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EFFECT OF INTRA-ROW SPACING ON GROWTH PERFORMANCE OF GARLIC (*ALLIUM SATIVUM*) AT THE EXPERIMENTAL SITE OF WOLLO UNIVERSITY, SOUTH WOLLO, ETHIOPIA

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ABSTRACT: *A field experiment was conducted at the experimental site of Wollo University, kelemeda during in 2013 cropping season. The objective of this study was to determine the effect of intra-row spacing on the growth performance of garlic. The experiment was conducted on a randomized complete block design with three replications. Only one local variety was used on the experiment. The result of the experiment revealed significant difference among treatments with regard to plant height at 56 days after emergence. Plant height was influenced by intra row spacing such that plant height increases when the intra row spacing of the plant decreases. A significance difference was also recorded in leaf width, leaf length and leaf number per plant as influenced by intra row spacing (P<0.05). The highest leaf width (1.99) was recorded in treatment five (planted with 20cm plant spacing). The wider the plant spacing the higher was the leaf number. However the results of the experiment did not include yield components. Thus, a similar research should be conducted so as to assure the results of this experiment and to include yield components.*

KEYWORDS: Garlic, Growth Performance, Experiment

INTRODUCTION

Garlic (*Allium sativum* L.2n=16) belongs to the family alliaceae and is the second most widely used Allium next to onion (Rubatzky and Yamaguchi, 1997). Garlic is one of the most ancient cultivated herbs and it is vegetatively propagated by cloves. This method of propagation allows the production of uniform crop that preserves quality traits such as flavor and nutritive properties of the plant (Ibioner, 1989, Salomon 2002). The garlic bulbs consists of numerous cloves which is the main economic organ consisting largely of swollen bladeless storage leaves. Although bolting occurs occasionally seed do not form (Brewster, 1994). Garlic is the basic flavoring for a multitude of dishes ranging from vegetable crop, meat, salad-tomato combination, spaghetti, sausages, pickles etc. (Brewster, 1994).Green

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and balanced crops are eaten fresh and cooked in many ways similar to those green onions. Especially in the tropics consumption of immature bulbs for salad use is also popular. Considerable amount of garlic. Especially in North America, are processed to dehydrated chips, flakes, granules and powder (Rabinowitch and Brewster, 1990).

The world garlic cultivation was increased from 771,000 ha in 1989-91to1, 126,000 ha of land in 2002 with total production of 6.5 million and 12.1 million tons respectively .The major producing countries are china, India, Korea republic (FAO,2003). In Ethiopia the alliums group (onion, garlic and shallot) are important bulb crops produced by small and commercial growers for both local use and export (Yohannes, 1987, Metasebia and Shimels, 1998). This crops are produced for home consumption and as source of income to many peasant farmers in many parts of countries (Getachew and Asfaw. 2000). Metasebia and Shimels (1998) reported that the per capita consumption of these crops is estimated to be over 1.74kg and 5.9kg in the rural and urban centers respectively. In Ethiopia statics on the production of alliums crops showed that about 29,060 ha of land was cultivated and 0.28 million tones of bulbs were produced in the year 2005/2006. Of the total cultivated alliums, the area coverage of garlic in 2005/2006 was 1248 1 ha, with a production of 1,071,719 quintal of bulbs being produced by 1,743,868 land holders. The production is carried out throughout the country both under irrigation and rain fed condition in different agro climatic conditions (CSA, 2006).

Planting larger cloves of garlic will produce larger bulbs than planting smaller cloves. The size bulbs harvested is directly related to the size of cloves planted and the spacing of plants. Bulb yield increases with decrease in plant density and this has been shown to correlate with the percentage of light interception by the crop leaf canopy (Brewster, 1994). Garlic now a day is an important cash crop in may part of the world. It is also produced in different part of Ethiopia, and is among the main commercial horticultural crop giving high return to producers. Its shelf life is relatively longer than other Allium crops.

Besides its economic importance and other multiple advantages of the crop, productivity of the crop is very low because of inappropriate production technologies such as plant density, fertilization, and pest and disease control. Thus this research was initiated to address the low productivity of garlic by implementing appropriate plant density.
The research was initiated to address the following main objectives

- ✓ To identify the optimum intra row spacing of garlic for maximum growth performance
- ✓ to evaluate the effect of intra row spacing on the yield and yield component of garlic

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RESEARCH METHODOLOGY

Description of the study area

The experiment was conducted in south Wollo Zone, at the experimental site of Wollo University, Kelem meda which has an altitude of 2600 m.a.s.l, annual rain fall ranging from 900 – 1000 mm and the average temperature ranging from 12oc – 26^{o}c. The soil type of the experimental site is heavy clay soil and the weather condition of the area is under "Dega".

Experimental Design

Local cultivar of garlic clove was used as a test crop for the Experiment, there were five treatments /0x40,5x40,10x40,15x40 and 20x40/ arranged in RCBD design with three replication. The total size of the experimental area was 70m^2. After preparation 10 plots were done with plot size of 1.5 m^2 with the distance of 0.5m between plots and 1m between blocks. The type of bed was raised bed with height of 15cm. 10cm was left during data collection to avoid border effects.

Data Collected

Data were recorded for the following parameters. All data pertaining to growth were collected from four plants randomly sampled from two central rows.

Plant height (PH). The length of the plant from the soil surface to the tip of the longest leaf. It was measured from the surface of the soil to the tip of the leaf by selecting four plants randomly in each treatment and the average plant height was taken in cms at the final date of data recording (56 days after emergence).

Leaf length (LL): It was recorded by selecting four plants from each treatment and the average leaf length was taken in cm by measuring the length from the base of the leaf to the top of the leaf at 56 days after emergence.

Leaf width (LW): It was measured by selecting four plants randomly from each treatment and the average leaves width was taken in cm by measuring the width at the middle part of the leaves (at widest part of the leaves) at 56 days after emergence.

Leaf number per plant (LN): It was determined by counting the healthy leaf by selecting four plants randomly from each treatment and average leaf number was taken at 56 days after emergence.

Biomass YIELD (YBM): The average yield biomass was measured by selecting four plants randomly from each treatment by uprooting them from the ground and remove the soil from the root part of plant. The average yield by biomass was taken in gram as the final date of data recording/67 days after emergence/

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RESULT AND DISCUSSIONS

Effect of intra row spacing garlic plant Height

The result of the experiment showed a significant difference among treatments with regard to plant height at 56 days after emergence (Table 1). The result showed that plant height was influenced by intra row spacing. The plant height increased, when the intra row spacing of the plant decreased. A plant with 0x40cm spacing was statically similar with treatment two planted with 5x40cm and 10x40 spacing but the measured plant height for treatment one was higher than treatment two & treatment three. The lowest plant height (53.25cm) was recorded from 20x40cm plant spacing. In general highest plant height was recorded from the narrowest plant spacing. This might be due to competition for light at high plant population density. At wider spacing due to less competition for light and other resource, plans remained unaffected by plant density. These results are in agreement with the results obtained by Jones and Mann (1963), Brewster (1994) on garlic.

Table 1 ANOVA table for plant height of garlic plant

Source of Variation	df	SS	MS	F-cal	F-tab 0.05	0.01
Treatment	4	21.7891	10.395x4	14.085*	6.04	18.0
Block	2	1.754	0.738x2	0.511^{ns}		
Error	8	3.951	0.377*8			
Total	14					
CV%			1.089			

* Significance difference among treatment, ns-non significance difference among blocks at 0.05 significance level.

Effect of Intra Row spacing on leaf width of Garlic

The analysis variance showed significance difference in leaf width on garlic plant as influenced by intra row spacing at P<0.05 (Table 2). The lowest leaf width (0.73) was recorded in treatment one (planted with 0cm plant spacing) while the highest leaf width (1.99) was recorded in treatment five (planted with 20cm plant spacing). However, treatment three was statically similar with treatment four even if there was numerical difference between them. This result may be attributed to the fact that wider plant spacing showed less competitive for resource and as a result leaves develop to larger size; this result was in conformity with findings of Om and Srivastava (1977) on garlic.

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Table 2 ANOVA table for leaf width of garlic plant

Source of Variation	df	SS	MS	F-cal	F-tab 0.05	0.01
Treatment	4	0.808	0.202	13.391*	6.04	18.0
Block	2	0.025	0.0125	0.862^{ns}		
Error	8	0.464	0.0145			
Total	14					
CV%			2.73			

Effect of Intra Row spacing on leaf length

The data obtained from the experiment showed that significance difference was recorded in leaf length on garlic plant as influenced by intra row spacing at P<0.05 (Table 3) As presented in table 3,statically treatment one planted with 0x40cm was similar with treatment two planted with 5cm plant spacing. However there was numerical difference between them.

Table 3. ANOVA table for leaf length of garlic plant

Source of Variation	df	SS	MS	F-cal	F-tab 0.05	0.01
Treatment	4	68.181	17.091	13.30*	6.04	18.0
Block	2	4.822	2.411	1.876^{ns}		
Error	8	10.141	1.285			
Total	14					
CV%			2.569			

Leaf length showed increasing trend when plant spacing decreased. The higher leaf length (51.34cm) was recorded from 0cm plant spacing planted treatment where as the lowest leaf length (43.21cm) was recorded from treatment three planted with 20x40cm plant spacing. Similar views were expressed by Dahania and Gajipara (1998) 0n garlic and onion.

Effect of Intra Row spacing on Leaf number per plant

The result of the experiment showed that there is a significance difference (p<0.05) among treatments with reference to leaf number per plant (Table 4). Statically no difference between treatment four (planted with 15x40cm) and treatment five 9planted with 20x40cm) but they are numerical difference. The highest leaf number per plant (6.117) was recorded from treatment two (planted with 10 x 40cm plant spacing) whereas the lowest leaf number

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per plant (3.04) was recorded from treatment one (planted with 0 x 40cm intra row spacing). In general, the wider the plant spacing the higher was the leaf number (table 4).This result is in agreement with finding of Om and Srivastava (1977) on garlic. Singh and Sachan (1999) also reported on garlic and onion that the greatest number of leaves per plant was found in the widest spacing. This could be partly due to the fact that wider spaced plants produce more axial branching than plants spaced at closer spacing.

Table 4 ANOVA table for leaf number of garlic plant

Source of Variation	df	SS	MS	F-cal	F-tab 0.05	0.01
Treatment	4	0.808	0.202	13.615*	6.04	18.0
Block	2	0.364	0.182	12.297^{ns}		
Error	8	0.12	0.015			
Total	14					
CV%			1.089			

Effect of Intra row spacing on yield bio mass of garlic plant

The analysis of the variance showed a significant difference in yield bio mass of garlic plants as influenced by intra row spacing at $p<0.05$. The lowest yield bio mass (10.6) was recorded in treatment one planted with 0 cm plant spacing. While the highest yield bio mass (32.66) was recorded in treatment three planted with 15 cm plant spacing. However treatment four was statically similar with treatment five even if there were numerical difference between them. This result may be attributed to fact that wider plant spacing showed less competitive for water, sun light, space and essential minerals. As a result the plant develops to a larger size and larger yield bio mass. This result was inconformity with findings of Om and Srivastava (1970) on garlic.

Table 5 ANOVA table for biomass yield

Source of Variation	df	SS	MS	F-cal	F-tab 0.05	0.01
Treatment	4	1088.4	271.1	1.82*	0.354	7.01
Block	2	105.73	52.866	2.306^{ns}		
Error	8	1194.4	149.267			
Total	14					
CV%			1.089			

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CONCLUSION AND RECOMMENDATION

The spacing used in the study showed significant variation among the different treatment in most of the parameter recorded. Moreover, many of the parameters like number of leaves per plant at 56 days after emergence, plant height, leaf number, and leaf length and yield bio mass were significantly affected due to the intra raw spacing difference. When the distance between plants increased the yield related parameters were increased. This is because plan density affects most of the yield indicators of garlic (the parameters considered) due to completion for light, space, and resources. Generally the wider the plant spacing the better growth performance of the garlic plant.

Due to time constraint, it is not able to include yield components. However, the yield related parameters are good indicators of yield. Thus those treatments which showed better performance of morphological parameters also suggest positive relation with yield. In order to check the positive relation of morphological parameters with yield a similar experiment should be conducted which further assure the results of the present experiment.

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