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Intra Row Spacing Effect on Growth Performance of Garlic (Allium Sativum (L.)) at Wolaita Sodo Southern Ethiopia

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Abstract
The experiment was conducted at Wolaita sodo University collage of Agriculture, Department of horticulture practical site (research site) during in 2011EC. 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 (RCBD) with three replications and three treatments those are 8cm, 10cm and 12cm between plants. The raw data of each parameter from each plot and replication were collected and analyzed by analysis of variance (ANOVA) and least significant difference (LSD) was used to separate means at $p<0.05$ probability levels of significance with scientific calculator or SAS 9.2 Soft ware version. 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 50 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 (10.6) was recorded in treatment three (planted with 12cm 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, Intra row spacing
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1. INTRODUCTION

Garlic (Allium sativum L.) is an important spice crop belonging to the family Alliaecae (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 bullets called cloves. The leaves consist of flat longitudinal folded blades diverging at widely spaced intervals from the false solid stem. Garlic has been used both as food and for medicine in many cultures for thousands of years. Garlic is a basic flavoring for a multitude of dishes ranging from vegetable sauce, meat, salad, tomato combination, spaghetti, sausages, pickles, etc (Brewster, 1994). Green and blanched tops are eaten fresh and cooked in ways similar to those green onions, especially in the tropics. Consumption of immature bulbs for salad use is also popular. Considerable amounts of garlic, especially in North America, are processed to dehydrated chips, flakes, granules, and powder (Rabinowitch and Brewster, 1990). Garlic is one of the best-studied medicinal plants that its antibacterial and antiseptic property is well known. Garlic contains remedies, which were applied against heart problems, headache, bites, high cholesterol, high blood pressure, cancer, common cold, and plaque. Worms and tumours (Keusgen, 2002). Brewster (1994) reported that many actions associated with garlic supplements may help prevent or alleviate arteriosclerosis. Garlic has been demonstrated to kill parasites including amoeba and hookworm in test tubes and animals. Garlic's active constituents have also been shown to kill HIV in the test tube, though these results have not been confirmed in human trials (WWW. health notes. com, 2002). Garlic has the high contents of oregano sculpture antioxidant compounds (Abdel Wahhab et al., 2012). It has-been successfully used in AIDs patients to treat cryptosporidium in China (Sovovo, 2004).

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, found in hot and humid lowlands (Grubben, 2004). Garlic has a wide area of adaptation and cultivation throughout the world; it is grown from temperate to sub tropical areas (Mohammed et al., 2012; Fritsch and Friesen, 2002). Its production occurs in many countries and cultivation ranges from the equator to about 50^0 latitude (Nonnecke, 1989). The world garlic cultivation was increased from 771,000 ha in 1989-1991 to 1,126,000 ha of land in 2002 with total production of 6.5 million and 12.1 million tons respectively. China, India and Korea Republic and Egypt are the major garlic producing countries in the world (FAO, 2011).

Garlic thrives well on fertile, well drained sand or silt loam soils with good moisture retaining properties (Sovovo, 2004). Garlic is primarily grown for its cloves used mostly as a food flavoring condiment. But many

producers in northern Iran cultivated this crop for its leaves to prepare different local dishes (Olfati et al., 2010). Garlic production requires a growing period of 4.5-6 months and the amount of rainfall ranges between 600 mm to 700 mm during its production season. Garlic production spread throughout the country and has been cultivated under irrigated as well as rain fed conditions, mainly in the mid and highlands of Ethiopia (Lemma and Hearth, 1994).

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 Shimelis, 1998). These crops are produced for home consumption and as a source of income to many peasant farmers in many parts of the country (Metasebia and Shimelis, 1998; Getachew and Asfaw, 2000). Statistics on the production of Alliums crops showed that about 15,290 ha of land was cultivated and 0.21 million tons of bulbs were produced in the year 2001-2002 (CACC 2002). According to the report of Metasebia and Shimelis (1998) the per capita consumption of these crops is estimated to be over 1.74 kg and 5.9 kg in the rural and urban centre, respectively. Among vegetable crops garlic ranks fourth in the number of landholders next to Ethiopian cabbage (2.23 million landholders), red peppers (1.30 million landholders), and potatoes (1.15 million landholders).In Tigray garlic is one of the high value vegetable crops produced during the cold season, in rotation with pulses that have contributed in breaking the life cycle of pest problems and improve soil fertility (Gebremedhin et al., 2010). In the year 2011-2012 production season, the area covered by garlic production was about 616.10 ha; the total production obtained from this hectare was 8891.8 tones (CSA, 2012).

1.1. Statement of problem

Garlic has multi use crop through the world. It is used for domestic consumption, for pharmaceutical value, and for spice purpose. As result its demand is increasing from time to time. To balance this demand the world garlic production should be increased but in Ethiopia the total area under garlic production in 2006/07 reached 9,266 hectares and the production is estimated to be over 683,000 quintals (MoARD, 2007).This indicates that the garlic production in Ethiopia is low. This might be due to many constraints such as poor agronomic practice, lack of improved variety, inappropriate disease, pest management and spacing. If the plants are densely planted it may not get sufficient nutrients due to great competition between them. Again if far away than optimum space the land will left without productive. Depending on the above fact this research proposal is proposed to evaluate the effect of intra row spacing on growth performance of garlic under wolaita sodo condition.

1.2. Objectives

General Objective

To identify the effect of intra row spacing on growth performance of garlic in wolaita sodo University

Specific Objectives

To determine the optimum intra row spacing on growth performance of garlic

2. MATERIALS AND METHOD

2.1. Experimental site

The experiment will be conduct at SNNP regional government in Wolaita zone, experimental site of Wolaita Sodo University south west of Addis Ababa. The experiment will be conducted under field conditions Wolaita sodo University College of Agriculture and Department of Horticulture demonstration site (research field). In the year of 2011 EC under supplementary irrigation. It is located in the southern part of Ethiopia with have 330Km far from Addis Abeba and geographically at 6-49^0 latitude and 37-45^0 longitude east and at elevation of 1800 *m.a.s.l.* with annual mean rainfall 1212mm. The soil of area is Clay loam with a PH 5-6.4 (wsu students hand book).

2.2. The Experimental material

The experimental materials such as local verities of garlic cloves, meter, ruler, pegs, typing paper, fertilizer such as DAP and UREA, watering cane, shovel, weighing balance, buckets, calculator, pen, note book and land were used during the experiment.

2.3. Experimental design

A Randomized Complete Block Design (RCBD) with three treatments and three replication was used. The total experimental area was(4.6*5.6)m^2 having a total area of 25.76m^2 which was divided in to three small homogenous blocks or replication and each blocks contains complete set of the treatments which was allotted to the plots within each block at random. Accordingly the total experimental area was divided in to three replication perpendicular to the soil fertility gradient.

2.4. Land preparation treatment and field layout

The land was cleared, ploughed (disked), leveled; large clods were broken down. Then remnant, stalks, non-

decomposed crop residues, weeds, and other unwanted materials were removed. Then soil was smoothed or fined and the land was laid out to evaluate the effect of different plant spacing on growth performance of garlic. Three levels of garlic intra row spacing (8cm, 10cm and 12cm) were used. After preparing the plots at 20 cm height with the plant spacing of 8cm, 10cm and 12cm in the end of fertilizer was applied according to national recommendation at the rate of 92kg/ha DAP and 92 kg/ha urea. The total DAP was applied during planting time. But urea was applied (9.4gm) in split of two times in each plot to increase growth of garlic during planting and after 28 days of planed and 42 days. The planted garlic cloves were taken under irrigation every day as the rain is available (if there equally to all individual plots except intra row spacing. Weeding and earthling up well be done by schedule when there were the appearances of weeds in plants.

2.5. Collected Data

Data related to growth parameters, such as plant height above the ground, leaf number, leaf length leaf width were collecting.

2.6. Method of data collection

Plant height (cm): A Plant height was measured in centimeter from the soil surface to the tip of matured leaf in the plant at maturity by a ruler.

Leaf number per plant: was measured the mean number of leaves produced by sampled plants and **were measured** calculated by dividing the total number of leaves counted from the sampled plants to the number of sampled plants to get mean leaf number per plant.

Leaf length (cm): The length of three leaves per plant (from upper, medium and lower) was measured at maturity by using ruler and the average leaf length was taken**.**

2.7. Method of Data Analysis

The raw data of each parameter from each plot and replication were collected and analyzed by analysis of variance (ANOVA) and least significant difference (LSD) was used to separate means at $p<0.05$ probability levels of significance with scientific calculator or SAS 9.2 soft ware version.

3. RESULT AND DISCUSSION

3.1. Growth parameters

Table 2: Effect of intra row spacing on, plant height, leaf length and leaf number

Plant spacing(cm)	Plant height(cm)/plant	Leaf length/plant(cm)	Leaf number/plant
	Mean	Mean	Mean
8cm	37.32	32.49	6.31
10cm	37.36	34.36	6.36
12cm	38.16	33.98	6.33
LSD	1.7236	5.45	0.5
CV%	2.04	1.75	3.42

In a column treatments having similar letter(s) do not differ significantly or Means with the same letter are not significantly different.

CV=coefficient of variation, LSD=least significance difference

3.1.1. Plant height

The analysis of variance revealed that there is significant ($p<0.05$) difference among treatments with regard to plant height (Appendix 1). The experimental 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 treatment with 8x30 cm was significant statically on plant height with other treatments. There was significant difference between plant height produced by the plants which were spaced 8x30cm, 10x30cm and 12x30cm. However, mean separation shows that the highest plant height was recorded by treatment 3(8cm), followed by treatment two (10cm), treatment three (12cm), which had average mean of plant height (37.32cm), (37.36cm), (38.16cm), respectively (table 1). 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. But at wider spacing due to less competition for light and other resource, plants remained unaffected by plant density. These results are in agreement with the results obtained by Jones and Mann (1963), (1994) Brewster on garlic.

3.1.2. Leaf length

The data obtained from the experiment showed that non significance difference was recorded in leaf length on garlic plant as influenced by intra row spacing at $P<0.05$ (Appendix 2). A treatment with 8x30cm spacing was none significantly different on leaf length with treatments 10x30cm and 12x30cm. Although leaf length was none significantly affected by 8x30cm, 10x30cm and12x30cm factors, generally leaf length showed decreasing trend as intra row spacing increased. That means, the highest leaf length was recorded from treatment one, followed

by treatment two, treatment three (Table 1). This indicates that, as spacing between plants increasing leaf length also increases. These results are in agreement with the results obtained by (Dhakular and Dalal, 2009) effect of spacing on garlic plant height and leaf length.

3.1. 3. Leaf number/plant

The result of the experiment revealed that there is a significance difference ($p<0.05$) among treatments with reference to leaf number per plant (Appendix 4). The intra row spacing at 10x30 cm significantly increased leaf number ($P<0.05$) over other intra row spacing.

In general, the wider the intra row spacing the higher was the leaf number (Table 1), that means the highest leaf number per plant (6.36) was recorded from treatment two (planted with 10 x 30cm spacing between plants), whereas the lowest leaf number per plant (6.31) was recorded from treatment one (planted with 8x30cm spacing between plants). This could be partly due to the fact that wider spaced plants produce more axillary branching than plants spaced at closer spacing that resulted in higher leaf number per plant. This result is in agreement with the findings of Om and Srivastava (1977) on garlic. Singh and Sachan (1999) also reported on onion that the greatest number of leaves per plant was found in the widest row spacing.

4. 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 50 days after emergence, plant height, leaf number, and leaf length were significantly affected due to the intra raw spacing difference. 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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7. APPENDIXES

Appendix Table 1: Analysis of variance on plant high

Source of variation	DF	SS	MS	F cal	F tab	
					5%	1%
Treatment	2	1.337	0.6685	1.136	6.94	18
Block	2	23.89	11.945	20.3**		
Error	4	2.353	0.588			
Total	8	27.58				

Appendix Table 2: Analysis of variance on leaf length (cm)

Source of variation	DF	SS	MS	F cal	F tab	
					5%	1%
Treatment	2	5.85	1.44	0.249	6.94	18
Block	2	10.75	5.355	0.92		
Error	2	23.14	5.77			
Total	8	39.7				

Appendix Table 3: Analysis of variance on leaf number

Source of variation	DF	SS	MS	F cal	F tab	
					5%	1%
Treatment	2	0.11	0.055	1.15	6.94	18
Block	2	7.67	3.835	80.7**		
Error	4	0.19	0.0475			
Total	8	7.91				