JOURNAL OF AGROFORESTRY AND ENVIRONMENT
ISSN 1995 - 6983
journal homepage : www.jaebd.com

Effect of different sources of nitrogen on growth and yield of two lines of garlic under wetland condition at BAU, Mymensingh

M. S. Alam, M. A. Rahim[1], S. Panahi Rad[2] and S. Bilkis[1]
Horticulture Division, Bangladesh Institute of nuclear Agriculture (BINA), Mymensingh, [1]Department of Horticulture, BAU, Mymensingh, [2]University of Tabriz, Iran, E-mail: mithuhort@yahoo.com

Abstract: The investigation was carried out in a low land of the Allium Field Laboratory, Horticulture Farm, Department of Horticulture, Bangladesh Agricultural University, Mymensingh and laboratory of Horticulture Division, Bangladesh Institute of Nuclear Agriculture (BINA) on the effect of different sources of nitrogen on growth and yield of two lines of garlic under wetland condition at BAU, Mymensingh during the period October, 2016 to April 2017. The 2-factor experiment had 4 sources of nitrogen (Factor A) and 2 garlic lines (Factor B) as follows –Factor A: 4 sources of nitrogen: i) Urea - 200 kg/ ha (30 g/plot) = 92 kg N/ha; ii) Urea -100 kg/ha (15 g/plot) + DAP-200 kg/ha (30 g/plot) = 92 kg N/ha ; iii) DAP- 400 kg/ha (60 g/plot) = 92 kg N/ha and iv) Cowdung -7666 kg/ha (1.15 kg/plot) = 92 kg N/ha; Factor B: Garlic lines i) G_2 and ii) G_{19}. The experiment was conducted in randomized complete block design (RCBD) with 3 replications. Unit plot size: 1.5m - 1m, plant spacing: 20 cm × 10 cm; total number of treatments: 4 × 2=8; total number of unit plots: 8 × 3= 24; total number of plants per plot = 75; Date of planting: 24 Nov, 2016; date of harvesting: 8 April, 2017. The results revealed that the plant height, number of leaves per plant, fresh and dry weight of bulb, length and diameter of bulb, total number of cloves, yield per plot and yield per hectare were significantly influenced by the treatment of the experiment under study. Results showed that Garlic line G_{19} produced the highest yield ((13.55 t/ha) and the lowest (10.15 t/ha) was found in garlic line G_2 under wet land condition. The yield was increased with different sources of nitrogen and thus the highest yield (12.74 t/ha) and maximum individual fresh weight of bulb (27.55 g) were recorded when cowdung was used. The lowest yield of 10.92 t/ha and minimum individual fresh weight of bulb 23.60 g were achieved from urea. Garlic line G_{19} and cowdung as the source of nitrogen gave maximum yield. The highest yield of 14.60 t/ha was recorded in garlic line G_{19} when cowdung was used. Whereas the lowest of 9.10 t/ha was found in garlic line G_2 with urea source.
Key words: Garlic, growth, sources of nitrogen, wetland, and yield.

Introduction

Garlic (*Allium sativum* L.) belongs to the family Alliaceae. It is the second most widely used among cultivated alliums after onion (*Allium cepa*). Garlic is grown extensively as a spice crop in Bangladesh, but its average yield is only 2.86 t/ha (FAO, 2017), which is very low compared to the yield of many other countries. The world average yield of garlic is 11.99 t/ha (FAO, 2017). The highest national yield is recorded from the Netherlands (48 t/ha) followed by Jordan (36 t/ha) and Lebanon (20 t/ha). The crop is grown under both rain-fed and irrigated conditions. It gives good result when grown on fertile well-drained and sand or silt-loam soils, with good moisture retaining properties (Zaman *et al.*, 2011). Garlic is mainly used as a spice, seasoning, and flavouring for foodstuff involving both green tops and bulbs due to its pungent flavor (Tadese, 2009). Use of high yielding variety is the most important consideration for cultivation of any crop. But very little attention has so far been given to the improvement of garlic either through selection, mutation breeding technique, hybridization or introduction of suitable variety in this country. Garlic nitrogen requirement is 5% N, 4% N, and 3% N at prebulbing, bulbing, and postbulbing stages, respectively and it is considered deficient in nitrogen with 4% N, 3% N, and 2% N at early season, midseason, and late season, respectively (Tyler *et al*., 2017 and Ebrahimi *et al.*, 2014). Manuring a crop is essential for its growth and development. Nutrients are applied to the soil through organic and inorganic means. Indiscriminate use of inorganic fertilizer is believed to cause determination of soil texture, structure, hinders microbial activity, pollutes ground water and finally decreases soil fertility and production. On the other hand, the use of organic manure improves texture, structure, humus, color, aeration water holding capacity and microbial activity of the soil. All these in return increase production and reduce environmental pollution (Pare *et al*., 2000). Recent genetic studies revealed that garlic displays a wide range of variation under various ecological conditions and some germplasm have adapted to specific environments through artificial and natural selection. Garlic germplasm normally show wide variations in characteristics such as bulb weight, coat layer, leaf length, growth habit and stress. So, evaluation of garlic genetic resources both by morpho-agronomic traits or molecular markers will make us to understand the variation between accessions and select out those with our interested character for breeding program (Volka. and Stern, 2009). Fertilizer is indispensable for the crop production systems of modern agriculture. Among the factors that influence the crop production, fertilizer is the most important one that plays a crucial role in yield increase. In Bangladesh, the demand for garlic is increasing gradually with the increasing of population. It is difficult to increase the area of the crop due to land constraint. One of the ways to overcome the problem is to increase yield per unit area. Application of balanced fertilizer and HYV is an important aspect for increasing yield. To ensure better yield, sources of nutrient and high yielding variety need to be assured. A number of researches works on fertilizers application and germplasm have been conducted in different parts of the world. But information under Bangladesh condition is not conclusive. Keeping all these facts in view, an attempt was made to assess the effect of different sources of nitrogen on growth and yield of two lines of garlic under wetland condition at BAU, Mymensingh was undertaken with the objectives: to develop garlic varieties through selection and to find out the suitable sources of nitrogen for the developed garlic varieties.

Materials and Methods

The experiment was carried out in a low land of the Allium Field Laboratory, Horticulture Farm, Department of Horticulture, Bangladesh Agricultural University, Mymensingh and laboratory of Horticulture Division, Bangladesh Institute of Nuclear Agriculture (BINA) on the

effect of different sources of nitrogen on growth and yield of two lines of garlic under wetland condition at BAU, Mymensingh during the period October, 2016 to April 2017. The 2-factor experiment had 4 sources of nitrogen (Factor A) and 2 garlic lines (Factor B) as follows –Factor A: 4 sources of nitrogen: i) Urea - 200 kg/ ha (30 g/plot) = 92 kg N/ha; ii) Urea -100 kg/ha (15 g/plot) + DAP-200 kg/ha (30 g/plot) = 92 kg N/ha ; iii) DAP- 400 kg/ha (60 g/plot) = 92 kg N/ha and iv) Cowdung -7666 kg/ha (1.15 kg/plot) = 92 kg N/ha; Factor B: Garlic lines i) G_2 and ii) G_{19}. The experiment was conducted in randomized complete block design (RCBD) with 3 replications using 20cm×10cm plant spacing. The total number of treatments: 4 ×2=8; The size of a unit plot was 1.5m×1m accommodating 24 plots. The total number of plants per plot was 75. Planting date of the lines was 9 Nov., 2016 and harvesting date was8 April, 2017.The garlic lines were collected from Allium project, Horticulture Farm, Department of Horticulture, Bangladesh Agricultural University, Mymensingh. TSP and MP at the rates of 267 and 333 kg/ha, respectively, were applied as basal doses during land preparation to all plots irrespective of nitrogen and potassium. The entire amount of cowdung, 1/3 urea and 1/3 DAP as per treatment were added to the soil at the time of final land preparation 7 days before planting. Rest of 2/3 Urea and 2/3 DAP as per treatment were top dressed in three equal installments at 25, 50 and 75 days after planting of cloves. The following data (height of plant, number of leaves per plant, fresh weight of leaves per plant, fresh weight of bulb, fresh weight of roots per plant, dry weight of leaves per plant, dry weight of bulb, dry weight of roots per plant, diameter of bulb, length of bulb, no. of cloves per bulb, yield of bulb per plot, yield of bulb per hectare**)** on physio-morphological growth parameters at 30 days interval after planting as well as on yield were recorded and continued up to final harvest. Intercultural operations were done as and when necessary. The means for all treatments were calculated and the analyses of variances for all the characters under consideration were performed by 'F' variance test. The significance of difference between pair of means was performed by Least Significant Difference (LSD) test taking 5% probability level as the minimum unit of significance (Gomez and Gomez, 1984).

Results

The main and combined effect of different sources of nitrogen and lines of garlic on growth and yield of garlic under wetland condition at BAU, Mymensingh have been presented in this chapter. Sources of nitrogen and lines of garlic had marked effects on yield and yield contributing parameters.

Main effect of garlic lines on growth and yield of garlic bulb under wetland condition at BAU, Mymensingh

Different yield contributing characters and yield of garlic were influenced by two lines of garlic at different DAP and at harvest. The tallest plant (66.40 cm) and the maximum number of leaves (7.50) per plant were recorded 120 DAP in garlic line G_{19}. The maximum fresh weight of bulb (27.85 g) per plant, number of clove (22.80) per plant, length of bulb (3.62 cm), diameter of bulb (3.53cm), yield (2.03 kg) per plot and yield (13.55 t/ha) per hectare at harvest were found higher in garlic line G_{19}. The shortest plant (26.22cm) and minimum number of leaves (4.45) per plant were found at 30 DAP in garlic line G_2. The minimum fresh weight of bulb (23.42g) per plant, number of clove (20.70) per plant, length of bulb (3.25 cm), diameter of bulb (3.17cm), yield (1.52 kg) per plot and yield (10.15 t/ha) per hectare at harvest were obtained in garlic line G_2 (Table 1).

Table 1. Main effect of garlic lines on growth and yield of garlic bulb under wetland condition at BAU, Mymensingh

Treatments	Height of plant in cm at DAP					No. of leaves/plant at DAP					Fresh wt. of bulb (g)	Length of bulb (cm)	Diameter of bulb (cm)	No. of cloves/ bulb	Yield/ plot (kg)[1]	Yield (t/ha)
	30	60	90	120	135	30	60	90	120	135						
G_{19}	32.32	44.75	63.35	66.40	59.55	4.95	5.92	7.50	7.25	6.90	27.85	3.62	3.53	22.80	2.03	13.55
G_2	26.22	36.30	50.45	60.45	53.02	4.45	4.90	6.90	6.91	6.60	23.42	3.25	3.17	20.70	1.52	10.15
LSD 5%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LSD 1%	2.25	3.32	2.42	3.46	3.11	0.56	0.45	0.31	0.38	0.36	1.51	0.27	0.24	2.60	0.18	0.72
Level of Sign.	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**

** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Non significant, The size of a plot was 1.5m × 1m

Main effect of different sources of nitrogen on growth and yield of garlic bulb under wetland condition at BAU, Mymensingh

Most of yield contributing characters and yield were affected by sources of nitrogen. Different yield contributing characters and yield of garlic were influenced by two lines of garlic at different DAP and at harvest. The tallest plant (69.00 cm) and the maximum number of leaves (7.58) per plant were recorded 120 DAP in 7666 kg/ha cowdung. The maximum fresh weight of bulb (27.85 g) per plant, number of clove (26.15) per plant, length of bulb (3.90 cm), diameter of bulb (3.80cm) and yield (1.91 kg) per plot at harvest were found higher in 7666 kg/ha cowdung. The shortest plant (27.50 cm) and minimum number of leaves (4.30) per plant were found at 30 DAP in 200 kg/ha urea. The minimum fresh weight of bulb (23.60g) per plant, number of clove (17.40) per plant, length of bulb (3.05 cm), diameter of bulb (2.90cm) and yield (1.64 kg) per plot e at harvest were obtained in 200 kg/ha urea (Table 2). The yield was increased with different sources of nitrogen and thus the highest yield (12.74 t/ha) was recorded when cowdung was used. The lowest yield (10.92 t/ha) per hectare was achieved from 200 kg/ha urea (Table 2).

Table 2. Main effect of different sources of nitrogen on growth and yield of garlic bulb under wetland condition at BAU, Mymensingh

Treatments	Height of plant in cm at DAP					No. of leaves/plant at DAP					Fresh wt. of bulb (g)	Length of bulb (cm)	Diameter of bulb (cm)	No. of cloves/ bulb	Yield/ plot (kg)[1]	Yield (t/ha)
	30	60	90	120	135	30	60	90	120	135						
T_1	31.00	42.40	61.40	69.00	61.70	5.15	6.20	7.75	7.58	7.25	27.55	3.90	3.80	26.15	1.91	12.74
T_2	30.35	41.10	57.30	64.50	57.90	4.80	5.80	7.50	7.33	6.95	26.20	3.55	3.55	23.10	1.82	12.10
T_3	28.25	40.10	55.20	61.00	54.15	4.55	4.95	7.10	6.88	6.55	25.20	3.25	3.17	20.35	1.75	11.64
T_4	27.50	38.50	53.70	59.20	51.40	4.30	4.70	6.45	6.52	6.25	23.60	3.05	2.90	17.40	1.64	10.92
LSD 5%	2.29	3.38	2.47	3.52	3.17	0.57	0.46	0.31	0.38	0.37	1.54	0.28	0.25	2.65	0.19	0.74
LSD 1%	3.18	4.69	3.43	4.89	4.40	0.79	0.64	0.43	0.53	0.51	2.14	0.39	0.34	3.67	0.26	1.02
Level of Sign.	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**

** = Significant at 1% level of probability, T_1 = 7666 kg/ha cowdung, T_2 = 100 kg/ha urea + 200 kg/ha DAP, T_3 = 400 kg/ha DAP, T_4 = 200 kg/ha urea
1The size of a plot was 1.5m × 1m

Table 3. Combined effect of garlic lines and different sources of nitrogen on growth and yield of garlic bulb under wetland condition at BAU, Mymensingh

Treatments	Height of plant in cm at DAP					No. of leaves/plant at DAP					Fresh wt. of bulb (g)	Length of bulb (cm)	Diameter of bulb (cm)	No. of cloves/ bulb	Yield/ plot (kg)[1]	Yield (t/ha)
	30	60	90	120	135	30	60	90	120	135						
V_1T_1	33.80	47.60	65.20	70.40	62.80	5.40	7.00	8.10	7.80	7.40	30.00	4.000	3.900	27.30	2.19	14.60
V_1T_2	33.50	45.20	64.00	68.40	61.20	5.00	6.40	7.80	7.50	7.00	28.20	3.70	3.60	24.20	2.06	13.72
V_1T_3	31.20	44.20	62.60	64.20	59.00	4.80	5.30	7.60	7.20	6.80	27.00	3.50	3.43	21.30	1.97	13.14
V_1T_4	30.80	42.00	61.60	62.60	55.20	4.60	5.00	6.50	6.50	6.40	26.20	3.30	3.20	18.40	1.91	12.75
V_2T_1	28.20	37.20	57.60	67.60	60.60	4.90	5.40	7.40	7.37	7.10	25.10	3.80	3.70	25.00	1.63	10.88
V_2T_2	27.20	37.00	50.60	60.60	54.60	4.60	5.20	7.20	7.17	6.90	24.20	3.40	3.50	22.00	1.57	10.49
V_2T_3	25.30	36.00	47.80	57.80	49.30	4.30	4.60	6.60	6.57	6.30	23.40	3.00	2.90	19.40	1.52	10.14
V_2T_4	24.20	35.00	45.80	55.80	47.60	4.00	4.40	6.40	6.53	6.10	21.00	2.80	2.60	16.40	1.36	9.10
LSD 5%	3.24	4.78	3.49	4.98	4.48	0.81	0.65	0.44	0.54	0.52	2.18	0.40	0.35	3.74	0.27	1.04
LSD 1%	4.50	6.64	4.85	6.91	6.22	1.12	0.90	0.61	0.75	0.72	3.03	0.55	0.49	5.20	0.37	1.44
Level of Sign.	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**

**= Significant at 1% level of probability, V_1 = Garlic line G_{19}, V_2 = Garlic line G_2, T_1 = 7666 kg/ha cowdung, T_2 = 100 kg/ha urea + 200 kg/ha DAP, T_3 = 400 kg/ha DAP, T_4 = 200 kg/ha urea, 1 The size of a plot was 1.5m × 1m

Combined effect of garlic lines and different sources of nitrogen on growth and yield of garlic bulb under wetland condition at BAU, Mymensingh

The data of the table revealed that most of the yield components at different DAP and yield were greatly affected by the combined effect of garlic lines and sources of nitrogen. The tallest plant (70.40 cm) and the maximum number of leaves (7.80) per plant were recorded 120 DAP in garlic line G_{19} with 666 kg/ha cowdung. The maximum fresh weight of bulb (30.00 g) per plant, number of clove (27.30) per plant, length of bulb (4.00 cm), diameter of bulb (3.900cm) and yield (2.19 kg) per plot at harvest were found higher in (Table 3). The shortest plant (24.20 cm) and minimum number of leaves (4.00) per plant were found at 30 DAP in 200 kg/ha urea. The minimum fresh weight of bulb (21.00g) per plant, number of clove (16.00) per plant, length of bulb (2.8 cm), diameter of bulb (2.6cm) and yield (2.19 kg) per plot e at harvest were obtained in 200 kg/ha urea. Garlic line G_{19} and 666 kg/ha cowdung as the source of nitrogen gave maximum yield. The highest yield of 14.60 t/ha was recorded in garlic line G_{19} when cowdung was used. Whereas the lowest of 9.10 t/ha was found in garlic line G_2 with 200 kg/ha urea source (Table 3).

Discussion

The highest performance in garlic line G_{19} was possibly due to accumulation of more quantity of carbohydrates and more deposition of photosynthates during vegetative growth of plant which probably led to the development of longer bulbs. This finding agrees with the reports of Singh *et al*. (2002) and Shamim (2001) who stated that garlic line was termed to be the most promising cultivars in terms of yield potential.

As sources of nitrogen, same amount of nitrogen as urea, DAP (Diammonium phosphate) and cowdung applied in the experimental field. Cowdung effect was better on all the mentioned parameters. The application of cowdung increased vegetative growth as well as yield (Zaman *et al.*, 2011 and Ebrahimi *et al.*, 2014). Cowdung supplied nitrogen along with other nutrients which encouraged cell division, cell enlargement and consequently more LAI leading to more photosynthetic activities for higher yield (Brewster, 1994). The present finding of achieving higher yield with cowdung is supported by the results of Setty *et al*. (1989).

When cowdung was applied in soil, it improves the physical conditions of the soil, resulting micro nutrient available which help the plant to easy establishment in the field and easy uptake of nutrient slowly at tender stage of the plant. These results partially agree with Dixit (1997) who stated that higher yield was obtained with the higher rate of FYM. Katyal (1967) suggested that 15 to 20 ton FYM/ha is appreciable for early growth stage of garlic crop. Garlic lines G_{19} performed better than garlic line G_2 with respect to yield and yield contributing characters except breadth of the longest leaf at different DAP.

The effects of different sources of nitrogen on the growth and yield of two garlic germplasm (G_{19} and G_2) were studied under wetland conditions during the growing season 2016-17. Cowdung @ 7666 kg/ha (92 kg N/ha) appeared to be the best source of nitrogen for the product of garlic under wetland conditions. The highest yields

under wetland (14.60 t/ha) conditions were obtained from the germplasm G_{19} supplied with 7666 kg cowdung per hectare.

Conclusion: Considering the findings of the experiments under study, the following practices may be recommended for the production of garlic line G_{19} and garlic line G_2 in Bangladesh: Cowdung is the best source of nitrogen for garlic production under wet land conditions; however, further investigation is necessary to same experiments.

Acknowledgement: The authors are heartiest grateful to the authority of the Alliums Project, Department of Horticulture, Bangladesh Agricultural University, Mymensingh for supplying the garlic lines and conducting the experiment at the Alliums Project field.

References

Brewster, J. L. 1994. Onion and other Vegetable Alliums. Crop Production Series in Horticulture, UK. 3: 83-87.

Dixit, S. P. 1994. Effect of nitrogen and cowdung on the productivity of garlic in a dry temperature high hills zone of Himachal Pradesh. Ann. Agril. Res., 18 (2): 258-261.

FAO (Food and Agricultural Organization), 2017. Production Year book. Food and Agriculture Organization of the United Nations, Rome, Italy. 57: 177.

Gomez, K, A. and A. A. Gomez. 1984. Statistical Procedures for Agricultural Research. Wiley- Inerscience Publication, John Wiley and Sons, New York. p. 680.

K. Tyler, D. May, J. Guerard, D. Ririe, and J. Hatakeda, 2017. Diagnosing nutrient needs of garlic. J. California Agriculture, vol. 42(2): 28–29

Katyal, S.L. 1977. Vegetable growing in India. Oxford & IBH Publishing Co. Culcutta, p. 120.

Pare, T., H. Dinel and M. Schnitzer. 2000. Carbon and O nitrogen mineralization in Soil Amended with non tabletized and tabletized poultry manure. Can. J. Soil Sci., 80 (2): 271-282.

Setty, B. S., G. S. Sulikeri and N. C. Hulamani. 1989. Effect of N, P and K on growth and yield of garlic (*Allium sativum* L.). Karnata J. Agril. Sci., 2(3): 160-164.

Shamim, M. 2001. Effect of nitrogen and potassium on growth, yield and storability of two garlic germplasm. MS Thesis, Dept. of Horticulture, BAU, Mymensingh. 130 p.

Singh, D. K., R. P. Gupta and S. N. Choudhary. 2002. Studies on the evaluation of the performance of advance lines in garlic. News Letter National Hort. Res. Dev. Foundation, India, 22 (2): 11-15.

T. G. Tadese, 2009. Participatory varietal evaluation and farmers-based seed production. A sustainable approach to garlic seed delivery in Atsbi Womberta Woreda, Eastern Tigray [M.S. thesis], Department of Crop and Horticultural Science, Mekelle University, Mek'ele, Ethiopia, 128P

Volka, G.M. and D. Stern, 2009. Phenotypic characteristics of ten garlic cultivars grown at different north American locations. Horti. Sci., 44(6): 238-1247

Zaman M.S., M.A., Hashem, M. Jahiruddin and M.A. Rahim, 2011.Effect of nitrogen for yield maximization of garlic in old brahmaputra flood plain soil. Bangladesh Journal of Agricultural Research, 36(2):357-367.

Ebrahimi M.H., S. Sharafzadeh and F. Bazrafshan, 2014. The influence of nitrogen levels on growth and bulb yield of two garlic cultivars. European Journal of Experimental Biology. 4(1):270-272.