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Effect of seed clove size and spacing on growth performance of garlic

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Abstract

An experiment was conducted using different size of seed clove and different spacing to investigate their effect on the growth performance of garlic *(Allium sativum)*. The three different clove sizes were large, medium and small planted in four spacings of 25 x 20 cm, 20 x 20 cm, 20 x 15 cm and 20 x 10 cm. Large sized clove produced the tallest plants, longest root, maximum number of leaves/plant and stem length and total dry matter. Plant spacing of 25 x 20 cm gave longest root, maximum leaf number per plant and maximum leaf dry matter while the spacing of 20 x 20 cm gave maximum plant height and root dry matter. Maximum pseudostem length was found from the closest plant spacing of 20 x 10 cm. This study demonstrates that clove site and spacing greatly influence growth performance of garlic. Further studies are proposed to establish optimum clove sites and plant densities that could be recommended to farmers

Key words: *Allium sativum*, dry matter, garlic growth, plant density

Introduction

Garlic (*Allium sativum* L.) is the second most widely used cultivated *Allium* next to onion because of its pungent characteristics (Bose and Som, 1990). Garlic has been widely used for its medicinal purposes since prehistoric times. Augusti (1977) reported that garlic extract contains a sulphur-containing component allicin, which has a hypocholesterolaemic action that reduces cholesterol concentration in human blood. Garlic is also successfully used in the treatment of chronic infections of the stomach and intestine, dysentery, typhoid, cholera and lung diseases. It is also used in preparing various products including chutneys, pickles, curry powders, curried vegetables, tomato ketchup in different Asia and Middle- East countries.

In Bangladesh the total production of garlic is 38000 metric tonnes from an area of 13000 ha (BBS, 2000). The average yield is only 3.08 t ha^{-1} that is very low compared to the world average of 11.07 t ha^{-1} (Anon., 1998). The requirement of garlic in Bangladesh is about 85000 metric tons (Rahim, 1992). The demand of garlic consumption is increasing day by day with the ever-increasing population of Bangladesh. The only way to solve the problem is to increase the production. This can be done in many ways, such as early planting of healthy and suitable sizes of bulbs, use of appropriate plant densities and amounts of organic and inorganic fertilisers.

Garlic is generally propagated by cloves in Bangladesh. The size of cloves used in planting can greatly influence the growth and yield of garlic (Sultana *et al.*, 1997; Alam, 2000). Garlic bulbing and expression of life cycle depends on the size of cloves, ultimately affecting crop yield (Baten *et al.*, 1989). Thus, use of best quality seed cloves is essential for improved production of garlic. Plant spacing also influences the growth and yield of garlic (D' Anna, 1995; Singh *et al.*, 1995). However little is known about the effect of clove size and spacing. The present study was undertaken to study the effect of clove size and spacing on the growth and yield of garlic and recommend appropriate clove size and spacing for garlic cultivation.

Materials and methods

The studies were carried out at the Field Laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh from November 2000 to April 2001. A local cultivar of garlic *'Pabna'* was used in this experiment. Uniform cloves were selected for planting. Cloves were graded into three groups viz. large (95.1 g 100^{-1} cloves), medium (66.5 g 100^{-1} cloves) and small (46.3g 100^{-1} cloves). Cow dung at 10 t ha^{-1} and triple super phosphate (TSP) at 90 kg ha^{-1} were added to the soil at final land preparation. Urea at 120 kg ha^{-1} and muriate of potash (MP) 180 kg ha^{-1} were top dressed in two equal installments at 30 and 60 days after planting (DAP). The experiment was conducted in randomized complete block design with four replications. Plot sizes were 4 m x 1.5 m. The cloves were dibbled at about 5 cm depth of soil. Weeding and other agronomic operations were done as and when necessary. The first crop sampling was done on 30 DAP and was continued until 120 DAP. At the time of each harvest, the number of plants per $0.05m^2$ area was randomly sampled. The height of the plants was measured using a graduated scale placed from ground level to top of the leaves. The selected plants of each plot were uprooted carefully in order to ensure maximum root extraction and they were carried to the laboratory in properly labeled polythene bags to prevent transpiration and respiratory losses. Harvested plants were washed in tap water to remove soil and blotted with blotting paper to dry samples. The plants were separated into leaves, stems and roots. Number of leaves, length of root, leaves and pseudostem was recorded separately at each harvest. Leaf area of the individual plant was measured according to Rahim and Fordham (1989). Various plant components were oven dried at 80±2°C for 48 hours until constant dry weight was achieved. Total dry matter was measured by accumulating the dry weight of each portion of plant. The data were subjected to analysis of variation using MSTAT-computer package program and means compared by Duncan's Multiple Range Test (DMRT).

Results and discussion

Plant height

Plant height in all the cloves increased continually until about 110 DAP. Significant variation ($P \leq 0.05$) among clove sizes was found only at 90 DAP (Table 1). Plant height was maximum at 110 DAP followed by a slight decline due to senescence of the top leaf. The tallest plant (51.14 cm) was obtained from the large seed clove followed by medium (50.11 cm) and small (49.17cm) at 120 DAP. Baten *et al.* (1989) also reported similar results. Production of large plants from large cloves was conceivably due to higher food reserves in the large seed cloves. Effect of plant spacing on plant height was recorded from 30 DAP to 120 DAP (Table 1). Plant height increased steadily from 30 DAP to 90 DAP. Thereafter a sharp increase and maximum was apparent. The plant height values were significantly different at 30 to 90 DAP except at 70 DAP. But no significant variation ($P \leq 0.05$) was observed in plant height at the subsequent stages of growth. Maximum plant height (50.56cm) was observed on plants under the plant spacing of 20 x 20 this was followed by plant heights of 50.53 cm, 49.36 cm and 49.27cm recorded on plants under the plant spacings of 20 x 15, 25 x 20, and 20 x 10, respectively at 110 DAP. Thus, a proportionate increase in both plant population and plant height was oberved. Similar reports were made by Singh *et al.* (1995). Although maximum plant height was recorded for the large clove and closest plant density (20 x 10) at 110 DAP (data not shown), the combined effect of clove size and plant density did significantly influence plant heights at different growth stages.

Table 1. Effect of seed clove size and spacing on plant length and root length.

Seed clove size	Days after planting											
	Plant length (cm)						Root length (cm)					
	30	50	70	90	110	120	30	50	70	90	110	120
Large	21.48	22.84	26.92	37.02a	51.14	50.51	7.99	8.73	8.36	9.17	9.66a	9.98a
Medium	20.97	21.88	25.23	37.88a	50.11	50.00	7.91	7.81	7.9	8.62	7.97b	8.30b
Small	20.76	21.68	23.65	34.00b	49.17	46.73	6.82	7.58	7.45	8.32	7.71b	7.61b
CV%	15.8	14.0	15.4	11.4	6.6	10.8	17.9	14.5	13.3	18.0	14.6	16.8
LSD	ns	ns	ns	2.94	ns	ns	ns	ns	ns	ns	1.17	1.09
Spacing												
25 x 20	22.13a	24.78a	24.60	37.21	49.83	49.56	7.56	8.74	8.20	9.05a	9.09a	9.30
20 x 20	21.44ab	24.01a	24.25	37.54	50.56	50.14	7.79	7.81	8.31	7.92ab	8.77a	8.79
20 x 15	20.66ab	24.91a	25.77	35.27	50.53	49.75	7.98	7.62	8.94	9.18a	8.33ab	8.50
20 x 10	18.05a	18.22b	26.45	35.19	49.27	47.42	6.85	7.95	9.07	7.66b	7.61b	8.20
CV%	15.8	14.0	15.4	11.4	6.6	10.8	17.9	14.5	13.3	18.0	14.6	16.8
LSD	3.65	3.53	ns	ns	ns	ns	ns	ns	ns	1.25	1.01	ns

Root length

Root length of different clove sizes followed almost identical pattern with plant height (Table 1). Root length gradually increased with time (DAP). Significant variation ($P \leq 0.05$) in root length among small, medium and large sized clove was found at 110 and 120 DAP only. Longest roots were recorded from large clove size (9.98 cm) followed by medium (8.3 cm) and small (7.61 cm) at 120 DAP. Root length gradually increased from 30 DAPS till 120 DAP. The plant density significantly affected root length in different growth stages with the exception of 30, 50, 70 and 120 DAP. Longest root (9.3 cm) was found in the plant density of (25 x 20), followed by 20 x 20, 20 x 15, 20 x 10 at 120 DAP. The interactive effect of clove size and plant density did not significantly influence root length at different growth stages. However, maximum root length was found for small clove and plant density 20 x 20 at 120 DAP (data not shown).

Number of leaves per plant

Number of leaves per plant in different cloves increased gradually from 30 - 120 DAP (Table 2). No significant variation was found from 30 to 70 DAP but from 90 to 120 DAP a significant ($P \leq 0.05$) variation was recorded. Large cloves gave maximum number of leaves (8.57) followed by medium (8.21) and small clove (7.83), respectively at 110 DAP. This observation corroborates earlier reports of Rahim *et al.* (1984) and Baten *et al.* (1989). The large clove had vigorous vegetative growth that resulted in the highest number of leaves per plant. Different plant density at 30 DAP to 80 DAP significantly influenced number of leaves/plant. The subsequent stages showed no significant difference. The number of leaves increased until 110 DAP and thereafter declined. Plant spacing of 25 x 20 gave maximum leaf number (8.36) followed by plant spacing 20 x 20, 20 x 15 and 20 x 10, respectively, at 110 DAP. The result of the present investigation are contradictory to earlier reports by Singh *et al.* (1995). No significant interactions were observed between clove site and plant spacing with regard to number of leaves/plant.

Pseudostem length

Clove size had significant effect on pseudostem length except at 30 and 50 DAP. Pseudostem length gradually increased from 30 to 120 DAP. The maximum pseudostem length was obtained from largest clove (15.46 cm) followed by medium (14.05 cm) and small (11.73 cm), respectively. Large cloves gave maximum pseudostem length presumably due to more food resources. Stem length was significantly influenced by different plant spacing at 30 to 90 DAP except at 70 DAP. The subsequent stages showed no significant differences ($P \leq 0.05$). The stem length increased until 120 DAP. The maximum stem length was (13.78 cm) from closest plant density 20 x 10 followed by 20 x 25, 20 x 15 and 20 x 20, respectively at 120 DAP. The interaction effect on pseudostem length was not significant.

Root dry matter

The effect of different clove size on development of root dry weight was observed and recorded at 20 day intervals beginning from 30 DAP until maturity and final data was collected at 120 DAP. The root DM increased sharply until 70 DAP followed by a steady increase up to 110 DAP thereafter it declined slightly. No significant variation in root dry matter was noticed except at 30 and 120 DAP. However, large clove size always had superiority in accumulating root dry matter in most of the growth period. Maximum root DM was found from large seed clove (4.55 g) followed by medium (4.46g) and small (4.12 g) at 110 DAP. The results of the present investigation are in agreement with earlier findings (Faruq, 2000). The final decrease in root dry matter might be due to root senescence and steady increase

Table 2. Effect of seed clove size and spacing on leaf no/plant and length of pseudostem of garlic.

Seed clove size	Days after planting											
	Leaf no/plant						Length of *pseudostem* (cm)					
	30	50	70	90	110	120	30	50	70	90	110	120
Large	3.90	4.27	6.37	7.94a	8.57a	8.53a	4.55	5.11	7.67a	12.28a	14.59a	15.46a
Medium	3.84	4.18	6.37	7.77a	8.21ab	7.99b	4.58	5.19	7.04b	11.44a	13.43a	14.05a
Small	3.75	4.25	6.10	6.95b	7.83b	7.44c	4.29	5.02	7.13b	9.82b	11.73b	11.73b
CV%	7.2	6.5	6.9	7.4	6.7	5.5	11.4	6.5	10.3	14.8	12.1	11.3
LSD	ns	ns	ns	0.53	0.52	0.42	ns	ns	ns	1.57	1.52	1.47
Spacing												
25 x 20	4.02a	4.52a	6.73a	7.44	8.36	8.14	4.86a	5.45a	7.45	11.29	13.42	13.78
20 x 20	3.97a	4.31a	6.37a	7.79	8.20	8.17	4.49a	5.37a	6.95	10.82	13.17	13.65
20 x 15	3.77ab	4.36a	6.37a	7.50	8.05	7.84	4.54a	5.10a	7.54	11.11	12.92	13.66
20 x 10	3.57b	3.73b	5.67b	7.49	8.16	7.84	4.00a	4.50b	7.17	11.49	13.49	13.89
CV%	7.2	6.5	6.9	7.4	6.7	5.	11.4	6.5	10.3	14.8	12.1	11.3
LSD	0.30	0.32	0.47	-	-	-	0.88	0.36	ns	ns	ns	ns

after 60 DAP might be due to developing more diversion of dry matter towards the bulb. Root dry matter was not significantly influenced ($P \leq 0.05$) by plant spacing at different stages except 120 DAP. Root dry matter increased gradually 30 ($P \leq 0.05$) to 120 DAP. Maximum root dry matter (4.78 g) was obtained from 20 x 20 cm plant spacing followed by 25 x 20 cm, 20 x 10 cm and 20 x 15 cm, respectively at 120 DAP.Clove size and plant density interacted with each other in respect of root DM accumulation. The interactive effect on dry weight of roots was not significantly different at the different growth stages.

Leaf dry matter partitioning

Leaf dry matter accumulation increased steadily with the advancement of plant growth in all clove sizes till the attainment of the maximum at about 110 DAP and did not differ significantly ($P \leq 0.05$) except 70, 90 and 110 DAP (Table 3). Large clove gave maximum leaf DM (14.8 g) followed by medium and small cloves, respectively at 110 DAP. Similar results have been reported earlier (Baten *et al.*, 1994; Alam, 2000). The photosynthetic efficiency of the leaves increased to meet their own as well as growing bulbs which might have accelerated higher leaf dry matter accumulation in all cloves. This decline in leaf dry matter was probably the result of distribution of DM from leaves to bulbs. Leaf dry matter showed gradual increase from 30 to 110 DAP and thereafter declined at maturity with a non-significant difference ($P \leq 0.05$) among various plant densities except 40, 80 and 110 DAP. The final decrease in leaf dry matter might be due to more diversion of DM towards the bulb. The maximum leaf dry matter was (15.23 g) found in the plant density of 20 x 25 at 110 DAP. Leaf dry matter was not significantly influenced by the interaction between clove size and plant spacing at different growth stages.

Stem dry matter accumulation

Variations in the cumulative stem dry matter accumulation in plants from different clove sizes of garlic as recorded from 30 DAP till final harvest are presented in Table 4. Initially there was a lag phase of DM accumulation extended up to 50 DAP. Thereafter the stem dry matter increased slowly until 70 DAP and followed a sharp increase until the attainment of maxima at final harvest in all the clove sizes. However, all the clove sizes differed significantly in their absolute dry matter found at all stages of growth. A significantly higher stem DM accumulation accounted for large clove (149.94 g) followed by medium (138.57 g) ($P \leq 0.05$) and small (127.01 g) at 120 DAP. Similar results were reported by Baten *et al.* (1994). The initial slow rate of stem dry matter accumulation was a result of much diversion of photosynthates to the expanding root and leaf systems, the slow rise in stem dry matter was related to the formation of younger bulbs. The increased stem dry matter accumulation after 90 DAP till final harvest was probably due to the much investment of photosynthates to the rapidly expanding bulbs. Stem dry matter accumulation slowly but steadily increased from 30 to 70 DAP. At 80 DAP the stem dry matter increased dramatically, followed by sharp increase until the attainment of maximum at final harvest. The maximum stem dry matter (144.59 g) was found in the plant density of 20 x 15 followed by 137.59 g, 136.59 g, and 135.25 g in the plant density of 20 x 10, 20 x 20, 20 x 25 cm respectively at 120 DAP.The effect of interaction between clove size and plant spacing was not significant.

Total dry matter accumulation

The rate of dry matter accumulation was slow and gradual until about 60 DAP in all the clove sizes. Thereafter, accelerated rates of dry matter accumulation continued up to 90 DAP. Then a linear phase of growth led to the peak between 90 to 120 DAP. All the cloves differed significantly ($P \leq 0.05$) in total dry matter at all stages of growth. A significantly higher total dry matter was found in large clove (169.52 g) followed by medium (157.47 g) and small (143.92 g). These observations are in agreement with Baten *et al.* (1990). Initially the canopy development of garlic was slow with low light interception by the canopy during early crop growth, which resulted in slow rate of total dry matter accumulation. After the initial lag period there was a rapid increase of canopy development, which resulted in linear increase in total dry matter accumulation. Total dry matter was significantly ($P \leq 0.05$) influenced by different plant spacing in different growth stages except 40, 60, 80 and 90 DAP. There was initial lag periods of total dry matter accumulation extended up to 70 DAP. Thereafter it increased slowly and continually until 90 DAP and followed by a sharp increase until the attainment of maximum at final harvest. Maximum total dry matter (162.24 g) was found in the plant density 20 x 15 followed by 156.63 g, 154.58 g and 154.43 g in the plant density of 20 x 10, 20 x 20 and 20 x 25, respectively at 120 DAP. The combined effect between clove size and plant density on TDM was not significantly different.

Conclusion

The experimental results revealed that the growth attributes of garlic are affected by seed clove size. Large clove gave better growth though from our experiment we did no observe any single spacing that was good for growth parameters. There is therefore need for further studies to establish optimum plant densities and clove sites that could be recommended to farmers for adoption.

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