots of 2×2 m (4m) were measured, demarcated and laid out. Irrigation drainage channel of 1 m were also made for conveyance of water.

Agronomic practice

At 5th week after sowing, the seedlings were transplanted on November 29, 2012 in Lake Alau and on December 3, 2012 in Pelachiroma with inter–row/intra–row spacing of 15 cm × 20 cm apart. Three days irrigation intervals were maintained for the first week and this was continued in the respective treatment plots, according to the sub-plot treatment (irrigation intervals), and maintained until two weeks to harvest. First weeding was done at 3 weeks after transplanting (WAT) and the second at 6 WAT. Organic manure was incorporated into the soil during land preparation with the following rates; poultry litter at 15 tons/ha, cow and goat dung at 20 tons/ha (split application) while the second half was applied at 6 WAT. Yield parameters measured were bulb diameter, cured bulb weight, percentage of marketable bulb and non-marketable bulb, and total yield in tons per hectare.

Statistical analyses

The data collected were subjected to statistical analyses of variance (ANOVA) at 5% using Statistical Application of Science (SAS) and the means were separated using Duncan’s Multiple Range Test (DMRT) as outline by Gomez and Gomez (1984).
Table 1. Physico-chemical properties of soil at the experimental site of Lake Alau and Pelachiroma during 2012/2013 dry cropping season.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Lake Alau (0-15 cm)</th>
<th>Lake Alau (15-30 cm)</th>
<th>Pelachiroma (0-15 cm)</th>
<th>Pelachiroma (15-30 cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical properties</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand (%)</td>
<td>84.80</td>
<td>77.30</td>
<td>69.30</td>
<td>65.50</td>
</tr>
<tr>
<td>Silt (%)</td>
<td>9.10</td>
<td>14.10</td>
<td>16.50</td>
<td>20.40</td>
</tr>
<tr>
<td>Clay (%)</td>
<td>6.10</td>
<td>8.60</td>
<td>14.10</td>
<td>14.10</td>
</tr>
<tr>
<td>Textural class</td>
<td>loamy sand</td>
<td>sandy loam</td>
<td>sandy loam</td>
<td>sandy loam</td>
</tr>
<tr>
<td><strong>Chemical properties</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH 1:2.5 (H₂O)</td>
<td>7.21</td>
<td>7.28</td>
<td>7.35</td>
<td>6.10</td>
</tr>
<tr>
<td>Electrical conductivity, EC (ms/cm)</td>
<td>0.07</td>
<td>0.07</td>
<td>0.08</td>
<td>0.11</td>
</tr>
<tr>
<td><strong>Exchangeable bases (Cmol/kg soil)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium, Ca</td>
<td>13.20</td>
<td>17.60</td>
<td>10.55</td>
<td>7.33</td>
</tr>
<tr>
<td>Magnesium, Mg</td>
<td>8.40</td>
<td>5.20</td>
<td>4.30</td>
<td>3.85</td>
</tr>
<tr>
<td>Potassium, K</td>
<td>0.18</td>
<td>0.20</td>
<td>0.80</td>
<td>0.42</td>
</tr>
<tr>
<td>Sodium, Na</td>
<td>0.05</td>
<td>0.22</td>
<td>0.12</td>
<td>0.32</td>
</tr>
<tr>
<td>Cation exchange capacity, CEC (Cmol/kg soil)</td>
<td>11.13</td>
<td>7.60</td>
<td>14.60</td>
<td>21.40</td>
</tr>
<tr>
<td>Effective cation exchange capacity (Cmol/kg soil)</td>
<td>12.00</td>
<td>7.90</td>
<td>14.85</td>
<td>22.12</td>
</tr>
<tr>
<td>Organic carbon, C (%)</td>
<td>0.23</td>
<td>0.41</td>
<td>0.70</td>
<td>0.28</td>
</tr>
<tr>
<td>Total nitrogen, N (%)</td>
<td>0.10</td>
<td>0.21</td>
<td>0.32</td>
<td>0.16</td>
</tr>
<tr>
<td>Organic matter (%)</td>
<td>0.82</td>
<td>0.46</td>
<td>3.72</td>
<td>1.32</td>
</tr>
<tr>
<td>C:N</td>
<td>2.35</td>
<td>1.95</td>
<td>2.80</td>
<td>3.16</td>
</tr>
<tr>
<td>Available Phosphorus, P (mg/kg)</td>
<td>10.30</td>
<td>5.24</td>
<td>18.45</td>
<td>15.10</td>
</tr>
</tbody>
</table>

Table 2. Meteorological data of Lake Alau and Pelachiroma during 2012/2013 dry cropping season.

<table>
<thead>
<tr>
<th>Month</th>
<th>Mean monthly temperature (°C) (Lake Alau)</th>
<th>Mean monthly temperature (°C) (Pelachiroma)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum</td>
<td>Mean</td>
</tr>
<tr>
<td>October</td>
<td>37.1</td>
<td>30</td>
</tr>
<tr>
<td>November</td>
<td>35.8</td>
<td>25.6</td>
</tr>
<tr>
<td>December</td>
<td>31</td>
<td>22.2</td>
</tr>
<tr>
<td>January</td>
<td>32</td>
<td>22.5</td>
</tr>
<tr>
<td>February</td>
<td>38.4</td>
<td>29</td>
</tr>
<tr>
<td>March</td>
<td>37.6</td>
<td>28.6</td>
</tr>
<tr>
<td>April</td>
<td>42.8</td>
<td>34.8</td>
</tr>
</tbody>
</table>


RESULTS AND DISCUSSION

Table 3 shows the effect of organic manure and irrigation intervals on total yield (t/ha) of onion during the dry season of 2012/2013 in Lake Alau, Pelachiroma and the combined location in Borno State. The results obtained show that onion yield (t/ha) was significantly affected (P<0.05) by organic manure in both location. Application of poultry litter at the recommended rate produced the highest tons per hectare in Lake Alau (32.24 t/ha), Pelachiroma (36.39 t/ha) and in the combined (34.31 t/ha), in which no statistical difference was found among them, whereas the least onion yield in tons/ha was under no manure (control) (8.31, 9.14 and 8.72 t/ha) for Lake Alau, pelachiroma and in the combined, respectively. The highest yield obtained by using poultry litter corresponds with the work of Mousa and Mohammed (2009) which indicates that addition of poultry manure increases onion yield. Blay et al. (2002) also reported that poultry litter when applied at the recommended rate promotes plant growth and bulb yield. Adewale et al. (2011) also confirmed that poultry manure increased the nutrient
status of soil which led to increased yield of onions. Giardini et al. (1992) reported that there is an increase in yield of onions bulb due to poultry manure application. Khalid and Shafei (2005) found that chicken manure at 25 t/ha resulted in high bulb yield.

Significant effect (P<0.05) of onions yield (ton/ha) was recorded as a result of irrigation interval in Lake Alau, Pelachiroma and the combine result (Table 3). The results indicate that 3 and 6 days intervals produced the highest bulb yield and was not statistically different when compared with 12 and 15 days interval that produced the lowest yield (ton/ha). The highest yield is in line with the trend which observes that any practice that favours increase in onion bulb weight must under similar conditions, result in proportionate increase in total yield.

Amans and Kadas (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) and Merroud 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 bulb yield/ha increased significantly with the 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 (ton/ha) with 5 days irrigation intervals.

Total yield (t/ha) of onion as influenced by interaction between organic manure and irrigation interval in Lake Alau is shown in Table 4. The highest onion yield (t/ha) was under poultry litter at 3 days (41.923t/ha) and 6 days (45.013t/ha), respectively. The lowest bulb yield (t/ha)
Table 5. Interaction between organic manures and irrigation intervals on total yield (t/ha⁻¹) in Pelachiroma during 2012/2013 dry cropping season.

<table>
<thead>
<tr>
<th>Organic manure (t/ha)</th>
<th>Irrigation interval (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 days</td>
</tr>
<tr>
<td>Goat dung</td>
<td>37.023b</td>
</tr>
<tr>
<td>Poultry litter</td>
<td>51.840a</td>
</tr>
<tr>
<td>No manure (control)</td>
<td>14.823fghi</td>
</tr>
<tr>
<td>SE (±)</td>
<td></td>
</tr>
</tbody>
</table>

Mean followed by same letter(s) are not significantly different according to DMRT at 5% level of probability.

Table 6. Interaction between organic manures and irrigation intervals on total yield (t/ha⁻¹) in the combined during 2012/2013 dry cropping season.

<table>
<thead>
<tr>
<th>Organic manure (t/ha)</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>Cow dung</td>
<td>32.617bcd</td>
</tr>
<tr>
<td>Goat dung</td>
<td>36.047bcd</td>
</tr>
<tr>
<td>Poultry litter</td>
<td>46.882a</td>
</tr>
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</tr>
<tr>
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was under no manure (control) at 15 days interval (3.840 t/ha). Interaction levels in Pelachiroma between organic manure and irrigation intervals on onion total bulb yield (t/ha) is as shown in Table 5. The highest yields were obtained with poultry litter application at 3 days (51.840 t/ha) and at 6 days interval (53.823 t/ha). The lowest onion yields (t/ha) were obtained with no manure (control) at 12 days (5.497 t/ha) and 15 days interval (4.190 t/ha) respectively. Application of poultry litter in the combined (Table 6) produced the highest onion yield at 3 days (46.882 t/ha) and at 6 days irrigation intervals (49.418 t/ha), while no manure (control) at 15 days intervals produced the lowest onion yield (4.015 t/ha).

Conclusion

Significant effect of organic manure and intervals were observed on bulb yield of onions grown during the dry season of 2012/2013 in Lake Alau and Pelachiroma of Borno State. Poultry litter (15 t/ha) had the highest bulb yield of onion in the two locations followed by goat dung. Irrigation intervals of 6 days produced the highest onion bulb yield (tons/ha) compared to 15 days which produced low yield. It is therefore recommended that different onion variety should be evaluated under similar studies to assess their responses. Also, farmers should supplement NPK fertilizer with poultry manure to reduce the cost of inorganic fertilizer required and their damaging effect on the soil. This experiment should be carried out in other agro-ecological zones to evaluate the responses of onion to different soil and climatic zone.

REFERENCES


Table 5. Interaction between organic manures and irrigation intervals on total yield (t/ha⁻¹) in Pelachiroma during 2012/2013 dry cropping season.

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</table>

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