J Agric Rural Dev **6**(1&2), 63-68, June 2008 ISSN 1810-1860

SCHOOL OF AGRICULTURE AND RURAL DEVELOPMENT
কৃষি ও পল্লী উন্নয়ন অনুষদ

Available online at
http://www.banglajol.info/index.php/jard

JARD
Journal of Agriculture & Rural Development

Effect of Nitrogen Rate and Application Interval on Yield and Profitability of Bilatidhonia

S. N. MOZUMDER[*1], M. MONIRUZZAMAN[2] & P. C. SARKER[3]

[1]Hill Agricultural Research Station, Ramgarh, BARI, Khagrachhari Hill District-4531, Bangladesh
[2]Agricultural Research Station, Raikhali, BARI, Chandraghona, Rangamati Hill District-4531, Bangladesh
[3]Regional Agricultural Research Station, BARI, Hathazari, Chittagong- 4330, Bangladesh

ABSTRACT

The experiments on Bilatidhonia (Eryngium foetidum L.) crop comprising three levels of application interval (D_1 = 15, D_2 = 30 and D_3 = 45 days after sowing) and four levels of nitrogen (N_1 = 150, N_2 = 175, N_3 = 200 and N_4 = 225 kg/ha) were carried out to determine the suitable N dose and application interval at ARS, Raikhali, Rangamati Hill District during two consecutive cropping season in 2003-04 and 2004-05. Plant height, number of leaves and leaf size had small variation with different nitrogen rates and application intervals. Number of plants/m^2 and fresh yield singly or in combination differed significantly with different nitrogen rates and application intervals. The application of 175 kg-N/ha and 30 days interval gave the highest fresh yield (35.27 t/ha) and benefit cost ratio (3.61).

Key words: Bilatidhonia, nitrogen rate, application interval, yield, profitability.

INTRODUCTION

Bilatidhonia (*Eryngium foetidum* L.) syn. Bangladhonia, long coriander, spiny coriander or culantro belongs to the family Apiaceae**.** It is a shade loving leafy crop containing some aromatic volatile oils that make it popular as a culinary herb or spice. Its world wide popularity and cultivation are increasing day by day due to the high nutritive value, attractive aroma and medicinal properties (Moniruzzaman, 2002). Among the factors that affect the growth, yield and quality of Bilatidhonia, fertilizer application is the most important. Amount and timing of fertilizer application affect the effectiveness of fertilizer used by the crop, crop growth and cost of labor. For successful crop production, all necessary nutrients must be supplied to the plants judiciously in a sufficient amount. Among different major plant nutrients, nitrogen is required in large amounts by plants because it is a constituent of macromolecules such as protein. The majority of plants rely on ammonium and nitrate nitrogen that originate from decomposition of organic material and are taken up from the soil. Thus the availability of N often limits plant growth. Nitrogen encourages cell elongation, above ground vegetative growth and imparts green color to plant leaves (Brady, 1990). Nitrogen makes the Bilatidhonia leaves succulent and soft which is a requisite of quality leaf. So, being a leafy crop, nitrogen fertilization is indispensable for yield maximization of Bilatidhonia. It requires nitrogen throughout the growing period. Nitrogen exhibits marked effect on vegetative growth, fiber and protein content of Bilatidhonia. Nitrogen is easily leached and early application of a large amount of N is wasted since the major growth requirement of Bilatidhonia is late in the growing period and

[*]Corresponding author: PhD Student, Department of Horticulture, BSMRAU, Salna, Gazipur-1706, E-mail: shailenbari95@yahoo.com

much of the early nitrogen would be lost as soil water moves out of the root zone. In the hilly areas, most of valleys containing silty loam soil having less organic matter, low water holding capacity results much loss of nitrogen due to leaching and other ways. One way of increasing the utilization of added nitrogen is through proper timing of nitrogen application to synchronize with the demand of Bilatidhonia. Therefore, the present experiment was undertaken to determine the suitable dose of nitrogen and its application interval on yield and profitability of Bilatidhonia in hilly areas.

MATERIALS AND METHODS

The experiment was conducted at the Agricultural Research Station, Raikhali, Rangamati situated in the south-eastern part of Bangladesh (Latitude $22^0$24'N and $91^0$57'E Longitude) in two consecutive cropping season during the year 2003-04 and 2004-05. The soil of experimental field was silty loam having soil pH 5.4, 1.76% organic matter and 0.92% total nitrogen. The experiment was laid out in split-plot design having three levels of application interval (D_1 = 15, D_2 = 30 and D_3 = 45 days after sowing) in main plots and four levels of nitrogen rate (N_1 = 150, N_2 = 175, N3 = 200 and N_4 = 225 kg N/ha) in sub plots with three replication. Seeds of Bilatidhonia were broadcasted on 15 December 2003 for first year experiment and in the same date of 2004 for the second year. The two adjacent plots measuring 3x1 m^2 constituted a unit plot. The crop was fertilized with nitrogen as per treatments (in the form of urea), 100 kg P_2O_5 (in the form of TSP), 150kg K_2O (in the form of MP) and 10 tons of well-decomposed cowdung per hectare. All the intercultural operations were done as and when required. Longer or larger plants were harvested from the plot at every 15 days intervals from April 15 to June 15 in both the years. Properly grown plants were harvested and counted as number of plants per square meter. Other poorly grown or very small sized or undersized seedlings were discarded and did not count. Emerging flower stalks were removed on a fortnightly basis. Data on plant height, number of leaves/plant, length of leaf, width of leaf, weight of single plant, weight of plant per plot and number of plants/m^2 were taken from whole plot. The recorded data were analyzed by MSTAT program and the treatment means were separated by DMRT for interpretation of the results. Economic calculation was done on the basis of local market price of inputs (fertilizers, seeds, labor etc.) and output (Tk. 20/kg fresh plant). The polynomial regression analysis was done and optimum dose of nutrient elements for maximum seed yield and economic rate of inputs were calculated from simple polynomial regression equations, *ie*. $Y = \alpha + \beta_1 x + \beta_2 x^2$ (Zaman *et al.* 1982). Here, X is the independent variable (input) and Y is the dependent variable (yield). The optimum dose of nutrient element for maximum yield is $X = -\beta_1/2\beta_2$ and economic dose were $X_e = X - (^{Px}/_{Py})/2\beta_2$. Here P_x is the price of input and P_y is the price of the products.

RESULTS AND DISCUSSION

Effect of nitrogen application interval

Number of leaves per plant and length of leaf differed significantly in 2004-2005 and in pooled data of two years but in 2003-04 most of the growth characters were not significantly differed due to N application interval (Table 1a). Number of harvested plant/m^2 and per hectare yield differed significantly in both the years due to different application interval of nitrogen (Table 1b). In 2003-04, significantly higher number of plants/m^2 (406) obtained from in 15 days interval whereas in 2004-05 it was higher (422.8) in 30 days intervals (Table 1b). The pooled data showed that nitrogen application at 15 days interval gave higher number of plants/m^2 (412) followed by 30 days interval (409.4) and it was significantly lower (381) in 45 days interval. In 2003-04, the maximum fresh yield (33.40 t/ha) was obtained from 15 days application interval that was statistically similar to 30 days interval (32.48 t/ha). In 2004-05 cropping season, fresh yield was maximum (30.87 t/ha) in 30 days interval which was statistically different with the yield of 15 and 45 days intervals. When pooled, significantly higher yield (31.68 t/ha) was obtained from 30 days interval, which was closely followed by 15 days interval (30.31 t/ha). In case of 15 days interval, the amount of nitrogen per installment was too low that all of the densely populated Bilatidhonia plants might not obtain sufficient amount of nitrogen for proper growth. On the other hand, being 45 days interval too longer the vegetative growth of Bilatidhonia was hampered due to the lack of sufficient nitrogen. As a result 30 days interval gave better yield than 15 and 45 days intervals of nitrogen application do. There may be another cause that deep tap rooted Bilatidhonia plants can uptake nitrogen from the leached part of N fertilizer up to 30 days from the application. Benefit cost ratio (BCR) showed the same trend like fresh yield. The maximum BCR (3.25) was obtained from 30 days interval of nitrogen application.

Table 1a. Effect of N rate and application interval on the growth parameters of Bilatidhonia

Treatment	Plant height (cm)			No of leaves /plant			Length of leaf (cm)			Width of leaf (cm)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
Application interval (D)												
15 days (D_1)	20.8	19.1	20.0	6.40	8.49b	7.45b	18.7	15.9b	17.30b	2.46	2.21	2.34
30 days (D_2)	20.6	19.0	19.8	6.70	8.75a	7.73a	19.1	16.9a	18.00a	2.41	2.20	2.31
45 days (D_3)	20.4	19.7	20.1	6.30	8.50b	7.40b	19.3	16.9a	18.10a	2.46	2.19	2.33
N rate (N)												
150 kg/ha (N_1)	20.8	18.5b	19.7	6.40	8.27b	7.34b	18.8	15.9b	17.4b	2.46	2.26	2.36
175 kg/ha (N_2)	20.0	19.6a	19.8	6.70	8.73a	7.72a	19.4	17.4a	18.4a	2.51	2.22	2.37
200 kg/ha (N_3)	20.4	19.6a	20.0	6.40	8.72a	7.56a	19.1	16.8a	18.0a	2.41	2.16	2.29
225 kg/ha (N_4)	20.4	19.4a	19.9	6.60	8.60a	7.60a	18.8	16.7ab	17.8ab	2.39	2.16	2.28
Sig. level	Ns	*	NS	NS	**	*	Ns	**	*	NS	NS	NS
CV (%)	4.10	4.18	4.14	6.79	4.66	5.73	5.49	3.01	4.25	7.07	5.12	6.10

Means having same letter(s) or without letter are not significantly different by DMRT. 'NS, * and '**' indicate non significant, significant at 5% and 1% probability level, respectively.

Table 1b. Effect of N rate and application interval on yield attributes and benefit cost ratio (BCR) of Bilatidhonia

Treatment	Wt. of single plant (g)			No. of plants/ m^2 (g)			Yield (t/ha)			Benefit cost ratio (BCR)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
Application interval (D)												
15 days (D_1)	13.92	8.60	11.26	406a	417.9	412.0a	33.40a	27.21b	30.31a	3.36a	2.74b	3.00ab
30 days (D_2)	13.51	8.80	11.16	396ab	422.8	409.4a	32.48ab	30.87a	31.68a	3.33a	3.16a	3.25a
45 days (D_3)	13.43	7.80	10.62	344b	418.0	381.0b	28.40b	27.80b	28.10b	2.92b	2.86b	2.89b
N rate (N)												
150 kg/ha (N_1)	12.36c	8.60	10.48b	345b	419.1	382.1b	27.82b	26.31c	27.07c	2.50b	2.69b	2.60b
175 kg/ha (N_2)	13.69a	8.20	10.95a	392ab	419.8	405.9a	32.04ab	29.61ab	30.83ab	3.05a	3.02ab	3.04ab
200 kg/ha (N_3)	13.88a	8.40	11.14a	420a	421.1	420.6a	34.44a	30.62a	32.53a	3.18a	3.12a	3.15a
225 kg/ha (N_4)	13.13b	8.20	10.67b	372ab	418.3	395.2ab	31.32ab	27.96b	29.64b	2.95ab	2.84b	2.90ab
Sig. level	**	NS	*	**	NS	*	**	**	**	**	**	**
CV (%)	3.23	10.72	6.98	8.54	4.74	6.64	9.28	4.69	7.10	8.88	6.29	7.59

Means having same letter(s) or without letter are not significantly different by DMRT. 'NS, * and '**'indicate non significant, significant at 5% and 1% probability level, respectively.

Effects of nitrogen

All the parameters except width of leaf and plant height were significantly affected by the application of different nitrogen rates (Table1a and 1b). In 2003-04, plant height, number of leaves/plant and leaf size showed little variation while weight of single plant, number of plants/m^2, fresh yield and BCR showed significant variation with different nitrogen doses. All parameters except the plant height and width of leaf showed significant variation with different nitrogen doses in 2004-05 cropping season. From the pooled results, it was observed that the number of leaves/plant (7.60) increased with the increased rate of N up to 225 kg/ha while the length (18.4 cm) and width of leaf (2.37 cm) increased up to 175 kg-N/ha then declined (Table 1a). The more number of leaves per plant in higher N doses might be the cause that N enhances new leaf formation by encouraging cell formation and elongation, above ground vegetative growth and imparts green color of plant leaves (Brady, 1990). Size of leaf decreased in higher N doses might be due to more number of leaf productions from single plant. The maximum single plant weight (11.14 g) and number of plants/m^2 (420.6) were obtained from 200kg N/ha that was statistically similar with 175 kg-N/ha (10.95 g and 405.9 plants/m^2, respectively). Fresh yield of Bilatidhonia and BCR increased with the increased application of nitrogen up to 200 kg-N/ha and declined thereafter. The maximum fresh yield (32.53 t/ha) and BCR (3.15) was obtained from 200 kg-N/ha and it was the lowest (27.07 t/ha and 2.60) when N applied @150 kg/ha. However, there was no significant difference among 175 kg, and 200 kg-N/ha in respect of single plant weight, number of plants/m^2, yield and BCR. The similar trend of response of Bilatidhonia with different nitrogen level was also observed by Islam *et al.* (2003). Casey *et al.* (2006) obtained maximum fresh yield of *Eryngium foetidum* at maximum level of nitrogen and suggested applying more than 90 kg-N/ha for production.

Combined effect

Among the parameters studied plant height, number of plants/m^2, fresh yield and BCR were significantly interacted by nitrogen rate and application interval. Maximum plant height (20.35 cm) was obtained from the treatment combination D_3N_2 and it was minimum (19.15 cm) in D_2N_1 (Table 2a). Number of leaves per plant, leaf size and single plant weight showed insignificant effect with the combination of N rate and application intervals. The highest number of harvested plants/m^2 (450.2) was obtained from the treatment combination D_1N_3 (15 days application interval with 200 kg-N/ha) and it was the lowest (354.0) in D_3N_1 (Table 2b). Minimum intervals with higher rate of N fertilizer help in uniform growth that might be the cause of maximum number of harvested plants/m^2 in D_1N_3. In 2003-04, the maximum yield (40.26 t/ha) and BCR (4.05) were obtained from the treatment combination D_1N_3 while in 2004-05 the maximum yield (34.14 t/ha) and BCR (3.50) were obtained from the treatment combination D_2N_2 (175 kg-N/ha with 30 days application interval). From the two years pooled data, the maximum fresh yield (35.27 t/ha) and BCR (3.61) were obtained from the treatment combination D_2N_2 which were at per D_1N_3 (33.93 t/ha and 3.42, respectively). These results were similar with the report of Islam *et al.,* (2003) who obtained the maximum yield of Bilatidhonia with 175 kg-N/ha. The minimum yield (25.20 t/ha) and BCR (2.60) were obtained from the treatment combination D_3N_1 (45 days intervals with 150 kg-N/ha). The maximum application duration with minimum nitrogen rate hampered the constant nitrogen supply that might be the cause of low yield and profitability in this treatment. However, the application of N @ 175 kg/ha with 30 days interval was found to be suitable in respect of management suitability and fresh yield in the hilly areas.

Table 2a. Interaction effect of N rate and application interval on growth parameters of Bilatidhonia

Treatment	Plant height (cm)			No of leaves /plant			Length of leaf (cm)			Width of leaf (cm)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
D_1N_1	21.4	18.1d	19.75ab	6.30	8.15	7.23	18.1	15.3	16.7	2.53	2.29	2.41
D_1N_2	21.1	19.6abc	20.35a	6.80	8.73	7.77	19.5	16.6	18.1	2.53	2.20	2.37
D_1N_3	20.5	19.4bc	19.95ab	6.00	8.65	7.33	18.6	16.6	17.6	2.49	2.21	2.35
D_1N_4	20.1	19.4bc	19.75ab	6.50	8.43	7.47	18.7	16.5	17.6	2.29	2.15	2.22
D_2N_1	20.4	17.9d	19.15b	6.70	8.45	7.58	18.6	16.2	17.4	2.33	2.27	2.30
D_2N_2	21.0	19.5abc	20.25a	6.90	8.90	7.90	19.5	17.5	18.5	2.60	2.23	2.42
D_2N_3	20.6	19.5abc	20.05a	6.70	8.94	7.82	19.9	17.1	18.5	2.29	2.11	2.20
D_2N_4	20.7	19.3c	20.00a	6.60	8.73	7.67	18.7	17.1	17.9	2.40	2.17	2.29
D_3N_1	20.7	19.5abc	20.10a	6.10	8.22	7.16	19.4	16.2	17.8	2.53	2.23	2.38
D_3N_3	20.8	19.9a	20.35a	6.30	8.57	7.44	19.2	18.1	18.7	2.40	2.22	2.31
D_3N_3	20.1	19.8ab	19.95a	6.40	8.60	7.50	18.9	16.8	17.9	2.43	2.16	2.30
D_3N_4	20.2	19.6abc	19.90ab	6.50	8.63	7.57	19.3	16.6	18.0	2.49	2.17	2.33
Sig. level	Ns	**	*	NS	NS	NS	Ns	NS	NS	NS	NS	NS
CV (%)	4.10	4.18	4.14	6.79	4.66	5.73	5.49	3.01	4.25	7.07	5.12	6.10

Means having same letter(s) or without letter are not significantly different by DMRT.
NS, * and '** indicate non significant, significant at 5% and 1% probability level, respectively.

Table 2b. Interaction effect of N rate and application interval on yield attributes and BCR of Bilatidhonia

Treatment	Wt. of single plant (g)			No. of plants/ m^2 (g)			Yield (t/ha)			BCR		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
D_1N_1	12.16	8.40	10.28	380bc	420.0	400.0ab	29.34cd	26.26de	27.80c	2.96c	2.65c	2.81bc
D_1N_2	13.29	8.40	10.85	384bc	418.7	401.4ab	30.14c	27.57cde	28.86b	3.04bc	2.78bc	2.91b
D_1N_3	13.44	9.00	11.22	**483a**	417.3	450.2a	**40.26a**	27.66cd	33.96ab	**4.05a**	2.78bc	3.42a
D_1N_4	12.80	8.60	10.70	377bc	415.7	396.4b	33.60bc	27.32cd	30.46b	3.38b	2.75bc	3.06ab
D_2N_1	12.15	9.60	10.88	364bc	419.3	391.7b	29.86c	26.53de	28.20bc	3.06bc	2.72c	2.89bc
D_2N_2	14.05	8.40	11.23	417b	430.0	423.5a	36.40ab	**34.14a**	35.27a	3.73ab	**3.50a**	**3.61a**
D_2N_3	14.09	8.00	11.05	395b	420.7	407.9ab	32.14bc	33.93a	33.04b	3.29b	3.47a	3.38a
D_2N_4	13.74	9.20	11.47	408b	421.0	414.5ab	31.54bc	28.80c	30.17b	3.22b	2.94b	3.08ab
D_3N_1	12.78	9.80	11.29	290d	418.0	354.0c	24.26b	26.13e	25.20d	2.50d	2.69c	2.60c
D_3N_3	13.97	7.60	10.79	373bc	410.7	391.9b	29.60cd	27.08de	28.34bc	3.05bc	2.79bc	2.92b
D_3N_3	14.13	8.40	11.27	381bc	425.3	403.2ab	30.94bc	30.26b	30.60b	3.18b	3.11ab	3.14a
D_3N_4	12.85	7.00	9.93	329cd	418.3	373.7b	28.80cd	27.72cd	28.26bc	2.95c	2.84b	2.90b
Sig. level	NS	NS	NS	**	NS	*	**	**	**	**	**	**
CV (%)	3.23	10.72	6.98	8.54	4.74	6.64	9.28	4.69	6.99	8.88	6.29	7.59

Means having same letter (s) or without letter are not significantly different by DMRT.
NS, * and '**' indicate non significant, significant at 5% and 1% probability level, respectively.

The polynomial regression analysis showed a moderate positive correlation (R = 0.8713) of fresh pod yield and applied nitrogen level with 30 days application intervals (Fig. 1). Figure-2 showed maximum positive correlation (R = 0.715) between BCR and application of N level with 30 days application interval than other two intervals. The calculated optimum level of N was 188 kg-N/ha for maximum fresh yield of Bilatidhonia at 30 days application interval and the economic dose was 187 kg-N/ha (Fig. 1).

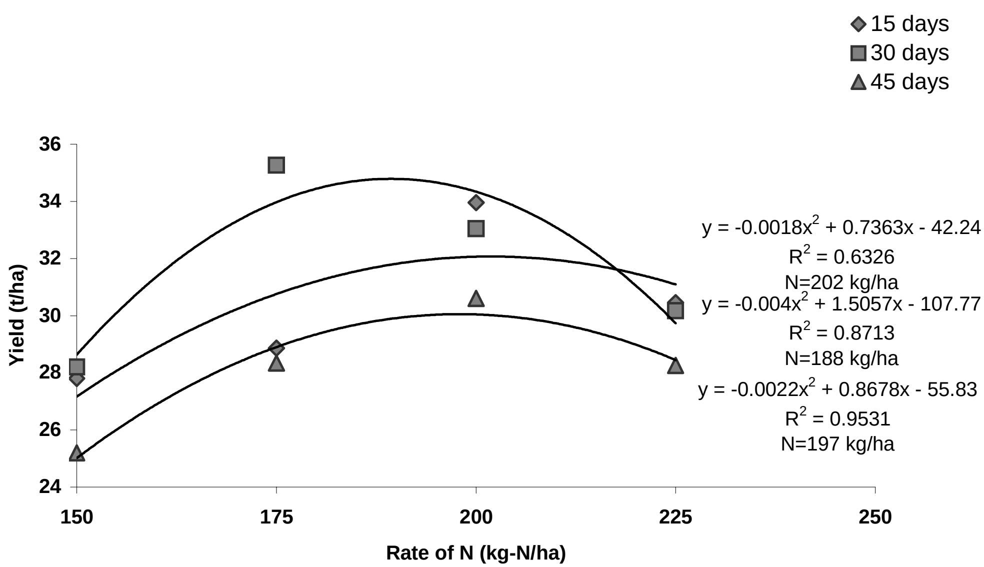

Fig.1 Effect of N rate with different application intervals on Yield of Bilatidhonia

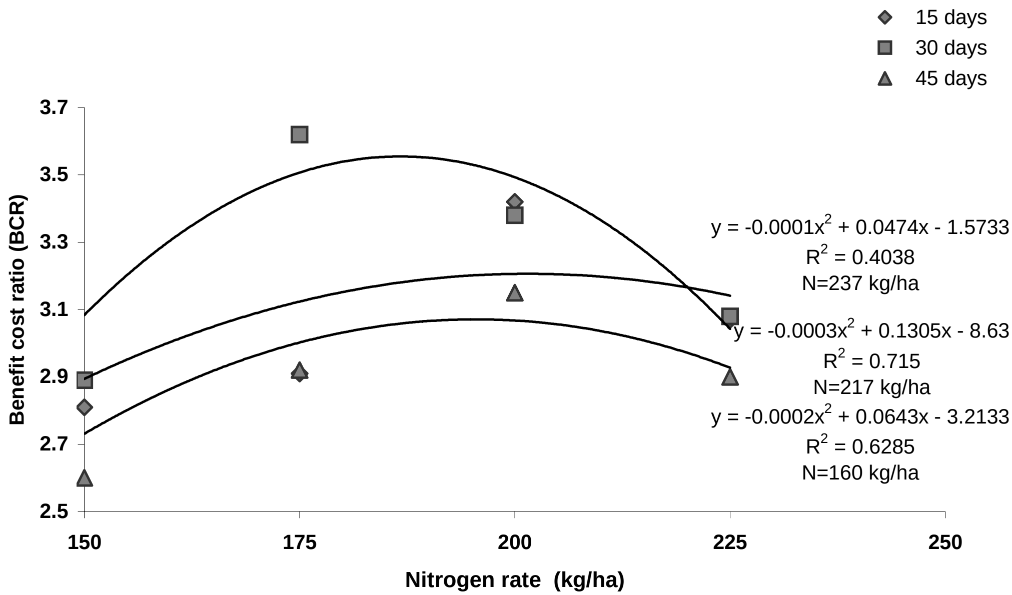

Fig.2 Influence of N rate and application interval on BCR

CONCLUSION

Considering two years results it was observed that the increasing number of installments with shorter application intervals reduced the amount of N per installment, on the other hand less number of installments with wider application intervals hampers continuous supply of nitrogen, both are hazardous for better yield. A moderate dose of nitrogen from 175 to 200 kg-N/ha with 30 days application intervals may be recommended for the production of Bilatidhonia in the hilly areas.

LITERATURE CITED

Brady, N. C. 1990. "The Nature and Properties of Soils" (Tenth Edn.). MacMillan Pub. Co., New York. 315 pp.

Casey C. A., Mangan, F. X., Herbert, S. J., Barker, A. V. and Carter A. K. 2006. The effect of light intensity and nitrogen fertilization on plant growth and leaf quality of NGO GAI (*Eryngium foetidum* L.) in massachusetts. *In* "International Horticultural Congress: The Future for Medicinal and Aromatic Plants". *ISHS Acta Hort.* XXVI, pp. 629.

Islam, M. R., Mozumder, S. N.**,** Moniruzzaman, M. and Alam, S. N. 2003. Effect of N, P and K on yield and Profitability of Bilatidhonia (*Eryngium foetidum* L.) cultivation in the hilly region. *Bang J Agric Res* **28**(1), 105-110.

Moniruzzaman, M., Rahman, S. M. M. and Mozumder, S. N. 2000**.** Effect of seed rate and shade on false coriander (*Eryngium foetidum* L.) production in the hilly area. *Bang Hort* **28**(1&2), 34-38.

Moniruzzaman, M. 2002. Effect of light intensity and nitrogen on the yield and quality of Bangladhonia (*Eryngium foetidum* L.). Unpublished [MS Thesis], Bangabandhu Sheikh Mijibur Rahman Agricultural University, Salna, Gazipur. 1706.

Zaman, S. M. H., Rahim, K. and Hawlader, M. 1987. "Simple Lessons from Biometry". Bangladesh Rice Research Institute, Gazipur. pp 29-34.