American-Eurasian J. Agric. & Environ. Sci., 17 (3): 227-231, 2017
ISSN 1818-6769

DOI: 10.5829/idosi.aejaes.2017.227.231

Influenced of Clove Weight and Depth of Planting on Yield and Yield Components of Garlic (*Allium sativum* L.) at Madawalabu University Experimental Site, Bale Zone, South Eastern Ethiopia

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Abstract: The study was carried out to determine the effect of clove size and planting depth on yield and yield components of garlic (*Allium sativum* L.) in Bale zone Madawalabu University experimental site during the 2016 autumn cropping season. The treatments consisted of three clove weights: large (3.60-4.5g), medium (2.6-3.5g) and small (1.5-2.5g) and four planting depth viz., 1.5, 2.5, 5 and 7cm using Kuriftu variety. The experiment was conducted using a randomized complete block design (RCBD) in a factorial arrangement with three replication. The results of this study revealed that interaction effects of clove weight and planting depth significantly influence plant height, mean bulb weight, total bulb yield and bulb diameter. The highest plant height, mean bulb weight ,total bulb yield and bulb length obtained when medium cloves weight and 2.5-5 cm planting depth, whereas the lowest plant height, mean bulb weight, total bulb weight and bulb diameter obtained when small cloves weight and 1.5 cm and 7cm planting depth was used. The main effects of clove size had significant influence on days of emergence, leaf length, leaf number plant^{-1}, total bulb weight, un-marketable yield and marketable yield. For all parameters the highest and lowest result was observed for plants that were raised from medium weight cloves and small clove weight respectively and highest result was observed in 5cm and lowest in 7cm depth of planting. The results of this study indicated that, using medium clove weight(2.6- 3.5g) with 2.5-5cm planting depth produced higher vegetative growth parameters , maximum garlic bulb yield and bulb quality (bulb diameter and average bulb weight). Therefore, it is suggested that planting medium clove weights with planting depth of 2.5-5cm produces the highest bulb yield and enhances the quality of garlic.

Key words: Bulb yield · Clove weight · Garlic · Planting depth

INTRODUCTION

Garlic (*Allium sativum* L.) is the foremost alliaceous vegetable plant and one of main vegetable crops worldwide. It has been used for flavoring, soup, sausages and salads, in addition to its medical value. It is one of the most important crops worldwide ranking second after onion in order of importance and cultivation [1]. Garlic is rich in sugar, protein, fat, calcium, potassium, phosphorus, sulfur, iodine, fiber, silicon and vitamins [2, 3]. The demand on garlic crop worldwide is increasing due to its medicinal value and economic importance. The world average yield of garlic is about 10 tons ha^{-1}, but can be increased up to 19 tons ha^{-1}. The increase in yield and improving bulb quality of garlic is usually dependent on many factors that influence the plant growth throughout the growth. Several studies in various parts of the world have shown that garlic production can be improved through appropriate cultural practices [2, 4-6]. The yield potential of garlic plant depends on the extent of vegetative growth attained before the formation of bulb commences [7]. The productivity of garlic in many parts of the world is low. A range of factors may contribute to garlic not achieving their potential yield. Among these factors influencing yield quantity and quality, planting depth and clove weight and planting depth are the most relevant. The use of clove weight and inappropriate depth could considerably reduce the yield and quality. In an

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investigation on a single garlic cultivar, [5] found higher emergence, heavier clove and higher early bulb yield with larger clove and that graded clove generally produced more uniform bulbs. Apart from being the principal method of reproduction, the clove is largely responsible for the pungent quality having the highest amount of sulphur compound compared with other crop parts [6]. Some growers grade their cloves by size/or weight and plant the largest ones. But most farmers use cloves varying in sizes/ or weights, which might affect plant stand, vegetative growth and bulb yield and quality. According to [5], large clove size produced higher garlic quality and improved bulb yield (bulb weight, bulb diameter and number of cloves per bulb) of the harvest. Hence, the need for grading of the cloves to be planted and also to determine the most appropriate planting depth for garlic, so that both its yield potentials would be properly exploited. In our country, there is little information available on effect of clove weight and planting depth in garlic production and productivity. Therefore, the objective of this study was to determine the effect of clove weight and planting depth on the bulb yield and yield component of garlic.

MATERIALS AND METHODS

The study was conducted at Madawalabu University experimental site, by using the three clove weight: large (3.6-4.5g), medium (2.6-3.5g) and small (1.5-2.5g), and four planting depth viz., 1.5, 2.5, 5 and 7cm. Clove weight classification is according to [8]. The experiment was laid out as a randomized complete block design (RCBD) in a factorial arrangement with three replications each. The gross plot size was (1.5m by 1m). The spacing between plots and blocks was 0.5m and 0.75m, respectively. The treatments were randomly assigned to each plot. Data on yield and yield components were determined from plants in the middle four rows, excluding plants in the two border rows as well as those at both ends of each row to avoid border effects. Recommended applied dose of inorganic fertilizers @150kg N & P ha^{-1} in the form of urea and DAP were used. P was incorporated into the soil at basal during planting and nitrogen was applied in two split application at 4 and 6 weeks after planting. Clove of *Kuriftu* variety obtained from Debrezit research center was used and planted upright with apical tip. Planting was carried out to provide good clove soil-water contact and thereafter irrigation was done once a week on the time of scarcity of rainfall. Other agronomic practices was done as per the need and traits such as: days to emergence, days to maturity, plant height, leaf length, number of leaves $plant^{-1}$, mean bulb weight, bulb length, bulb diameter, total bulb yield $plot^{-1}$, total bulb yield ha^{-1}, unmarketable and marketable clove category where measured.

Data Analysis: The data were subjected to analysis of a variance (ANOVA) using SAS software version 9.1 (13). All significant pairs of treatment means were compared using the Least Significant Difference (LSD) test at 5% level of significance.

RESULTS AND DISCUSSION

Days to Emergence and Maturity: The main effect of clove size was significant ($P<0.05$) on the number of days required for emergence of the plant above the soil surface. However, the main effects of planting depth as well as the interaction effect of clove weight and planting depth were not found significant on the said parameters. When the weight of clove was increased from small to medium and large the number of days required for emergence of the plant above the soil surface was significantly and linearly decreased (Table 1). The longest duration for emergence was required by plants from the small cloves weight whereas the shortest duration was required by plants from large-weight cloves. Earlier emergence of garlic plants from the large-weight cloves than small weight ones could be attributed to availability of higher amounts of stored food. This result was in agreement with the findings of [7] and [5] show that large-sized cloves emerged earlier and produced higher garlic yield with improved bulb quality (bulb weight, bulb diameter and number of cloves per bulb) than small-sized ones. The flinging of [9] also reported that percentage of seedlings emergence was significantly ($P<0.05$) increased by using cloves with weights of more than 1.5g compared with clove weights less than 1g. On the other hand, days to maturity was not significantly influenced by clove weight, planting depth, and their interaction.

Plant Height and Leaf Length: Plant height and leaf length were significantly ($P<0.05$) and highly significantly ($P<0.01$) influenced by interaction of clove weight and planting depth, respectively. This result is in consistent with the findings of [8] reported large-sized cloves produced plants which were taller $plant^{-1}$. The main effects of clove weight significantly influence this leaf length, and planting depth also significantly influence on the trait of plant height. The highest plant height was

Table 1: The main effects of clove size and plant depth on days to emergence and days to maturity.

Treatments	Days to emergence	Days to maturity
Clove Weight (g)		
Small	8.2 c	138.0
Medium	10.5 b	137.3
Large	12.6 a	138.0
LSD (0.05)	0.69	Ns
CV (%)	7.1	1.1
Plant Depth		
1.5cm	11.4	129
2.5cm	12.56	131.5
5cm	12.98	131
7cm	13	130.72
LSD (0.05)	Ns	Ns
CV (%)	7.1	1.12

Means followed by the same letter within a column are not significantly different at 5% level of significance.

Table 2: The main effects of clove size and plant depth on plant height, leaf length and leaf number per plant

Treatments	Plant Height	Leaf Length	Leaf No /Plant
Clove Weight, (g)			
Small	43.911	26.48^{AB}	11.409
Medium	47.598	27.632^{A}	12.54
Large	45.745	23.54^{B}	12.34
LSD (0.05)	NS	3.6	NS
CV (%)	16.11	18.31	11.31
Plant Depth			
1.5cm	44.66AB	25.533	12.39
2.5cm	50.49A	25.962	12.46
5cm	47.66A	26.332	11.64
7cm	40.20B	25.632	11.35
LSD (0.05)	6.2	NS	NS
CV (%)	14.07	18.47	11.24

Means followed by the same letter within a column are not significantly different at 5% level of significance.

Table 3: The main effects of clove size and plant depth on bulb length and bulb diameter.

Treatments	Bulb Length	Bulb Diameter
Clove Weight(g)		
Small	3.5108	3.3750
Medium	4.1575	4.0717
Large	3.7167	3.7333
LSD (0.05)	NS	NS
CV (%)	22.94	23.96
Plant Depth		
1.5cm	3.5922 BC	3.4367
2.5cm	4.3667 A	3.6700
5cm	4.011 AB	4.000
7cm	3.210C	3.800
LSD (0.05)	0.772	NS
CV (%)	21.14	25.04

Means followed by the same letter within a column are not significantly different at 5% level of significance.

obtained when medium weight cloves were planted at the depth of 2.5-5cm. This is result of the positive effect of higher vegetative growth which was obtained by planting large clove weight, possibly lending to the development of larger bulbs and higher yield [7]. On the other hand, the lowest plant height and leaf length was recorded in treatments that involved planting of small cloves weight at planting depth of 7 cm in both site (Table 2).

Leaf Number Plant^{-1}: The main effects of clove weight and planting depth did not significantly affect leaf number plant^{-1}. In the same way, the interaction effects of clove weight and planting depth non-significantly influence on leaf number plant^{-1}. Even if significant difference is not observed there was numerical difference among the treatment. This result is in line with the finding of [8] reported that large-weight cloves produced plants were more leaves plant^{-1}.

Bulb Length and Bulb Diameter: The interaction effect of clove weight and planting depth was significant ($P<0.05$) on bulb length of garlic. The highest bulb length and bulb diameter were obtained when medium weight cloves were planted at the depth of 2.5-5 cm. Yet, the lowest bulb length was recorded in treatments that involved planting of small cloves planting at 7cm depth and the lower bulb diameter was at 1.5cm planting depth in both sites. Therefore, it can be evidently deduced that the combination of medium-weight cloves and planting depth of 2.5cm increased bulb length as compared to other combinations. Moreover, plots were planted with medium-weight cloves significant difference in bulb length from plots planted with small-weight cloves. Likewise, [5] reported that the smaller seed weight severely affected crop yield, bulb length and bulb diameter. On the other hand the main effect of bulb diameter showed non-significant effect on clove weight and planting depth. However, there is a numerical difference between the three treatments. [9] also indicated that bulb diameter higher when the largest clove weights were used as compared with the smallest clove weights and the least bulb diameter were achieved by using the small clove weights.

Mean Bulb Weight and Total Bulb Yield: The interaction effect of mean bulb weight and total bulb yield highly significantly ($P< 0.01$) and main effect of planting depth significantly ($P<0.05$) affected the mean bulb weight. The main effects clove size had non-significant. The present study showed that the highest mean bulb

Table 4: The main effects of clove size and plant depth on mean bulb weight and total bulb yield

Treatments	Mean Bulb Weight	Total Bulb Yield
Clove Weight(g)		
Small	187.42	326.33[B]
Medium	231.25	389.2[A]
Large	211.67	392.3[A]
LSD (0.05)	NS	24.623
CV (%)	27.42	21.40
Plant Depth		
1.5cm	185.56 [BC]	335.7
2.5cm	232.44 [AB]	355.7
5cm	243.33 [A]	405.5
7cm	179.11 [C]	353.7
LSD (0.05)	51.545	NS
CV (%)	25.48	26.93

Means followed by the same letter within a column are not significantly different at 5% level of significance.

Table 5: The main effects of clove size and plant depth on Marketable yield and Unmarketable yield.

Treatments	Marketable yield and	Unmarketable yield
Clove Weight (g)		
Small	296.00 B	20.167A
Medium	368.83 A	16.167AB
Large	365.83A	12.750 B
LSD (0.05)	65.505	7.4069
CV (%)	22.90	14.37
Plant Depth		
1.5cm	320.3	15.444
2.5cm	342.56	13.111
5cm	386.22	19.333
7cm	325.11	17.556
LSD (0.05)	NS	NS
CV (%)	28.64	26.78

Means followed by the same letter within a column are not significantly different at 5% level of significance.

weight was attained in response to combining planting of medium-weight cloves with 5cm planting depth. This was followed by planting large-sized cloves at the same planting depth this finding agreed with finding of [9] showed average bulb weight, were significantly ($P< 0.05$) higher when the largest clove were used as compared with the smallest clove weights and the least average bulb weight were achieved by using the small clove weights. Conversely, the lowest mean bulb weight was obtained in response to combining planting of small-weight cloves with the planting depth of 7 cm (Table 4). There was a positive increase in mean bulb weight at medium and large weight clove (3-4g). Weight might be ascribed to increase food reserved. On other hand, the main effects planting depth had non-significant but clove weight significantly effect on total bulb yield. The highest total bulb yield was attained in response to combining planting of medium-weight cloves with the planting depth of 5cm. This was followed by large clove weight with same planting depth. The present study agreed with the data obtained by [9] higher bulb yield was achieved when large (3.1-4g) cloves were used compared with other clove weights and also maximum garlic yield values (19.2 and 18.4 tons ha^{-1}) were achieved by using large clove weights (3.1-4.0 g). This could be a result of the positive effect of higher vegetative growth which was obtained by planting large clove weight, possibly lending to the development of larger bulbs and higher yield [7]. However, in this finding the total bulb yield was obtained in response to combining planting of large weight cloves with the planting depth of 2.5-5cm (Table 4).

Marketable Bulb: The main effect of planting depth and the interaction effect of clove size and planting depth had a non-significant effect on this parameter and the main effect of clove size significantly ($P<0.05$) affected the marketable bulb. Consistently increasing marketable bulb size was observed in response to increasing the weight of cloves planted. Thus, the thickest cloves (with the largest width) were obtained from plots planted with medium weight cloves. Planting small-weight cloves resulted in the production of small-size cloves (Table 5). This means that the failure of the small-weight seed cloves to develop into marketable bulb size due to higher competition for resources as compared to large weight seed cloves. This might be due to the presence of higher amount of initial reserved food material in the large weight cloves which enhanced more cell division and cell elongation resulting in vigorous plants that yielded larger bulbs than the medium and smaller ones. The study was in line with what had been reported by other researchers, such as [10] and [11] who stated that using medium cloves weight (3-4g) for planting produced marketable clove size. On the other hand planting depth had non-significant effect on marketable yield. The highest marketable yield was attained in response to combining planting of medium-weight cloves with the planting depth of 5cm. This was followed by large cove size with same planting depth (Table 5).

Unmarketable Bulb: The main effect planting depth was non-significant on the number of unmarketable bulb and even if they are non-significant different statically, they are numerically difference between the treatments. Clove weight are significantly influence unmarketable bulb.

CONCLUSION AND RECOMMENDATION

The need for garlic crop in Ethiopia as well as worldwide is increasing due to its medicinal value and economic importance. In Ethiopia, little information generated by research regarding cultural practice on garlic. The harvested garlic yield and size is directly related to the size of cloves planted and planting depth of the crop. Therefore, planting appropriate cloves of garlic at appropriate planting depth can improve garlic production. To this effect, an experiment was conducted during the 2016 cropping season at Maddawalabu University experimental site of Bale Zone Ethiopia, to determine the influence of clove size and planting depth on yield and yield components of garlic. The experiment was laid-out as a randomized complete block design in a factorial arrangement with three levels of clove weight; large (3.6-4.5g), medium (2.6-3.5 g) and small (1.5-2.5 g) and four planting depth (1.5, 2.5, 5 and 7 cm). The results revealed that interaction effects of clove weight and planting depth significantly influence plant height, mean bulb weight, total bulb yield and bulb diameter. The highest plant height, mean bulb weight, the highest total bulb yield and bulb length obtained when medium cloves weight and 2.5-5cm planting depth were used. While the lowest plant height, mean bulb weight total bulb weight and bulb diameter obtained when small cloves weight and planting depth at 1.5 and 7cm were used. Similarly, the main effects of clove weight had significant influence on days of emergence, leaf length, leaf number plant^{-1}, total bulb weigh, unmarketable yield and marketable yield significant. In all parameters highest and lowest result was obtained for plants that were raised from medium weight (2.6-3.5g) cloves and small weight (1.5-2.5g) clove, respectively. The main effects of planting depth had significant influence on mean bulb weight and bulb length. In these two parameters the highest results were observed in 5cm and lowest in 7cm depth of planting and plant height was significant. Hence planting medium clove weights with planting depth of 2.5-5cm produced higher vegetative growth parameters, maximum garlic bulb yield and bulb quality was considerably improved by using medium clove weight. Generally, planting medium clove weights (2.6-3.5g) with planting depth of 2.5-5 cm produces higher bulb yield and enhances the bulb quality of garlic.

ACKNOWLEDGEMENTS

We would like to greatly acknowledged Debrezit Agricultural Research Centers for their genuine support in provision of garlic clove and we are highly thankful to Madawalabu University, research and community service for smooth facilitation and funding of this study. We would also thank to College of Agriculture and Natural Resource staff especially Musa Negeso for unreserved help starting from field preparation up to data collection.

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