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Research Article

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Effect of Planting Time and Planting System on the Growth and Yield of Some Garlic Germplasm

MR Hossain[1], MA Rahman[1], MA Rahim[1], MA Haque[2], MM Rahman[3]* and MA Mondol[4]

[1]*Dept. of Horticulture, Bangladesh Agricultural University, Bangladesh*

[2]*Dept. of Agronomy, Bangladesh Agricultural University, Bangladesh*

[3]*Dept. of Agricultural Engineering, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh*

[4]*Bangladesh Sugar and Food Industries Corporation, Bangladesh*

***Corresponding author**

MM Rahman, Dept. of Agricultural Engineering, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh

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Abstract

The vegetative growth, yield attributes and yield of garlic depends on timely planting, planting system and high yielding cultivar. The purpose of this experiment was to investigate the effects of planting time, planting system with variety on the growth and yield of garlic germplasm. Two experiments were performed during the study, and the experiments were laid out in Randomized Complete Block Design (RCBD). Four planting time (such as 26 October, 9 November, 20 November and 10 December), two factors for planting system (such as zero tillage and dry land) and four varieties (such as BAU garlic-1, BAU garlic-2, BAU garlic-3 and G-51) were considered during the experiments. The results revealed that the planting time had significant influence on growth parameters, yield attributes and yield of garlic. The highest values of growth parameters as well as bulb yield (10.33 t/ha) were obtained at 26 October whereas the lowest values were recorded at 10 December resulting bulb yield (8.47 t/ha). On the other hand, the planting system had also significant influence on the vegetative growth and yield of garlic. The highest values of growth characters, yield attributes and yield of garlic was found in zero tillage compared to dry land. BAU Garlic-3 was provided the highest growth as well as bulb yield among other three varieties. It was also noticed that, the combined treatment of zero tillage and variety of BAU Garlic-3 gave the highest values of growth and yield attributes as well as bulb yield (8.80 t/ha) parallel with other combined effects. Results expressed that the early planting and the combination of zero tillage and BAU Garlic-3 variety has given the profound effects on the growth parameters as bulb yield of garlic.

Keywords: Planting time, Zero tillage, Garlic, Variety, Growth, Yield

Introduction

Garlic (Allium sativum L) is one of the most aromatic herbaceous annual spices, which is the second most widely spice crop next to onion in the world [1-3]. Garlic originated in central Asia, and nowadays, many countries in the world are producing different variety of garlic. Garlic is also growing extensively as a spice crop in Bangladesh, but the yield is very low in comparison with the yield of many other countries [4]. The average yield of garlic produced in Bangladesh was about 224 thousand metric tons of garlic from 105 thousand acres of land [5]. The yield of garlic may be lower due to the lack of inadequate cultural management practices in respect of soil water shortage in the soil profile, and due to delay planting [6]. Moreover, the demand of garlic consumption is increasing every day in the over population of Bangladesh with respect to its pungent flavor as a seasoning or condiment [7]. Therefore, the emphasis must be given to increase the yield of garlic per hectare by adopting improved methods of cultivation such as appropriate planting time, growing condition and disease resistant variety.

Planting time plays an important role on the growth, yield attributes and yield of garlic [7]. Garlic is a thermo and photo-sensitive crop, and its vegetative growths as well as bulb formation are greatly influenced by growing environment [8,9]. Garlic production also depends on the cool weather, well-drained and moderately clay loam at higher elevation. The growth period of garlic in Bangladesh is centered in the cool season as a result only early planted crops can take full advantages of the cool period. But, the farmers of Bangladesh may not always adopt early planting with reference to climatic limitations and cropping pattern. For this reason, plants are exposed to high temperature before initiation of clove and during the period of growth and development as a result of producing low bulb yield, and sometimes a percentage of plants fail to begin bulb formation entirely.

Moreover, a considerable amount of low laying flood affected areas such as Chalan beel of North-Western part of Bangladesh can be bought under garlic production through utilization of conserved moisture in soil profile as well as no tillage condition of soil. But, the common practice of garlic production in the dry lands of Rajshahi, Nilphamari, Syedpur, Meherpur and Pabna areas is to make a good tilth of soil, and to maintain soil moisture near to field

capacity [6]. The production of garlic bulb is also greatly influenced by organic manure, tillage and mulch [10]. Out of these, tillage practices play a vital role in conserving soil moisture at different depths of the soil profile. As garlic is grown during the dry spell, farmers have to depend either on natural precipitation or on irrigation [10]. Besides, the irrigation facilities are not sufficient in all the regions of Bangladesh. In the zero tillage conditions, no tillage practices are performed and soil moisture can be retained. Thus, it is important to compare farmer practices under dry land condition with that of the zero tillage for wet land condition in 'Chalan Beel' area. On the other hand, few high yielding varieties of garlic are available in Bangladesh, and the use of that cultivar is the most important consideration for cultivation of any other crops [7-11]. The production of garlic can be greatly influenced by the identification and adaptation of a suitable cultivar and its cultural practices for particular area. But very little attention has been conducted to study the feasibility of garlic production by the planting time, the selection of good cultivars with planting conditions in Bangladesh. Therefore, the present study was undertaken to observe the effects of planting time, planting system and variety on the growth parameters, yield attributes and yield of the garlic germplasm;

Materials and Methods

Experimental Site, Climate and Soil

The experiment was conducted at USDA Alliums' Project Field Laboratory in Horticulture Farm, Bangladesh Agricultural University, and Mymensingh. The experimental area was located in the subtropical climatic zone characterized by low rainfall, low humidity, low temperature and short day period during Rabi season (October to March). And, Rabi season is the most favorable condition for garlic cultivation. The soil at experimental site was sandy loam where the pH and organic matter were 6.45 and 0.85%, respectively.

Experimental Procedure

Garlic varieties were collected from the USDA Alliums' Project, Department of Horticulture, Bangladesh Agricultural University, and Mymensingh. Two experiments were conducted for this research during the period from October 2012 to April 2013. For the first experiment, the plot was prepared separately by ploughing and cross ploughing with power tiller followed by laddering in the month of October, 2012. Later, the plot was prepared for the second experiment in the month of December, 2102. During the land preparation, weeds and stubbles were also removed. The plot was finally prepared after applying the basal doses of manure and fertilizers, and irrigation and drainage channels were also prepared around that plots. Well-processed cow dung, poultry manure (PM) and mustard oil cake (MOC) was applied to this plots about 15 days before the planting of cloves. Fertilizers were used to get the source of N, P, K, S, Mg, Zn and B, respectively. Full amount of TSP, gypsum, zinc oxide, magnesium oxide and boric acid and 50% each of urea, muriate of potash and DAP were applied at the time of planting. The rest of the 50% urea, muriate of potash and DAP were applied as top dressed in two equal installments at 30 and 60 days after planting.

The two outer layers of garlic cloves were separated from each mother bulb for planting in the field. One thousand cloves were planted in each unit plot maintaining spacing of 20 cm x 10 cm, and the cloves were dibbled at 5 cm depth of soil. Cloves were also planted around the experimental area to check the border effect. The unsprouted cloves and damaged plants were replaced by the healthy border plants within two weeks after planting. Weeding in the control plots was done regularly to keep them free from weeds. Royal at the rate of 25 g in 10 liters of water was applied at an interval of 15 days after planting up to one month before harvesting to control purple leaf blotch disease of garlic. The harvesting was done depending on the maturity of the plant starting from April 1 to April 20. Ten plants were selected randomly from each unit plot for the collection of data during different growing stages of plants. Plant height (cm), Number of leaves per plant, Fresh weight of leaves (g), Dry weight of leaves (g), Dry weight of roots (g), Diameter of bulb, Number of cloves per bulb, Yield of bulb per plot and Yield of bulb per hectare (tons) were obtained at 30, 60, 90 and 120 days after planting (DAP).

Design of the Experiment and Statistical Analysis

Two experiments were performed for this research, in which one was the effect of planting time on the growth and yield of BAU Garlic-3. This experiment was laid out in Randomized complete dock Design (RCBD) with three replications, where the total number of plot was 12, and the planting time was the treatment (T_1 = 26 October, 2012; T_2 = 9 November, 2012; T_3 = 20 November, 2012; T_4 = 10 December, 2012). Others one was the effect of planting system on the growth and yield of some garlic germplasm where the planting system was zero tillage and dry land. The variety of Garlic was considered as BAU Garlic-1 (V_1), BAU Garlic-2 (V_2) BAU Garlic-3 (V_3) and G-51 (V_4). This experiment was also laid out in Randomized Complete Block Design (RCBD) with three replications, where the total number of plot was 24. The size of each unit plot was 20 m x 1 m, and the spacing between plants to plant was 20 cm x 10 cm. The collected data from the experiment on yield and yield components were statistically analyzed following factorial experiment in RCBD wherever necessary. The means for all the treatments were calculated and the analyses of variances for most of the characters under consideration were performed by "F" variance test. The collected data were statistically analyzed and the mean differences were tested by the Least Significant Difference test [12].

Results and Discussion

Effect of Planting Time on Growth and Yield of Garlic

Effect on plant characters in garlic

The results presented that the planting time have influenced on the plant height and number of leaves of BAU Garlic-3 [Table 1]. The delayed planting decreased plant height at different growth stages according to the results [Table 1]. The highest plant was obtained at 26 October planting in all growth stages (20.33, 33.73, 58.87 and 60.87 cm for 30, 60, 90 and 120 DAP, respectively) followed by 9 November planting (18.27, 31.87, 58.73 and 60.53 cm for 30, 60, 90 and 120 DAP, respectively). In contrast, the shortest plant was recorded at 10 December planting (16.33, 29.95, 49.93 and 58.23 cm for 30, 60, 90 and 120 DAP, respectively). This result means that Early planted crops availed favorable environment, longer cool period and shorter day-length, which extends the maximum plant height [7]. The similar results were also agreed with the experiences of Rahim et al. [13] and Siddique and Rabbani [14]. On the other hand, the number of leaves per plant was significantly influenced by different DAP in [Table 1]. The leaf number decreased with the delayed planting of garlic. But, the number of leaves was increased gradually with the progressing of time in all planting dates. The highest number of leaves per plant was observed at 26 October planting in all growth stages (3.67,

5.80, 7.40 and 7.60 per plant for 30, 60, 90, and 120 DAP, respectively) followed by 9 November planting. This is possibly due to the fact that early planting attained longer period for vegetative growth and development which increases leaves compared to delay planting. This finding was agreed with the results of [11-17].

Table 1: Main effects of planting time on plant height and number of leaves per plant of garlic

Planting time	Plant height (cm) at				No. of leaves/plant at			
	30DAP	60DAP	90DAP	120DAP	30DAP	60DAP	90DAP	120DAP
T_1	20.33	33.73	58.87	60.87	3.67	5.80	7.40	7.60
T_2	18.27	31.87	58.73	60.53	3.53	5.80	7.00	7.40
T_3	18.07	31.07	56.07	59.67	3.50	4.73	5.87	6.93
T_4	16.33	29.95	49.93	58.23	3.35	4.60	5.82	6.67
$LSD_{0.05}$	0.75	1.83	3.25	1.52	0.109	0.653	0.558	0.606
$LSD_{0.01}$	1.14	2.78	4.92	2.31	0.166	0.990	0.845	0.918
Level of significance	**	**	**	*	**	**	**	*

(DAP= Days after planting, T_1 = 26 October, T_2 = 9 November, T_3 = 20 November, T_4 = 10 December, ** = Significant at 1% level of probability, * = Significant at 5% level of probability)

Results have significant variation on fresh weight of leaf caused by planting time [Table 2]. The highest fresh weight of leaves (21.47 g) was found at 26 October planting and the lowest was recorded at 10 December planting (15.27 g). Results showed that there have no significant variations on leaf dry weight due to planting time [Table 2]. The highest dry weight of leaves (1.92 g) was found at 26 October planting and the lowest was recorded at 10 December planting (1.84 g). The fresh weight of leaves and leaf dry weight decreased with the delay planting as a result of decreased the number of leaf production. Leaf fresh weight and Leaf dry weight decreased with the delay planting as reported by the Rahim et al. [11], Anwar et al. [15] and Swati et al. [16]. The effect of planting time on root dry weight was significant variations as shown in [Table 2]. The root dry weight decreased with the delay planting due to decrease the number of root production [18]. The highest root dry weight (0.774 g per plant) was found at 26 October planting where the lowest was recorded at 10 December planting (0.60 g per plant). This result is in agreement with reported of many workers [19-21].

Effect on Yield Attributes and Yields in Garlic

The delayed planting decreased bulb diameter because of delay planting crop get less time for growth and development of bulb compared to early planting crop [Figure 1]. The maximum bulb diameter in garlic was obtained in early planting whereas the highest (4.13 cm) was recorded at 26 October planting followed by 9 November planting (4.01 cm). Early planted crops produced larger bulb than delayed planting in garlic as reported by [13,14]. Results revealed that the number of cloves per bulb was influenced significantly by different DAP [Table 2]. The cloves number decreased with the delayed planting. The highest number of cloves per bulb was observed at 26 October planting (30.20 per bulb) followed by 9 November planting (28.40 per bulb). On the other hand, the lowest number of cloves per bulb was recorded at 10 December planting (26.47 per bulb). This is possibly happened due to the fact that early planting attained longer period for vegetative growth and development which enhances higher cloves compared to delay planting. This finding was agreed with the results of [11,16].

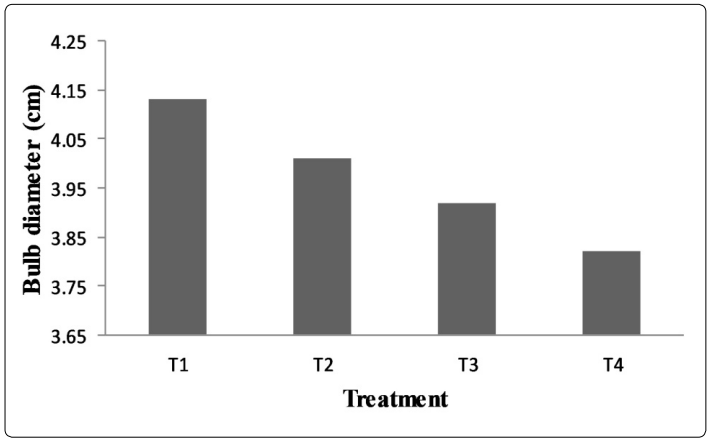

Figure 1: Bulb diameter of garlic as influenced by date of planting. (T_1 = 26 October, T_2 = 9 November, T_3 = 20 November, T_4 = 10 December)

Table 2: Main effects of planting time on fresh weight of leaf, leaf dry weight/plant, root dry weight/plant, bulb diameter, cloves/plant and bulb weight

Planting time	Fresh wt. of leaf (g)	Leaf dry weight per plant (g)	Root dry weight per plant (g)	Bulb diameter (cm)	No. of cloves per plant	Bulb wt. per plant (g)	Bulb wt. (t/ha)
T_1	21.47	1.92	0.774	4.13	30.20	20.67	10.33
T_2	17.60	1.89	0.669	4.01	28.40	18.40	9.20
T_3	16.07	1.89	0.635	3.92	28.07	17.60	8.80
T_4	15.27	1.84	0.600	3.82	26.47	16.93	8.47
$LSD_{0.05}$	0.972	-	0.063	0.141	1.73	1.03	0.568
$LSD_{0.01}$	1.473	-	0.096	0.214	2.63	1.56	0.860
Level of significance	**	NS	**	**	**	**	**

(T_1 = 26 October, T_2 = 09 November, T_3 = 20 November, T_4 = 10 December, ** = Significant at 1% level of probability, NS = Not significant)

The bulb weight and bulb yield decreased with the delay planting due to decrease the number of cloves per plant and smaller size bulb production [Table 2]. The highest bulb weight (20.67 g per plant) was found at 26 October planting and the lowest was recorded at 10 December planting (16.93 g per plant). In contrast, the highest bulb yield (10.33 t/ha) was obtained at 26 October planting whereas the lowest was recorded at 10 December planting (8.47 t/ha) [Figure 2]. This results agreed with the experiences of many workers [15, 16].

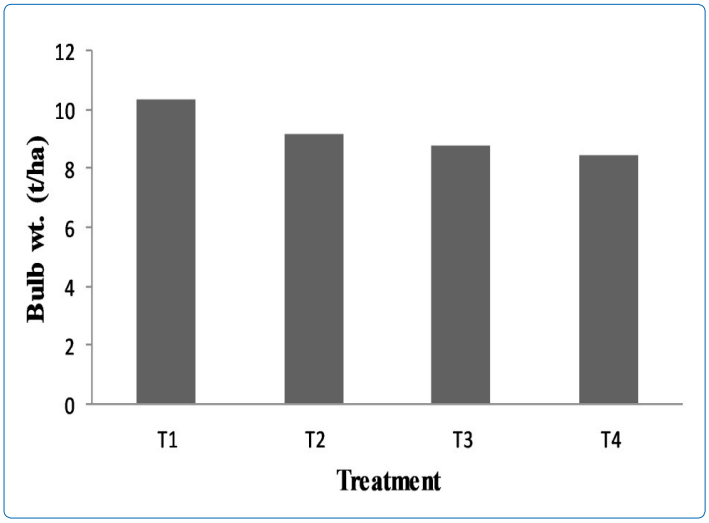

Figure 2: Bulb yield of garlic as influenced by date of planting. (T_1 = 26 October, T_2 = 9 November, T_3 = 20 November, T_4 = 10 December)

Effect of planting system on growth and yield of garlic

Effect on plant characteristics in garlic

Results showed that the zero tillage produced the maximum plant height (50.67 cm) at 90 DAP and was significant at 1% level of probability [Table 3]. Contrariwise, the minimum plant height (18.53 cm) was found in dry land system at 30 DAP. Results also revealed that the plant height was higher in zero tillage condition than dry land at different growth stages. The variations were happened due to different tillage conditions. In addition, it was observed that BAU Garlic-3 produced the highest plant height (53.27 cm) at 90 DAP, whereas the lowest plant heights (18.00 cm) were found in G-51 at 30 DAP [Table 4]. This result also described that plant height increases with age of planting.

Table 3: Main effects of planting system on plant height and number of leaves/plant of garlic

Planting system	Plant height (cm) at				No. of leaves/plant at			
	30DAP	60DAP	90DAP	120DAP	30DAP	60DAP	90DAP	120DAP
Zero tillage	19.92	31.87	50.67	50.08	3.75	5.18	6.90	6.70
Dry land	18.53	29.23	45.15	45.06	3.59	4.82	6.45	6.36
$LSD_{0.05}$	0.448	0.939	0.610	0.642	0.083	0.100	0.124	0.130
$LSD_{0.01}$	0.622	1.304	0.847	0.892	0.115	0.139	0.172	0.180
Level of significance	**	**	**	**	**	**	**	**

(DAP= Days after planting, ** Significance at 1% level of Probability)

Table 4: Main effects of variety on plant height and number of leaves/plant of garlic

Variety	Plant height (cm) at				No. of leaves/plant at			
	30DAP	60DAP	90DAP	120DAP	30DAP	60DAP	90DAP	120DAP
BAU Garlic-1	19.60	30.83	49.40	48.89	3.67	5.00	6.77	6.63
BAU Garlic-2	18.77	30.67	45.67	45.27	3.60	4.97	6.70	6.55
BAU Garlic-3	20.53	32.10	53.27	52.93	3.87	5.34	6.90	6.81
G-51	18.00	28.60	43.30	43.18	3.55	4.70	6.33	6.15
$LSD_{0.05}$	0.634	1.329	0.863	0.909	0.118	0.141	0.175	0.184
$LSD_{0.01}$	0.880	1.844	1.197	1.261	0.163	0.196	0.243	0.255
Level of significance	**	**	**	**	**	**	**	**

(DAP= Days after planting, ** = Significant at 1% level of probability)

Moreover, the combined effect of variety and planting system at different growth stage were presented in [Table 5]. Which showed significant variation the longest plant height (56.07 cm) was recorded in the combined treatment of BAU Garlic-3 with zero tillage at 90 DAP, and the shortest plant height (16.87 cm) was observed in dry land with G-51 at 30 DAP. The influences of four garlic varieties were found to be significant in respect of leaf number per plant at 30, 60, 90 and 120 DAP [Table 4]. The maximum leaf number (6.90) was found at 90 DAP, and the lowest (3.59) were found in dry land system at 30 DAP. This result describes that the leaf number increased with age of planting.

Table 5: Combined effects of planting system and variety on plant height and number of leaves/plant of garlic

Planting system	Variety	Plant height (cm) at				No. of leaves/plant at			
		30DAP	60DAP	90DAP	120DAP	30DAP	60DAP	90DAP	120DAP
Zero tillage	V_1	20.00	32.33	52.27	52.06	3.73	5.13	6.93	6.70
	V_2	19.73	32.27	49.00	48.33	3.67	5.07	6.87	6.65
	V_3	20.80	34.13	56.07	55.73	4.00	5.67	7.00	6.90
	V_4	19.13	28.73	45.33	44.13	3.60	4.87	6.80	6.55
Dry land	V_1	19.20	29.33	46.53	45.60	3.60	4.87	6.60	6.55
	V_2	17.80	29.07	42.33	42.20	3.53	4.87	6.53	6.45
	V_3	20.27	30.07	50.47	50.00	3.73	5.02	6.80	6.72
	V_4	16.87	28.47	41.27	42.10	3.51	4.53	5.87	5.75
$LSD_{0.05}$		0.896	1.877	1.219	1.28	0.166	0.200	0.248	0.260
$LSD_{0.01}$		1.241	2.600	1.688	1.78	0.230	0.276	0.343	0.360
Level of significance		*	*	*	**	NS	**	**	**

(** Significance at 1% level of probability, * Significance at 5% level of probability, NS= Not significance, V_1=BAU Garlic-1, V_2= BAU Garlic-2, V_3= BAU Garlic-3, V_4= G-51)

It was also found that at every growth stages, the leaf number was maximum in BAU Garlic-3 (6.90) among than other garlic varieties. The difference in number of leaves among the cultivars might be due to varying varietals characters. In addition, the leaf number was influenced by the combined effect of variety and planting system at 30, 60, 90 and 120 DAP [Table 5]. The leaf number (7.00) was higher in the combined treatment of zero tillage and BAU Garlic-3 at 90 DAP, whereas the lowest (3.51) was recorded in G-51 with Dry land at 30 DAP. There was significant variation on fresh weight of leaf due to planting system [Table 6]. The higher fresh weight of leaf (13.53 g) was obtained in zero tillage condition, and the lower (13.10 g) was recorded in dry land condition. Elsewhere, there was significant variation on fresh weight of leaf in respect of variety [Table 7]. The highest fresh weight of leaves (15.23 g) was found in BAU- Garlic-3, and the lowest (12.20 g) was recorded in G-51. The combination of planting system and variety were also showed significant influence on fresh weight of leaves [Table 8]. The highest fresh weight of leaves (15.27 g) was found in the combined treatment of BAU Garlic-3 with zero tillage, and the lowest (11.73 g) was recorded in G-51 with dry land condition.

Table 6: Main effects of planting system on fresh weight of leaf, leaf dry weight/plant, root dry weight/plant, bulb diameter, no. of cloves/plant and bulb weight

Planting system	Fresh wt. of leaf (g)	Leaf dry wt./plant (g)	Root dry wt./plant (g)	Bulb diameter (cm)	No, of cloves/ plant	Bulb wt./plant (g)	Bulb wt. (t/ha)
Zero tillage	13.53	1.71	0.612	3.88	21.78	15.21	7.60
Dry land	13.10	1.69	0.600	3.80	21.27	14.39	7.19
$LSD_{0.05}$	0.209	0.009	0.009	0.028	0.255	0.130	0.068
$LSD_{0.01}$	0.290	0.012	0.012	0.038	0.355	0.180	0.094
Level of significance	*	**	**	**	*	**	**

(** Significance at 1% level of probability, * Significance at 5% level of probability)

Table 7: Main effects of variety on fresh weight of leaf, leaf dry weight/plant, root dry weight/plant, bulb diameter, cloves/plant and bulb weight

Variety	Fresh wt. of leaf (g)	Leaf dry wt./ plant (g)	Root dry wt./ plant (g)	Bulb diameter (cm)	No. of cloves/ plant	Bulb wt./plant (g)	Bulb wt. (t/ha)
BAU Garlic-1	13.20	1.66	0.606	3.84	21.43	15.03	7.51
BAU Garlic-2	12.63	1.64	0.590	3.80	19.30	13.85	6.92
BAU Garlic-3	15.23	1.88	0.643	3.93	26.47	17.15	8.57
G-51	12.20	1.63	0.586	3.78	18.90	13.18	6.59
$LSD_{0.05}$	0.296	0.012	0.012	0.039	0.361	0.184	0.096
$LSD_{0.01}$	0.410	0.017	0.017	0.054	0.501	0.255	0.133
Level of significance	**	**	**	**	**	**	**

(** = Significant at 1% level of probability)

Table 8: Combined effects of variety on fresh weight of leaf, leaf dry weight/plant, root dry weight/plant, bulb diameter, cloves/plant and bulb weight

Planting system	Variety	Fresh wt. of leaf (g)	Leaf dry wt./ plant (g)	Root dry wt./ plant (g)	Bulb diameter (cm)	No. of cloves/ plant	Bulb wt./plant (g)	Bulb wt. (t/ ha)
Zero tillage	V_1	13.40	1.66	0.607	3.85	22.00	15.52	7.76
	V_2	12.80	1.65	0.587	3.84	19.40	14.07	7.03
	V_3	15.27	1.91	0.663	4.00	26.53	17.60	8.80
	V_4	12.67	1.63	0.591	3.83	19.20	13.67	6.83
Dry land	V_1	13.00	1.66	0.604	3.84	20.87	14.53	7.26
	V_2	12.47	1.63	0.593	3.76	19.20	13.63	6.81
	V_3	15.20	1.85	0.623	3.86	26.40	16.70	8.35
	V_4	11.73	1.62	0.580	3.73	18.60	12.70	6.35
$LSD_{0.05}$		0.418	0.018	0.018	0.055	0.510	0.260	0.136
$LSD_{0.01}$		0.579	0.024	0.024	0.077	0.707	0.360	0.188
Level of significance		*	**	**	*	*	*	*

(** Significance at 1% level of Probability, * Significance at 5% level of Probability)

The effect of planting system on leaf dry weight per plant was significant, where the higher leaf dry weight was observed in zero tillage (1.71 g per plant) compared to dry land condition (1.69 g per plant) [Table 6]. There was also significant variation on leaf dry weight per plant in case of variety [Table 7]. The higher leaf dry weight was observed in BAU Garlic-3 (1.88 g per plant) compared to among other garlic varieties. This is possibly happened due to increase leaf size in BAU Garlic-3 than other three varieties. In addition, Leaf dry weight was significantly influenced by the combined effect of variety and planting system [Table 8]. Results revealed that leaf dry weight (1.91 g) was higher in the combined treatment of zero tillage and BAU Garlic-3, and the lowest (1.62 g) was recorded in the dry land and G-51. In planting system, root dry weight per plant varied significantly [Table 6], where the higher root dry weight per plant was recorded in zero tillage (0.612 g) compared to dry land (0.60 g). Also**,** root dry weight per plant varied significantly in respect of variety [Table 7]. The highest root dry weight per plant was recorded in BAU Garlic-3 (0.64 g) compared to BAU Garlic-1, BAU Garlic-2 and G-51. The variation in root dry weight might be happened due to the differences in root number of garlic.

Result also revealed that the root dry weight was influenced significantly by the combined effect of variety and planting system [Table 8]. The root dry weight (0.663 g) was higher in the combined treatment of zero tillage and BAU Garlic-3, and the lower (0.58 g) was observed in the dry land and the variety of G-51.

Effect on yield attributes and yields in garlic

The effect of planting system on bulb diameter was significant difference [Figure 3], where the bulb diameter (3.88 cm) was higher in zero tillage compared to dry land (3.80 cm). The effect of variety on bulb diameter was also varied significantly [Table 7]. The bulb diameter was higher in BAU Garlic-3 (3.93 cm) compared to BAU Garlic-1, BAU Garlic-2 and G-51. Genotypic variations in bulb diameter were observed by Rahman et al. [17] supported the experimental result. On the other hand, the combined effect of variety and planting system on bulb diameter was presented [Table 8] and showed that the highest bulb diameter (4.00 cm) was recorded in the combined treatment of BAU Garlic-3 with zero tillage, and the lowest (3.73) cm was observed in Garlic-51 with dry land.

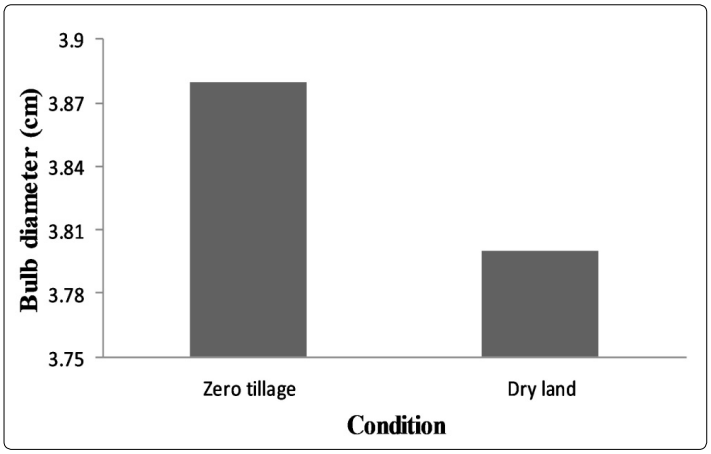

Figure 3: Bulb diameter of garlic as influence by planting system

There were significant variation on cloves number per bulb in respect of the planning system and variety of garlic [Table 6,7]. The cloves number per bulb was greater in zero tillage (21.78) compared to dry land (21.27), and the clove number per bulb was greater in BAU Garlic-3 (26.47) among other variety of garlic[Table 6]. Genotypic variation in cloves number per bulb was also observed by Faruq [22] agreed this experimental result. Besides, the cloves number per bulb was influenced by the combined effect of variety and planting system [Table 8]. Results revealed that cloves number was higher in the combined treatment of zero tillage with BAU Garlic-3 variety (26.53), and the lowest was recorded in G-51 with dry land (18.60). The higher bulb weight was observed in zero tillage (15.21 g per bulb) compared to dry land (14.39 g per bulb). There was also significant variation on bulb weight in regard to variety [Table 7]. The higher bulb weight was observed in BAU Garlic-3 (17.15 g per bulb) compared to BAU Garlic-1, BAU Garlic-2 and G-51. The bulb weight was higher in BAU Garlic-3 might be due to increase the cloves number among the varieties. On the other hand, Bulb weight per plant was significantly influenced by the combined effect of variety and planting system [Table 8]. Results revealed that the highest bulb weight per plant was recorded in the combined treatment of BAU Garlic-3 with zero tillage (17.60 g per plant), and the lowest was recorded in G-51 with dry land (12.70 g per plant). Moreover, the effect of planting system and variety on bulb

yield ton per hectare was shown in [Table 6,7]. The higher bulb yield was observed in zero tillage (7.60 t/ha) compared to dry land (7.19 t/ha) [Figure 4].

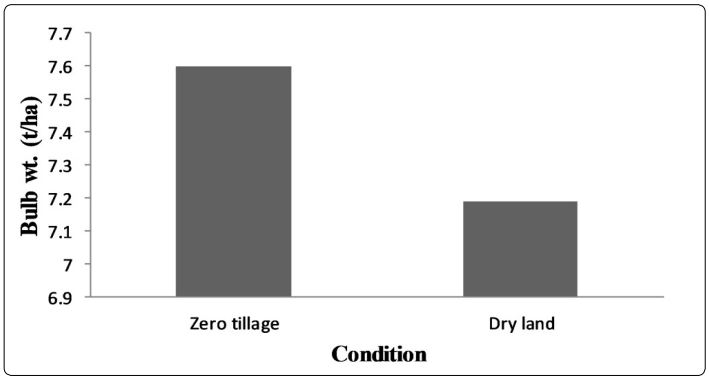

Figure 4: Bulb yield of garlic as influenced by planting system

The higher bulb yield was observed in BAU Garlic-3 (8.57 t/ha) compared to BAU Garlic-1 (7.51 t/ha), BAU Garlic-2 (6.92 t/ha) and G-51 (6.59 t/ha) [Figure 5]. The bulb yield was higher in BAU Garlic-3 might be due to increase individual bulb weight than other varieties. Genotypic variation in bulb weight and yield was also observed by Rahman et al. [17] in garlic that supported the experimental results. In addition, Bulb yield was significantly influenced by the combined effect of variety and planting system [Table 8]. The highest bulb yield was recorded in the combined treatment of BAU Garlic-3 with zero tillage (8.80 t/ha), and the lowest was recorded in G-51 with dry land (6.35 t/ha) [Figure 6].

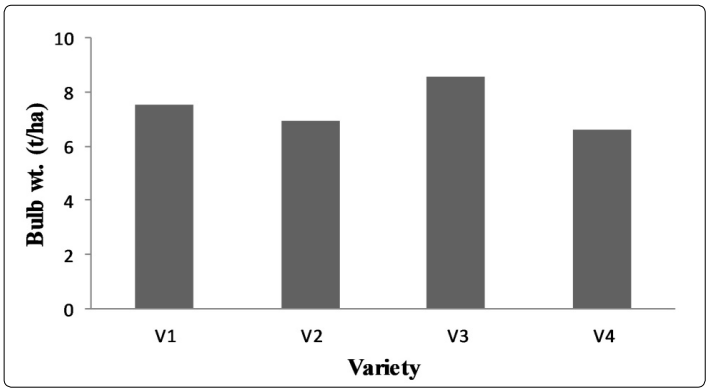

Figure 5: Bulb yield of garlic as influenced by the variety

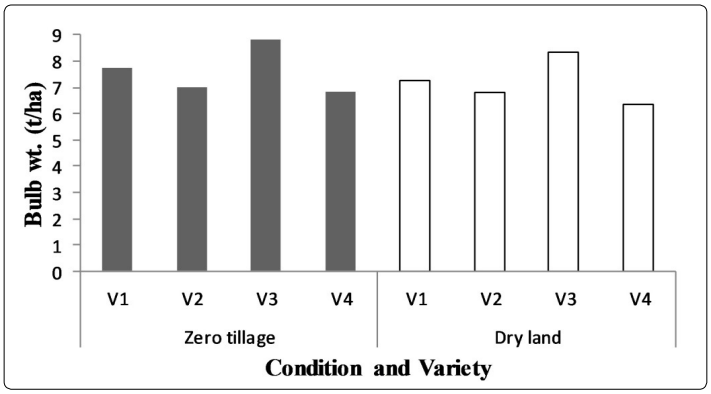

Figure 6: Combined effect of planting system and variety on bulb yield

From the above results, it was also observed that unlike dry land, zero tillage produced higher growth and yield of some garlic germplasm. The results of the study are in partial agreement with the experiences of [23-25]. Zero tillage conserves more moisture in the soil profile before and after planting of garlic than the dry land conditions, as a result moisture was available at the root zone of the plant enhancing vegetative growth and ultimately higher yield in the zero tillage. On the other hand, the higher growth and yield was obtained from BAU- Garlic-3 among other varieties of garlic, and the lowest was found in G-51. In addition, the significant combined effects were found due to the combinations of different variety and planting systems in respect of growth stage. The higher growth and yield was obtained for the combined treatment of zero tillage and BAU Garlic-3 compared to dry land and other three varieties in all growth stage. From the above discussion, it was clarified that zero tillage in combination with BAU Garlic-3 were the maximum growth and bulb yield. So it can be recommended that BAU Garlic-3 with zero tillage is the best planting system for garlic growers in Bangladesh.

Conclusions

Two experiments were conducted in this study for investigating the effect of planting time and planting system on the growth characteristics, yield and yield attributes of garlic. Based on the first experiment, the vegetative growth, yield attributes and yield of garlic decreased with delayed planting, whereas the better growth and maximum yield was obtained from the early planting of garlic. Early planted crops availed favorable environment, longer cool period and shorter day-length, which influenced the elongation of garlic plant resulting maximum plant height and better yield. Thus, it can be recommended that early planting is a good time for the maximum vegetative growth and yield of garlic. In addition, the effect of planting system on the growth and yield of garlic was obtained from the second experiment. Based on the results, it may be concluded that the growth and yield of BAU Garlic-3 with zero tillage showed the better development and performances. Zero tillage keeps more moisture compared to dry land condition, and at this condition moisture was available at the root zone of the plant enhancing vegetative growth. Among the varieties, BAU Garlic-3 showed the maximum vegetative growth and yield. Further, the higher vegetative growth and yield was obtained in the combination of zero tillage with BAU Garlic-3. The garlic production under zero tillage condition could be used for higher storability. Therefore, it is recommended that zero tillage is better for the maximum growth and yield of garlic.

References

1. Kurian JC (1995) Plant that Heal. 1st Edn, OrientaI Watchman Publishing House.
2. Purseglove JW (1975) Tropical Crops: Monocotyledons. ELBS Longman.
3. Bose TK, MG Som (1990) Vegetable Crops in India. 1st Edn, Naya Prakash.
4. Thompson HC, WC Kelly (1957) Vegetable crops. MC. Graw Hill Book Co.
5. BBS (2013) Monthly Statistically Bulletin. Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic of Bangladesh.

6. Kabir MA, MA Rahim, DAN Majumder (2016) Productivity of garlic under different tillage methods and mulches in organic condition. Bangladesh J. Agril. Res 41: 53-66.

7. Shuvra J, M Hossain, M Rahman, U Shaha (2017) Effect of Planting Time on Growth, Development and Yield Performance of Ten Garlic Genotypes. European academic research 7: 3156-3176.

8. Jones HA, LK Mann (1963) Onions and Their Allies. Leonard Hill (Book) Limited, London.

9. Rahim MA, Fordham (1988) Effects of storage temperature on the initiation and development of garlic cloves (Allium sativum L.). Scientia Hort 37: 25-28.

10. Baten MA, BS Nahar, SC Sarkr, MAH Khan (1995) Effect of Different Mulches on the Growth and Yield of Late Planted Garlic (Allium jastivus L). Pak. J. Ind. Res 38: 140-141.

11. Rahim MA, MNA Chowdhury, HRMM Anwar, MS Alam (2003) Effect of Planting Dates on the Growth and Yield of Garlic Germplasm. Asian Journal of Plant Sciences 2: 171-174.

12. Gomez KA, AA Gomez (1984) Statistical Procedure for Agricultural Research. John Wiely and Sons 47:296-299.

13. Rahim MA, MA Siddique, MM Hossain (1984) Effect of time of planting, mother bulb size and plant density on the yield of garlic. Bangladesh J. Agril. Res 9: 112- 118.

14. Siddique MA, MG Rabbani (1985) Growth and bulbing of garlic in response to low temperature treatment of bulb and planting date. Bangladesh J. Bot 14: 41-46.

15. Anwar HRMM, MA Rahim, MSH Chowdhury, MA Haider, MA Quadir (1996) Effect of planting time and growth regulators on the growth and yield of garlic. Prog. Agric 7: 137-142.

16. Swati B, KS Khirad, AK Shrivastav (2013) Effect of planting dates on growth and yield on garlic (Allium sativum L.). International Journal of Horticulture 3:189-191.

17. Rahman MK, MA Rahim, MS Alam (2007) Effect of planting time and mulch on growth and yield of garlic. J. Agrof. and Env 1: 79-81.

18. Islam MA, MH Reza, SMAHM Kamal, MA Wazed, KM Islam (2008) Effect of Planting Date and Gibberellic Acid on the Growth and Yield of Garlic. The Agriculturists 6: 132-139.

19. Lipinski S (1993) Influence of planting date on growth and cropping in several non- bolting garlic types. Biuletyn warzywniczy 40: 45-54.

20. Mishra HN, S Sahoo, AK Mohapatra, AKB Mohapatra (1997) Effects of different dates of planting on growth and yield of garlic (Allium sativum L.) under high altitude conditions of Southern Orissa. Orissa J. Hort 25: 53- 54.

21. Islam MN, MA Rahim, HRMM Anwar (1998) Effect of date of planting arid different germplasm on the growth and seed bulb yield of garlic. Bangladesh J. Seed Sd. Tech 1: 45 - 54.

22. Faruq MA (2000) Effects of date of planting and clove size on growth and yield of garlic. Master thesis, Department of Horticulture, Bangladesh Agricultural University.

23. Verma UN, MK Sinha, VC Srivastava (1991) Effect of tillage and nitrogen management on wheat (Triticum aestivum) after transplanted rice (Oryza sativa). Indian Journal of Agricultural Science 61: 795-802.

24. Khuhro GA, GS Tunio, M Nizamuddin, M Nihaluddin (2002) Zero tillage sowing method of wheat followed by transplanted rice (in rice-wheat system). Pakistan Journal of Applied Science 2:307.

25. Mondal NA, SMA Hossain, SU Bhuiya, M Jahiruddin (2007) Tillage and mulch effects on soil environment, growth and yield of rainfed barley. Annals of Bangladesh Agriculture 11:33-44.