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Land Configuration and Varietal Effects on Yield Contributing Traits and Yield of Garlic

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Abstract: A field experiment was conducted to study the effects of ridge, furrow and flat planting methods on performance of three cultivars of garlic. Plant height was significantly affected and plants on ridges had the maximum height. Individual bulb weight, bulb diameter and 100 cloves weight were significantly higher in ridge method compared with other two methods. While, the number of cloves per bulb was higher in furrow method. The higher individual bulb weight, bulb diameter and 100 cloves weight of the plants grown in ridges gave a corresponding higher yield of garlic. Among the cultivars, cv. Faridpur had significantly higher individual bulb weight, bulb diameter, 100 cloves weight and a corresponding higher yield. However, it had few cloves per bulb compared with other two cultivars. Planting in ridges has potential application for the yield improvement of garlic.

Key words: *Allium sativum* L., bulb yield, furrow, planting method, ridge

Introduction

Garlic (*Allium sativum* L.), a member of the Alliaceae Family, has been cultivated for thousands of years and is widely used for both its culinary and medicinal attributes. As we have become more accustomed to garlic flavour and knowledgeable about many health benefits of eating garlic, popularity of this crop has increased all over the world. It is grown in the mild and short winter in Bangladesh. Varieties adapted to mild climates do not perform well and usually develop a very "hot" flavour. They have very small bulb with many cloves of minute size. Varieties with high yielding potential have not been developed to grow well in mild climates. Recently, there is a good demand for high-quality garlic. It has prompted an interest in garlic researches in *in vitro* and field conditions.

Garlic is propagated from cloves of the bulb. Seed clove storage temperature and pre-planting temperature treatment have remarkable influence on the initiation, development and yield of garlic (Siddique and Rabbani, 1985; Rahim and Fordham, 1988; Haque *et al.*, 1990, 1993). Initiation and development are also influenced by the environmental factors prevailing during the subsequent period of growth (Rahim and Fordham, 1990). However, information on this aspect is scanty. The farmers of Bangladesh generally plant garlic in furrows, make the soil flat and finally make ridges around the plants. There is no report of the comparative study of the ridge, furrow and flat soil conditions. In general, ridges have more available sunlight and higher temperature than the furrow and flat soil. Therefore, it is expected that soil configuration might have considerable effect on garlic growth, development and yield. In present study, the effects of different soil configurations viz. ridge, furrow and flat planting methods on the yield contributing characteristics and yield of garlic were investigated with three cultivars of garlic.

Materials and Methods

The experiment was carried out at the Field Laboratory of Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, during November, 2000 to March 2001. The soils of the experimental site were sandy loam in texture and belong to the Brahmaputra alluvial tract. The climate of the locality was humid tropical, characterized by a heavy down pour of rainfall during the months from June to September and scanty rainfall during rabi season (November to March).

Three cultivars of garlic (Faridpur, Meherpur and Kishoregonj) collected from the local market were used as planting materials for the experiment. The main land was ploughed and cross-ploughed several times followed by laddering using bullock drawn country plough. The land was finally prepared by spading and crop residues, etc. were removed. Cow dung (10 tons ha^{-1}), urea (173 kg ha^{-1}), triple superphosphate (TSP, 148 kg ha^{-1}) and muriate of potash (MP, 148 kg ha^{-1}) were applied to the land. The entire amounts of cow dung and TSP were applied at the time to final land preparation. Half of the dose of urea and MP was applied 15 days after planting (DAP) and the rest was applied at 26 DAP.

The experiment was laid out in a randomized complete block design. The blocks were separated from each other by 0.75 m, and plots within a block were separated from each other by 0.5 m. The total number of unit pots was 27. The three planting methods were: ridge method (M_1), furrow method (M_2) and flat method (M_3). Garlic cloves were planted in rows on 14th November, 2000. The distance between two adjacent ridge or furrow bottom was 20 cm. The clove to clove distance was 20 cm. Weeding was done as and when required. The crop was irrigated twice in a month. Crop sampling, beginning from 30 DAP was carried out at 12 days interval until 130 DAP. At all growth stages plant height and number of leaves per plant were recorded. At the time of final harvest, the diameter of bulbs were measured by a slide calipers. Individual bulbs were weighed by electric balance and yield was calculated as ton per hectare. Number of cloves per bulb was also recorded. Analysis of variance was performed for plant height, yield and yield components and their treatment means were compared by least significant difference (LSD) and Duncan's multiple range test (DMRT).

Results and Discussion

Plant height: Plant height was recorded from 30 to 114 DAP (Fig. 1). It was evident that plant height increased gradually with the advancement of plant growth. The plants grown in ridges were significantly taller than those grown in furrows and flat soils. Plant height was maximum at 90 DAP followed by a slight decline due to senescence of the top leaf. The Faridpur cultivar had attained the tallest plant followed by Meherpur and Kishoregonj, respectively (Fig. 2). The interaction of planting methods and cultivar showed significant effects on plant height. The cv. Faridpur attained the tallest plant in ridge method throughout the growth period (not presented). However, the effect of bed configuration on the plant height was more pronounced within the cultivar themselves. Temperature has a positive impact on the growth of crop plant. In general, high temperature, within some limit, favours crop growth. Soil temperature was observed higher in ridges than the other methods of planting (Radke, 1982). Thus, increased plant height in the ridge planting method could be ascribed for the high temperature in it. Identical findings were reported for onion (Singh and Singh, 1995). The higher plant height in cv. Faridpur seemed to be due to its higher mother clove size during planting. Large sized cloves and bulbs enhanced the plant height in garlic and onion (Grad *et al.*, 1993; Singh and Sachan, 1998).

Table 1: Number of leaves per garlic plant at different stages of growth as influenced by different planting methods

Planting methods	Number of leaves per plant at various DPA							
	30	42	54	66	78	90	102	114
M_1	2.73a	3.36a	4.46a	5.40a	6.44a	8.40a	8.35a	8.32a
M_2	2.40b	2.64b	3.49b	3.85b	4.37b	6.23b	6.15b	6.11b
M_3	1.95c	2.42c	2.69c	3.50c	4.22b	4.72c	4.63c	4.60c

Table 2: Varietal difference on number of leaves per plant at different growth stages of garlic

Cultivars	Number of leaves per plant at various DPA							
	30	42	54	66	78	90	102	114
V_1	1.98c	2.20c	2.87c	3.38c	4.03c	5.57 c	5.50c	5.46c
V_2	2.20b	2.58b	3.41b	4.00b	4.97b	6.42 b	6.35b	6.32b
V_3	2.90a	3.65a	4.36a	5.35a	6.03a	7.38a	7.29a	7.24a

Table 3: Effect of planting methods on yield and yield components of garlic

Methods	Individual bulb weight (g)	Bulb diameter (cm)	No. of cloves/ bulb	100 cloves weight (g)	Yield (t/ha)
M_1	12.37a	3.60a	20.00b	44.33a	3.57a
M_2	8.44b	3.03b	21.00b	34.22b	2.44b
M_3	6.98c	2.01c	24.00a	26.78c	2.13c

Table 4: Varietal performance on the yield and yield components of garlic

Varieties	Individual bulb weight (g)	Bulb diameter (cm)	Number of cloves/ bulb	100-cloves weight (g)	Yield (t/ha)
V_1	6.67c	2.64b	24.00a	32.00c	2.24c
V_2	8.74b	2.72b	22.00ab	34.00b	2.67b
V_3	12.37a	3.28a	19.00b	39.34a	3.22a

Table 5: Interaction effect of planting methods and cultivar on yield and yield components of garlic

Method x Cultivar	Individual bulb weight (g)	Bulb diameter (cm)	Number of cloves/bulb	100-cloves weight (g)	Yield (t/ha)
M_1V_1	10.00c	3.30c	25.00a	42.00c	3.33b
M_1V_2	12.00b	3.50b	20.00abc	43.33b	3.33b
M_1V_3	15.10a	4.00a	17.00bc	47.66a	4.00a
M_2V_1	5.33ef	2.80d	26.00a	31.00f	2.00de
M_2V_2	8.00d	2.90d	23.00ab	32.66e	2.33cd
M_2V_3	12.00b	3.40bc	14.00c	39.00d	3.00bc
M_3V_1	4.67f	1.83f	21.00abc	23.00h	1.40e
M_3V_2	6.22e	1.77f	24.00ab	26.00g	2.33cd
M_3V_3	10.00c	2.43f	28.00a	31.33f	2.67bcd

Values with different letters within a column differ significantly at $P < 0.05$ (DMRT)

M_1 = Ridge method M_2 = Furrow method M_3 = Flat method V_1 = Kishoregonj V_2 = Meherpur V_3 = Faridpur

Leaf number per plant: The number of leaves per plant was significantly different among the treatments at different days after planting (Table 1). Ridge method had superiority in generating leaves at all stages of plant growth. The ridge method gave the highest number of leaves per plant (8.40) followed by furrow (6.23) and flat (4.72) methods at 90 DAP. There was a highly significant difference in number of leaves per plant among the cultivars at all stages of plant growth. The cv. Faridpur generated higher number of leaves than cv. Meherpur and cv. Kishoregonj at all stages. It generated the maximum number of 7.38 leaves per plant as was observed at 90 DAP (Table 2). Highest number of leaves was found from cv. Faridpur. The mother cloves size and clove weight were higher in cv. Faridpur than cv. Meherpur and cv. Kishoregonj. Mother clove size has a regulatory effect on the number of leaves (Couto, 1961; Burba *et al.*, 1982) and large sized cloves and bulbs produced greater number of leaves per plant both in garlic and onion (Grad *et al.*, 1993; Singh and Sachan, 1998). The highest number of leaves per plant in cv. Faridpur might be due to the highest clove size in this cultivar.

Individual bulb weight: Individual bulb weight was significantly affected by planting methods (Table 3). The highest individual bulb weight (12.37 g) was recorded with M_1 (Ridge method). The minimum individual bulb weight (6.98 g) was recorded with M_3 (Flat method). Individual bulb weight differed significantly among the cultivars (Table 4). Maximum individual bulb weight (12.37 g) was recorded in cv. Faridpur and the minimum (6.67 g) was found in cv. Kishoregonj. Individual bulb weight was significantly influenced by the interaction between cultivar and planting method (Table 5). Maximum individual bulb weight (15.10 g) was recorded from the interaction between M_1V_3 (Ridge method x cv. Faridpur). The lowest one (4.67 g) was recorded in M_3V_1 (Flat method x cv. Kishoregonj). Ridges might have created a favourable environment for bulb growth resulting in the highest individual bulb weight in plants growing in them. The clove size of the cultivars was recorded before planting. It was found that initially the cloves of cv. Faridpur was larger than those of cv. Meherpur and cv. Kishoregonj. The higher bulb weight of the cv. Faridpur might be due to the larger size of the mother cloves. Burba *et al.* (1982) stated that heavier bulbs were formed from larger cloves.

Bulb diameter: Diameter of bulb was significantly influenced by the planting methods (Table 3). The maximum bulb diameter (3.6 cm) was recorded from M_1 (Ridge method). The minimum bulb diameter (2.0 cm) was recorded from M_3 (Flat method). Like bulb weight, a significant difference was found in bulb diameter among the cultivars (Table 4). The highest bulb diameter was recorded with cv. Faridpur (3.28 cm). The lowest bulb diameter (2.64 cm) was recorded with cv. Kishoregonj. Table 5 indicates Variety and

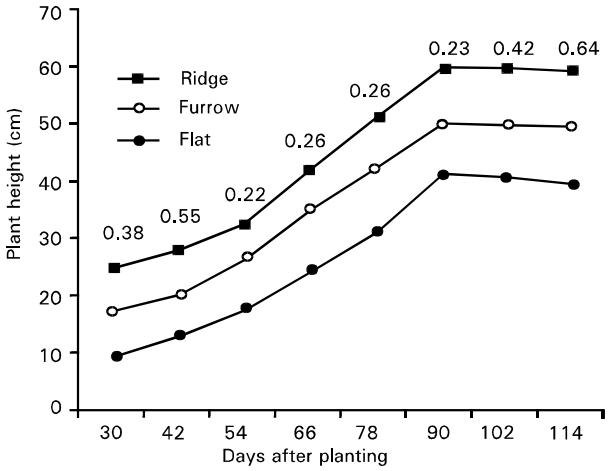

Fig. 1: Effect of planting methods on plant height at different growth stage of garlic. The figures indicate LSD value at P< 0.01

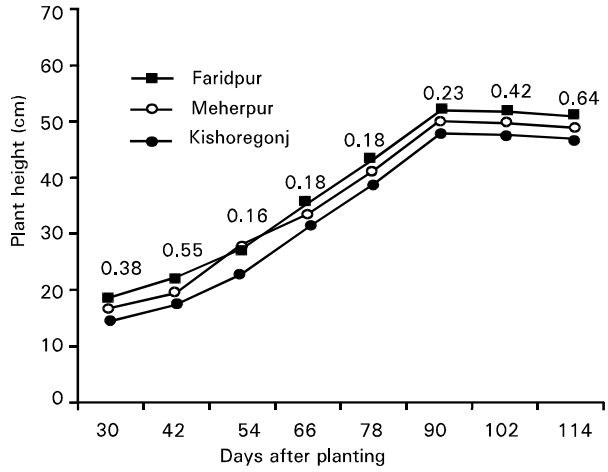

Fig. 2: Varietal difference in plant height at different growth stages of garlic. The figures except 30, 42 and 114 DPA indicate LSD at P < 0.01 and that of 30, 42 and 114 DPA indicate LSD at P < 0.05

planting methods interacted with each other in respect of bulb diameter also (Table 5). The highest bulb diameter (4.00 cm) was produced in M_1V_3 (Ridge method vs cv. Faridpur) and the lowest one (1.77 cm) was produced in M_3V_2 (Flat method vs cv. Meherpur). Cultivar Faridpur planted in ridges had the highest bulb diameter. The higher bulb diameter of cv. Faridpur was related to the higher weight of the mother clove at the time of planting triggered by the favourable environmental condition created by the ridges. Increased diameter of bulb was resulted by higher seed clove weight (Couto, 1961; Baten *et al.*, 1994).

Number of cloves per bulb: Number of clove per bulb differed significantly among different planting methods. Maximum number of cloves per bulb (24.00) was found with M_3 (Flat method) and minimum (20.00) was noticed with M_1 (Ridge method) (Table 3). Number of cloves per bulb was significantly different among cultivars. The maximum number of cloves (24.00) was recorded in cv. Kishoregonj and minimum number (19.00) was found in cv. Faridpur (Table 4). This result was opposite to the bulb weight and bulb diameter where, cv. Faridpur with larger seed clove gave the higher weight and diameter of the bulbs. The number of cloves per bulb was inversely related to the mother clove size. Number of cloves per bulb was significantly influenced by the interaction between method and variety. Maximum number of cloves per bulb was obtained (28.00) from the interaction between M_3V_3 (Flat method x cv. Faridpur) (Table 5). The lowest number of clove (14.00) was recorded in M_2V_3 (Furrow x cv. Faridpur). The large sized cloves had no effect on number of bulblets (cloves) per bulb (Grad *et al.*, 1993).

100 cloves weight: Planting method showed a significant influence on 100-cloves weight (Table 3). The highest 100-clove weight (44.33 g) was obtained with M_1 (Ridge method) followed by M_2 (Furrow) and M_3 (Flat method), respectively. Cultivars differed significantly among themselves regarding weight of 100-cloves and cv. Faridpur ranked the first (39.34 g). The lowest 100-cloves weight was found in cv. Kishoregonj (Table 4). The interaction effect on 100-clove weight of planting method and cultivars was found to be significant. Maximum 100-cloves weight (47.66 g) was recorded in the interaction of M_1V_3 (Ridge method x cv. Faridpur) and the lowest one (23.00 g) was recorded in M_3V_1 (Flat method x cv. Kishoregonj) (Table 5). The number and weight of cloves per bulb is an inherent character of the cultivars and cv. Faridpur expressed its fewer number of heavier cloves per bulb before and after the experiment.

Yield: Yield of garlic was significantly affected by planting methods (Table 3). Results indicated that maximum yield (3.57 t ha^{-1}) was recorded from M_1 (Ridge method). The minimum yield (2.13 t ha^{-1}) was recorded from M_3 (Flat method). Yield of garlic differed significantly among the cultivars (Table 4). Maximum yield of 3.22 t ha^{-1} was obtained from cv. Faridpur and minimum (2.24 t ha^{-1}) from cv. Kishoregonj. Yield was significantly influenced by the interaction between variety and methods and maximum yield (4.00 t ha^{-1}) was obtained from the interaction between M_1V_3 (Ridge method x cv. Faridpur). The lowest yield (1.40 t ha^{-1}) was recorded in M_3V_1 (Flat method x cv. Kishoregonj) (Table 5). Maximum yield was recorded by M_1 (Ridge method) in the present study. It is stated that onion planted on raised beds gave the higher bulb yield. In cassava, the storage root yield was higher (although non-significant) in ridges in comparison to flat planting method (Madhuakar, 1997). However, a significant increase in grain yield was reported by ridge seedbeds over their flat counterparts for different tillage systems has been reported in sorghum (Kanton *et al.*, 2000). The higher yield observed in cv. Faridpur compared with other two cultivars may be due to a greater aptitude on the part of cv. Faridpur to increase photosynthetic surface, in terms of number and area of leaves (Castillo *et al.*, 1996).

Garlic yield has been gradually decreasing in Bangladesh. Due to the continuing population growth, the demand of garlic is increasing every year. The area under garlic cultivation can, under no circumstances, be increased here. To increase total production, the only way is the improvement of the yield. The results presented here indicate that garlic yield can be increased by adopting ridge planting method instead of flat method. However, further studies are required to investigate the microclimatic conditions that favour garlic growth and yield under ridge planting method.

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