RESPONSE OF GARLIC (ALLIUM SATIVUM L.) TO INTRA-ROW SPACING AT AJIWA IRRIGATION SITE OF KATSINA STATE – NIGERIA

Aminu K. Doro
College of Agriculture, Hassan Usman Katsina Polytechnic, Katsina
E-mail: aminudoro20@yahoo.com+234- 803- 9714-994

Abstract
Field trials were conducted during 2010 and 2011 dry seasons under irrigation at Ajiwa in Katsina State (Lat. 13° 17’ N and Long. 7° 05’ E) to determine the yield responses of garlic to varying intra-row spacing. The treatments consisted of four intra-row spacings (5, 10, 15 and 20cm) which were replicated three times in a randomized complete block design. Results indicated that varying intra-row spacings from 5 to 20cm increased significantly \( P < 0.01 \) all yield characters assessed in all the trials except cured bulb yield (t/ha) which decreased as a result of increasing intra-row spacing from 5 to 20cm in all the trials. Based on the results obtained, it could be concluded that for optimum bulb yield (t/ha) in garlic, the intra-row spacings of 5cm using variety Ex-Sokoto should be adopted.

Keywords: Response, intra-row spacing, yield, garlic

Introduction
Garlic (Allium sativum L.) is an important spice crop belonging to the family Alliaceae (Dayi, 2008). Garlic plant ranges from 30 to 60cm in height depending on the cultivars and has superficial adventitious roots. It produces a bulb which consists of bulblets called cloves. The leaves consist of flat longitudinal folded blades diverging at widely spaced intervals from the false solid stem. Garlic cloves contain approximately 63% water, 7% protein, 0.2% fat, 28% carbohydrates, 0.8% fiber and a large number of sulphur compounds which contribute to the pungent and taste of garlic (Rabinowitch and Currah, 2002).

In tropical Africa garlic is grown during the cold season in the sahel and high elevations in east and South Africa. It is popular crop in the savanna zone. It is rarely, if ever found in hot and humid lowlands (Grubben, 2004). Relatively high temperature up to 30°C is required for optimum bulb development but cooling conditions in the early stages favour vegetative grown. Excessive humidity and rainfall are detrimental to both vegetative growth and for bulb formation. Garlic thrives well on fertile, well drained sand or silt loam soils with good moisture retaining properties (Sovovo, 2004).

Garlic is a flavor component in a wide variety of dishes, but mainly in or on meats, vegetables, stews, soup, salads, tomato dishes, spaghetti and courses (Mcgee, 2004). Garlic has been used both as food and for medicine in many cultures for thousand of years. Garlic is claimed to prevent heart diseases, high cholesterol, high blood pressure, cancer, common cold, and plaque. It has been successfully used in AIDS patients to treat cryptosporidium in China (Sovovo, 2004).

In Nigeria garlic is grown during the dry season (November to March) under irrigation. It has been in cultivation for many decades in part of Kano, Sokoto and Borno State. Today its cultivation is rapidly spreading to other savannah areas such as Jigawa, Bauchi and Katsina State (Ahmed, 2006). Garlic cultivation is gaining popularity among farmers in Nigeria, but the farmers obtained very low yield (3 -4 t ha\(^{-1}\)) compared to the expected potential yield (16t ha\(^{-1}\)), (Abubakar, 2008). This problem of low yield could be attributed to adoption of inferior cultural practices. A number of unidentified introduced cultivars of garlic are under cultivation in Nigeria (Norman, 1992). Based on morphological structures, different varieties exist and the cultivars vary in plant size, bulb colour, bulb shape, maturity period, number and size of cloves and final bulb yield as noted by Abubakar (2008). Genetic variability in garlic has been reported especially in its response to environment and management practices. One of the constraints to garlic production in Nigeria is the use of varieties that are not high yielding (Miko, 2000).
Optimum spacing is desirable in crops as this ensures maximum yields. The best planting distance is that which renders maximum space for each crop and allows uniform distribution of available space (Dayi, 2008). In Nigeria, planting density due to wide spacing was identified as one of the reason for low yield in garlic (Karaye and Yakubu, 2002). Despite the contribution of garlic to the nutrition and health of the people of Nigeria, not much research work has been done on the agronomy of this crop.

A number of studies in various parts of the world have shown that garlic production can be improved through proper spacing. It has been reported by Mohammad et al (1996) that plant spacing significantly increase number of cloves per bulb, bulb size, bulb weight and yield. Naruka and Dhaka (2001) indicated that garlic bulb yields increased significantly with increasing intra-row spacings. It was with this background that the present work was initiated with the objective of determining the optimum intra-row spacings for maximum yield under Nigerian conditions.

Materials and methods
Field trials were conducted under irrigation during the period November, 2009 to March 2010 and November 2010 to March 2011 at Ajiwa in Katsina State. The site is approximately located at 13° 17' N, 7° 05E and 610m above sea level in the Sudan savanna ecological zones of Nigeria (Kowal and Knabe, 1972). The treatments consisted of four intra-row spacings (5, 10, 15 and 20cm). These treatments were replicated three times in a randomized block design. The gross plot size was 1.5 x 1.5m with 1.0 x 1.0m as net plot size. The land was cleared, harrowed, leveled and prepared into irrigation basins, with irrigation channels provided, one distributor channel between two blocks of basins. Bulbs were split into cloves which were later soaked in water for 24 hours to allow the cloves to imbibe water, which triggered quick sprouting after removing the protective scale leaves surrounding the cotyledons of the cloves. The field was immediately irrigated after planting until two weeks to harvest when irrigation was stopped to allow for uniform crop maturity.

Observations were recorded on some yield and yield components and the data collected were subjected to analysis of variance as described by Little and Hills (1978). Treatment means where ‘F’ test showed significant difference were compared, using Duncan Multiple Range Test (DMRT) as reported by Steel and Torrie (1981).

Results and discussion
Number of cloves per bulb
The number of cloves per bulb in the 2010 and in 2011 dry season as influenced by treatments is shown in Table 1. Increasing intra-row spacings had significant effects on the number of cloves per bulb in all the trials (Table 1). Increase of intra-row spacings from 5 to 20cm significantly increased number of cloves per bulb in 2010 and in 2011 dry seasons, although no significant differences were observed between 5 and 10cm intra-row spacings, 10 and 15cm intra-row spacings and 15 and 20cm intra-row spacings in 2010 dry season. Increase of intra-row spacings and significant effects on the number of cloves per bulb in all the trials. As a result of increase of intra-row spacings from 5 to 20cm significant increased of number of cloves per bulb was observed in 2011 dry season. These observations could be associated with that garlic crops planted at wider spacing tend to established better compared with those closely spaced, because widely spaced plants are able to intercept more light and suffer less competition for nutrients, hence produced more yield per individual stands. Similar observations were observed by Abubakar, et al. (2008).

Bulb diameter
Varying intra-row spacing significantly affected bulb diameter in both seasons (Table 2). Increasing intra-row spacing from 5 to 20cm significantly (P < 0.01) increased bulb diameter in 2010 and in 2011 dry season. Similarly there was no significant difference on bulb diameter with the increase of intra-row spacing from 15 to 20cm in 2011 dry season. Varying intra-row spacing significantly affected bulb diameter in all the trials. Increasing intra-row spacings from 5 to 20cm significantly increased bulb diameter in 2010 dry season. Similar observations have been reported by Khan et al. (2003) whom reported that wide spacing produced higher value of bulb diameter.
Individual bulb weight
The result of this investigation revealed that increasing intra-row spacings from 5 to 20cm significantly ($P < 0.01$) reduced cured bulb yield (t/ha) in all the trials, although intra-row spacings 15 and 20cm produced statistically similar cured bulb yield (t/ha) in 2010 dry season. Variation in spacing, caused significant effect on cured bulb individual bulb weight of garlic was affected by intra-row spacings (Table 3). Increasing intra-row spacings from 5 to 20cm significantly ($P < 0.01$) increased individual bulb weight in all the trials except in 2010 dry season, where increase of spacing from 15 to 20cm reduced individual bulb weight significantly. Intra-row spacings of 5 and 10cm produced statistically similar individual bulb weight in all the trials. Similarly 10 and 15cm intra-row spacings recorded statistically similar individual bulb weight in 2011 dry season. The result of this investigation indicated that individual bulb weight of garlic was affected by spacing. Increase of intra-row spacing from 5 to 20cm significantly increased individual bulb weight in all the trials except in 2010 dry season. This result could be due to the declining level of inter-plant competition. Adejpe et al. (2004) also found similar response.

Cured bulb yield tonne per hectare (t/ha)
Variation in intra-row spacings caused significant effect on cured bulb yield (t/ha) (Table 4).
Table 2: Bulb weight and cured bulb yield as affected by intra-row spacing in 2010 and 2011 dry seasons.

<table>
<thead>
<tr>
<th>Treatment Spacing (cm)</th>
<th>2010</th>
<th></th>
<th>2011</th>
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<tbody>
<tr>
<td></td>
<td>Bulb weight</td>
<td>Cured Bulb yield</td>
<td>Bulb weight</td>
<td>Cured Bulb yield</td>
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<tr>
<td></td>
<td>(g)</td>
<td>(t/ha)</td>
<td>(g)</td>
<td>(t/ha)</td>
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<tr>
<td>5</td>
<td>2.40&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>4.92&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.38&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.40&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>10</td>
<td>2.57&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.24&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.58&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.20&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>15</td>
<td>2.88&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.17&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.76&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.16&lt;sup&gt;c&lt;/sup&gt;</td>
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Means within a column having same letter (s) are statistically similar at 1% level of significance.
** = 1% level of significance.

**Conclusion**

Based on the results obtained in this study, it could be suggested that the use of 5cm intra-row spacing appeared to be the optimum for garlic using variety Ex-Sokoto under similar environmental condition.

**References**


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