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Effect of organic manure on the growth and yield of garlic under zero tillage condition

M. A. Kabir, M.A. Rahim[1] and D.A.N. Majumder[2]
Department of Horticulture, Hajee Mohammad Danesh Science and Technology University, Dinajpur. [1]Department of Horticulture, Bangladesh Agricultural University, Mymensingh, [2]Plant Biotechnology Lab, BRAC Agricultural Research and Development Centre, Gazipur,

Abstract: A study was carried out at the field laboratory, USDA-Alliums' project, Bangladesh Agricultural University, Mymensingh during rabi season of 2006-2007. Seven organic treatments viz. well decomposed cow dung, compost, poultry litter, mustard oil cake, bone meal, ash and rotten water hyacinth were used to determine the effects of manure on the growth and yield of garlic under zero tillage conditions. Results revealed that the plant height; number of leaves per plant; length and breadth of the longest leaf; fresh and dry weights of leaves, bulb & roots; breadth of bulb; total number of cloves and yield per plot were markedly influenced by all the different manures. However, the tallest plant, maximum number of leaves, highest breadth and length of the longest leaves were recorded from the mustard oil cake. But on the basis of economic analysis, maximum BCR (2.59) were recorded with cow dung.
Key words: Garlic, zero tillage, organic manure, growth, yield

Introduction

Garlic (*Allium sativum* L.), a herbaceous perennial species belonging to the family Alliaceae (Kurian, 1995), is one of the vital bulbous spices. It is popular all over the world as a valuable spice for different dishes. The demand for garlic in Bangladesh is rising with the increase in population. It is difficult to increase the area of the crop due to scarcity of land. Successful garlic cultivation largely depends on the optimum cultural management practices. These include judicious manuring, efficient use of residual soil moisture and mulching. Out of these, the effect of organic manure on garlic is crucial as it is a heavy feeder with shallow roots. But here, most soils have less than 1.5%, and some even less than 1% organic matter content (BARC, 2005). So, the present work was undertaken to find out the suitable organic manures for optimal growth and yield of garlic under zero tillage conditions.

Materials and Methods

After harvesting wet land rice, garlic cloves were planted in the field under zero tillage conditions. Seven organic treatments viz. well decomposed cow dung @ 25 t/ha, compost @ 20 t/ha, poultry litter @ 5 t/ha, mustard oil cake @ 4 t/ha, bone meal @ 3 t/ha, ash @ 7 t/ha and well rotten water hyacinth @ 20 t/ha were added as per the experimental layout (Kabir, 2004). Immediately after planting of cloves, thick rice straw mulch was used for conserving soil moisture. The crop was always kept under careful observation. Ten plants were selected at random from each plot for the collection of data. When the tops of garlic plants turned yellow or light brown and show signs of drying, were ready for harvesting. Data on physio-morphological parameters at 20 days interval after planting as well as on yield were recorded and continued up to the final harvest. The followings data were recorded: plant height (cm), no. of leaves per plant, length of the longest leaf per plant, breadth of the longest leaf per plant, fresh weight of leaves per plant (g), dry weight of leaves per plant (g), fresh weight of roots per plant (g), dry weight of roots per plant (g), fresh weight of bulbs per plant (g), dry weight of bulbs per plant (g), diameter of bulbs (cm), no. of cloves per bulb, yield of bulb per plot (kg) and yield of bulb per hectare (t). The collected data were statistically analyzed and the mean differences were tested by the Least Significant Difference Test.

Results and Discussion

Growth parameters of garlic: Organic fertilizers showed the significant variation in pant height at different stages of growth i.e. 30, 50, 70, 90 and 110 days after planting (Table 1). Among the treatments it was observed that plant height increased gradually with the advancement of time. Plant height showed increasing trend up to 90 DAP for each treatment. The highest plant (75.53cm) at 90 DAP was found from mustard oil cake (MOC) and the lowest (27.47 cm) at 30 DAP was recorded from the control. Number of leaves varied significantly at 30, 50, 70, 90, and 110 DAP with different organic manures. The maximum number of leaves (7.73) was recorded from the mustard oil cake followed by cow dung (7.33) and inorganic fertilizers (6.93) and the minimum was observed (6.00) from control (Table 1). At each DAP, the highest number of leaves per plant was noted with mustard oil cake (MOC).

The variations due to different organic matter under study were highly significant in respect of length of the longest leaf per plant. At 90 days after planting (Table 2) the longest leaf (51.93 cm) was recorded from the mustard oil cake. The shortest leaf per plant (20.93 cm) was obtained from the control at 30 days after planting. Again, the maximum breadth of the longest leaf was recorded from mustard oil cake (1.45 cm) followed by cow dung (1.38 cm). The lowest breadth of the longest leaf (0.45cm) was recorded from the control.

Yield and yield contributing traits of garlic: The fresh weight of leaves was maximum (7.83g) by the application of mustard oil cake and the lowest (3.27g) from the control followed by ash (4.85g) and poultry dropping (5.07g). The result also indicated that mustard oil cake gave the highest fresh weight of bulb (17.20g) followed cow dung (15.91g) and inorganic fertilizers (15.30g). The lowest fresh weight of bulb (7.07g) was found from the control. Mustard oil cake encouraged the maximum vegetative growth; so, the fresh weights of leaves and bulbs were highest by the application of mustard oil cake.

Organic matters had also significant influence on the fresh weight of garlic roots. Mustard oil cake produced the highest (0.66 g) fresh weight of roots. The minimum fresh weight of roots (0.38 g) was observed from the control (Table 3). On the other hand, the maximum dry weight of leaves (1.71g) was produce by the application of only

inorganic fertilizers. Minimum dry weight of leaves (0.73 g) was observed from the control.

Table 1. Effects of different organic manures on the growth parameters of garlic

Treatments	Plant height (cm) at different DAP					Number of leaves/plant at different DAP				
	30	50	70	90	110	30	50	70	90	110
Cow dung	35.87	40.73	60.60	73.53	69.00	4.73	5.07	5.80	7.33	6.87
Compost	32.87	38.87	56.40	67.47	64.13	4.33	4.67	5.20	6.87	6.40
Mustard oil cake	37.00	42.87	63.13	75.53	71.40	4.33	5.13	5.80	7.73	6.93
Poultry dropping	28.53	36.73	55.93	65.53	61.80	3.73	4.47	4.87	6.33	6.0
Water hyacinth	31.73	38.67	55.47	68.33	65.87	4.20	4.80	5.20	6.73	6.40
Bone meal	34.40	41.47	61.00	71.53	68.93	4.27	5.07	5.40	7.0	6.67
Ash	30.20	36.53	52.87	60.27	56.87	3.93	4.13	4.93	6.40	6.0
Only inorganic fertilizers	31.80	39.13	60.33	71.87	70.40	4.20	4.87	5.60	6.93	6.93
Control	27.47	35.13	51.93	58.07	54.47	3.40	4.00	4.60	6.00	5.8
LSD 5%	3.89	4.10	6.07	6.47	5.63	0.55	0.41	0.59	0.58	0.67
LSD 1%	5.36	5.65	8.37	8.91	7.75	0.76	0.56	0.81	0.80	0.93
Level of significance	**	*	*	**	**	**	**	*	**	*

** Significant at 1% level, * Significant at 5% level

Table 2. Effects of different organic manures on the length and breadth of the longest leaf of garlic at different days after planting under zero tillage conditions

Treatments	Length of the longest leaf (cm) at different DAP					Breadth of the longest leaf (cm) at different DAP				
	30	50	70	90	110	30	50	70	90	110
Cow dung	30.07	37.00	43.13	50.93	41.40	0.61	0.75	1.21	1.38	1.26
Compost	27.60	34.53	40.33	45.60	37.80	0.58	0.65	1.10	1.27	1.16
Mustard oil cake	31.33	38.67	44.00	51.93	41.93	0.66	0.79	1.25	1.45	1.31
Poultry dropping	24.00	31.40	36.67	44.60	33.53	0.49	0.57	1.03	1.24	1.09
Water hyacinth	26.73	33.00	39.53	45.33	37.87	0.60	0.69	1.17	1.27	1.15
Bone meal	27.67	35.13	40.87	48.73	38.27	0.59	0.71	1.16	1.32	1.19
Ash	23.20	31.87	36.00	44.13	34.40	0.49	0.54	1.00	1.17	1.03
Only inorganic fertilizers	27.80	33.67	41.80	49.27	40.87	0.63	0.69	1.14	1.35	1.22
Control	20.93	29.07	32.60	42.20	30.73	0.45	0.44	0.95	1.09	0.97
LSD 5%	2.67	4.44	4.61	5.73	3.96	0.10	0.08	0.12	0.16	0.17
LSD 1%	3.67	6.11	6.35	7.89	5.46	0.13	0.11	0.17	0.21	0.23
Level of significance	**	**	**	**	**	**	**	**	**	**

** Significant at 1% level

Table 3. Effects of different organic manures on the yield and yield contributing traits of garlic under zero tillage conditions

Treatments	Fresh weight (g) of			Dry weight (g) of			Bulb diameter (cm)	Cloves/ bulb (No.)	Yield (kg/ plot)	Yield (kg/ha
	Leaves per plant	Bulb	Roots per plant	Leaves per plant	Bulb	Roots per plant				
Cow dung	7.05	15.91	0.65	1.52	4.70	0.21	3.19	17.33	1.59	7.95
Compost	6.16	14.13	0.61	1.37	3.82	0.19	2.96	14.80	1.41	7.07
Mustard oil cake	7.83	17.20	0.66	1.51	4.60	0.19	3.49	18.60	1.72	8.6
Poultry dropping	5.07	11.73	0.53	1.30	3.73	0.17	2.69	11.27	1.17	5.87
Water hyacinth	5.83	13.75	0.57	1.33	3.76	0.18	2.97	15.73	1.37	6.87
Bone meal	6.74	15.11	0.59	1.42	4.37	0.20	3.09	16.93	1.51	7.56
Ash	4.85	11.36	0.42	1.12	3.64	0.14	2.48	12.00	1.14	5.68
Only inorganic fertilizers	6.80	15.30	0.62	1.71	4.39	0.20	3.15	17.73	1.53	7.65
Control	3.27	7.07	0.38	0.73	2.57	0.12	2.09	9.00	0.71	3.53
LSD 5%	1.11	1.61	0.05	0.18	0.82	0.02	0.31	2.67	0.25	1.23
LSD 1%	1.53	2.21	0.08	0.25	1.13	0.03	0.42	3.68	0.34	1.70
Level of significance	**	**	**	**	**	**	**	**	**	**

** Significant at 1% level

Large number of bulbs was observed from the treatment of cow dung. So, the maximum dry weight of bulbs (4.70 g) was recorded from the treatment of cow dung, which was statistically similar with that of mustard oil cake (4.60g). The minimum dry weight of bulbs (2.57 g) was observed from the control (Table 3). The maximum dry weight of bulbs obtained from the mustard oil cake was probably due to the fact that organic fertilizers provided good soil conditions for the growth and supplied sufficient plant nutrients that helped in the production of large bulb of maximum dry weight. Dry weight was also related to the fresh weight. The highest dry weight of roots (0.21g) was recorded when the crops were raised with cow dung and the lowest (0.12 g) was recorded from the plot without inorganic fertilizers. The result indicated that the organic matter gave the highest bulb diameter (3.49 cm) followed by cow dung (3.19cm). The lowest diameter of bulb (2.09 cm) was found from the control. Once more, the maximum number of cloves per plant (18.60) was also obtained from mustard oil cake. Different organic manure showed highly significant variations on the yield of garlic per plot. Mustard oil cake gave the highest yield per plot (1.72 kg) as well as per hectare (8.60 t) followed by cow dung (7.95 t/ha). The lowest yield (3.53 t/ha) was obtained from the control (Table 3).

Table 4. Correlation co-efficient between yield and yield contributing traits of garlic under zero tillage conditions

Traits	No. of leaves/plant at 90 DAP	Bulb diameter (cm)	Fresh wt. of bulb (g)	Fresh wt. of leaves per plant (g)	Dry wt. of bulb (g)	Dry wt. of leaves per plant (g)	Cloves per bulb	Yield kg/plot
Plant height (cm) at 90 DAP	.809**	.836**	.861**	.855**	.814**	.741**	.839**	0.826**
No. of leaves /plant at 90 DAP		.789**	.836**	.850**	.761**	.644**	.726**	0.754**
Bulb diameter (cm)			.931**	.850**	.765**	.770**	.838**	0.914**
Fresh weight of bulb (g)				.924**	.867**	.827**	.855**	0.946**
Fresh wt. of leaves per plant (g)					.863**	.811**	.868**	0.907**
Dry weight of bulb (g)						.743**	.770**	0.800**
Dry wt. of leaves per plant (g)							.819**	0.835**
Cloves per bulb(no.)								0.857**

** Significant at 1% level

Table 5. Path co-efficient analysis showing direct (bold) and indirect effect of yield components towards the yield of garlic under zero tillage conditions

Traits	Plant height (cm) at 90 DAP	No. of leaves at 90 DAP	Bulb diameter (cm)	Fresh wt. of bulb (g)	Fresh wt. of leaves/ plants (g)	Dry wt. of bulb (g)	Dry wt. of leaves (g)	Cloves per bulb	Yield (kg/plot)
Plant height (cm) at 90 DAP	**0.011**	-0.161	0.208	0.478	0.302	-0.091	0.064	0.015	0.826
No. of leaves per plant at 90 DAP	0.010	**-0.199**	0.196	0.464	0.301	-0.086	0.055	0.013	0.754
Bulb diameter (cm)	0.010	-0.157	**0.249**	0.516	0.301	-0.086	0.066	0.015	0.914
Fresh weight of bulb (g)	0.010	-0.167	0.232	**0.555**	0.327	-0.097	0.071	0.015	**0.946**
Fresh weight of leaves per plant (g)	0.010	-0.169	0.211	0.513	**0.354**	-0.097	0.070	0.015	0.907
Dry weight of bulb (g)	0.009	-0.152	0.190	0.481	0.305	**-0.112**	0.064	0.014	0.800
Dry weight of leaves per plant (g)	0.008	-0.128	0.191	0.459	0.287	-0.083	**0.086**	0.015	0.835
Cloves/ per bulb (No.)	0.010	-0.145	0.208	0.475	0.307	-0.087	0.071	**0.018**	0.857

Table 6. Cost and return of garlic production due to different organic manures under zero tillage conditions

Treatments	Yield of bulb (t / ha)	Gross return (Tk. / ha)	Total cost of production (Tk.)	Net return (Tk.)	BCR
Cow dung	7.95	278250	107629.25	170620.75	2.59
Compost	7.07	247450	109803.50	137646.50	2.25
Mustard oil cake	8.60	301000	151727.50	149272.50	1.98
Poultry dropping	5.87	205450	98765.00	106685.00	2.08
Water hyacinth	6.87	264600	103671.00	160929.00	2.55
Bone meal	7.56	240450	160536.00	79914.00	1.5
Ash	5.68	198800	96869.50	101930.50	2.05
Only inorganic fertilizers	7.65	267750	104340.00	163410.00	2.57
Control	3.53	123550	82820.50	40729.50	1.49

Correlation Matrix: From the correlation matrix (Table 4) it would be clear that all the studied parameters were significantly associated among themselves. Correlation coefficients revealed that plant height and number of leaves per plant at 90 days after planting had an affirmative association with the bulb diameter, fresh weight of bulb, dry weight of bulb and leaves, no. of cloves per bulb and the yield per plot. The results also showed that all the yield contributing traits viz. diameter of bulb, fresh weight of bulb and leaves; dry weight of bulb and leaves; no. of cloves were positively and significantly correlated with the bulb yield.

Path coefficient analysis for yield: The results obtained from the path co-efficient analysis indicated that plant height at 90 DAP, fresh weights of bulbs and leaves, dry weight of leaves, bulb diameter and number of cloves per plant had positive direct effects on the yield. On the other hand, number of leaves per plant and dry bulb weight showed negative direct effects on the yield (Table 5). The residual effect of path analysis was 0.265, which revealed that there were treatment variability's on the selected nine traits of garlic. This residual effect towards yield in this study may be due to many reasons such as characters not studied here and sampling errors.

BCR analysis: Economic analyses among the treatments of organic manuring revealed that the highest cost of Tk. 160536.00 was incurred in bone meal, whereas it was least (Tk. 82820.50) in the control (Table 6). It was found that cow dung gave the highest net return of Tk. 170620.75 followed by inorganic fertilizers (Tk. 163410.00). Considering the benefit cost ratio (BCR), cow dung also had higher value (2.59) than the rest treatments. Oppositely, the degree of profitability among the tested organic manures under study were in the order of cow dung >only inorganic fertilizers > well rotten water hyacinth > compost > poultry dropping > ash > mustard oil cake > control > bone meal.

the experimental results it could be concluded that organic manure had a significant effect on the yield and yield contributing traits of garlic. This was possibly due to the fact that organic manure not only increased the production of crops by supplying all the essential plant nutrients, but also provided organic matter to the soil. It also encouraged cell division, cell enlargement and more photosynthetic activities for higher yield. Organic manures improves texture, structure, humus, aeration, water holding capacity, buffer action, cation exchange capacity and microbial activity of any soil and thus helps to increase and conserve soil productivity. Garlic is a shallow rooted plant so, it needs continuations moisture supply to the soil. The results of the present study are in partial agreement with the findings of Cho *et al*. (1994), Gudi *et al*. (1988), and Khalaf and Taha (1988). Oppositely, Limat *et al*. (1984) reported that profitability of garlic was maximum with bulbs grown using processed industrial waste followed by FYM. The experiment revealed that organic fertilizer like cow dung was found to be best for higher yield and economic return of garlic under the zero tillage conditions.

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