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

Effect of plant spacing and potassium on growth and yield of cabbage

K. Shamima, M.A. Haque[1], F. Ahmed[2], Farzana Sultana[3], Md. Yousuf Ali[4]
Mushroom Development Institute, Savar, Dhaka; [1]Deapart of Agricultural Extension Education, [2]Deapartment of Agroforestry, [4]Department of Seed Science and Technology, Bangladesh Agricultural University, Mymensingh; [4]Department of Horticulture and Postharvest Technology, Sher-e-Bangla Agricultural University, Dhaka.
E-mail: enam4656@gmail.com

Abstract: The experiment was conducted in Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, during October 2017 to February 2018 to find out the effect of plant spacing and potassium on growth and yield of cabbage. The experiment consisted of Factor A: three plant spacing; S_1: 60 cm x 30 cm, S_2: 60 cm x 40 cm and S_3: 60 cm x 60 cm and Factor B: four levels of potassium fertilizer; K: 0 kg; K_1; 90 kg; K_2: 120 kg and K_3: 150 kg K_20/ha respectively. The experiment was conducted in Randomized Complete Block Design (RCBD) with three replications. Different treatments showed significant variations on growth, yield components and yield of cabbage. Highest plant height at 60 DAT (37.70cm), maximum diameter of head (19.05 cm) and fresh weight of head (187kg) were found from S_3 and lowest was observed from S_1. On the other hand, the tallest plant height at 60 DAT (39.51 cm), maximum diameter of head (18.81 cm) and fresh weight of head (1.62 kg) were found from K_3 and lowest was observed from K_0 treatment. For combined effect the highest plant height at 60 DAT (40.23 cm), maximum diameter of head (21.02 cm), highest fresh weight of head (2.21 kg) were found from S_3K_3 and lowest was observed from S_1K_0 treatment. The highest gross yield (81.89 tha^{-1}), marketable yield (61.30 tha^{-1}) and benefit cost ratio (1.98) was noted from S_2K_3 and lowest from S_1K_0. So, 60 cm x 40cm spacing with 150 kg K_20/ha was best for growth and yield of cabbage.
Key words: Effect, plant, spacing, potassium, growth, yield, cabbage.

Introduction

Cabbage is a popular vegetable throughout the world because of its adaptability to a wide range of climatic conditions and soil, ease of production and storage, and its high nutritive value and high consumers demand. Cabbage (*Brassica oleracea* var. capitate L.), is a nutritious and high-value leafy vegetable in Bangladesh (Islam *et al*., 2017) and it is widely grown in both tropical and temperate regions. The major cabbage-growing countries of the world are South Korea, Germany, Japan, India, South Africa and China. Cabbage is grown country-wide in Bangladesh mainly limited in rabi season but production is more concentrated in Bogra, Jessore, Kustia. Meherpur and Tangail are the cabbage growing areas in Bangladesh. The average yield of cabbage in Bangladesh is far lower (13.25 tha^{-1}) than other countries (32.31 tha^{-1}) (BBS, 2013 and FAO, 2012). The total yield of cabbage could be raised by practicing improved production technology which includes judicious application of fertilizers, proper cultural management and optimum spacing. Plant spacing is one of the factors that affects growth and yield of cabbage. It is well established that plant spacing has significant influence on growth and yield of cabbage. Plant spacing and fertilizer applications have significant influence on the growth and yield in crop production (Muhibbullah *et al*., 2005; Chen, J.H, 2006). Optimum plant spacing ensures the proper use of land, as well as growth and nutrition in plants (Islam *et al*., 2017). The judicial application of potassium fertilizers is an important consideration to improve the yield and quality of the cabbage production (Bahadur *et al*., 2004). The objective of the work is to evaluate the growth and yield performance of cabbage in various plant spacing and using potassium fertilizers.

Materials and Methods

The experiment was conducted at the Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, during 4 October 20017 to 15 February 2018 on cabbage cv. Atlas-70. Seeds (hybrid F1) obtained locally (Sakata Seed Corporation, Japan). Soil samples of experimental plot collected from various places depth of 15 cm and sent to Sher-e-Bangla Agricultural University, Dhaka and Humboldt Soil Testing Laboratory for analysis. Two factors experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The double factor experiment consisted of three plant spacing's, 60 cm×30 cm (S1), 60 cm×40 cm (S2) and 60 cm×60 cm (S3). Four levels of Potassium fertilizer treatments applied, Control (K_o), 90 kg K_20/ha (k_1), 120 kgK_2O/ha (K_2) and I50 kg K_20/ha (K_3). Therefore, the treatment combinations are S_1K_0, S_1K_1, S_1K_2, S_1K_3, $S_2K.0$, S_2K_1, S_2K_2 S_2K_3. S_3K_0, S_3K_1, S_3K_2 and S_3K_3 respectively. The experiment area was first divided into 3 blocks. Each block was divided into 12 plots for the treatment combinations. Therefore, total numbers of plots were 36 and 12 treatment combinations were assigned to each block as per design of the experiment. The size of the unit plot was 3.2 m x 1.2 m. A distance of 50cm was maintained between the plot and 1 m between the block. Thus, the total land area was 20.9 m x 13.6 m. Fertilizer and manures applied in the experiment such as urea 348 kg/ha, TSP 180 kg/ha, MOP as per treatment, Zypsum 166 kg /ha, Boron 7 kg/ha and Cowdung 6 ton/ha respectively. Full dose of cowdung, TSP, Zypsum and Boron were applied during final land preparation. The total amount of Urea and MOP were applied in two installments. The first half was 15 and second half at 35 days after seedling were transplanted and light irrigation was applied followed by fertilizer application (Miah *et al*., 2012). Healthy transplants (three weeks old) were selected from the seedbed and transplanted in the experimental plots. Planting was done in the afternoon to avoid transplanting shock. Seedlings were watered after transplanting. Banana leaves were used around seedlings as mulch. Weeding and irrigation were done manually. Five plants were selected randomly for data collection in each plot and labeled. Data collected on plant height, plant diameter, stem length, head thickness, and head diameter. Marketable weight (compact head) per plant was measured and total marketable yield

recorded. Data were statistically analyzed with MSTAT-C software. The means for all the characters were performed by F test. The mean differences among the treatments were evaluated with LSD test at 1% and 5% level of significance (Gomez and Gomez, 1984).

Results and Discussion

The soil analysis before the planting and after the harvesting of cabbage indicated the soil organic matter content was 2.55% and 2.60%, respectively. During planting, the soil pH was 5.6 and the electrical conductivity (EC) was 72.54 (µc/cm). The soil pH and EC increased after harvesting the crop (Islam *et al*., 2017). The average yield of cabbage was significantly influenced by the chemicals fertilizer treatments and plant spacing (Table 1). The plant height was recorded at 30, 45 and 60 days after transplanting (DAT). The plant height was significantly different ($p \leq 0.01$) between the fertilizer and spacing treatments. The spread of the cabbage plant data was recorded at 30, 45 and 60 DAT. The tallest plant at 30 DAT (17.22 cm), 45 DAT (32.17 cm) and 60 DAT (37.70 cm) were found in the widest spacing treatment (53), whereas, the shortest plant height at 30 DAT (16.08 cm), 45 DAT (29.84 cm) and 60 DAT (35.68 cm) were found in the closest spacing treatment (S_1). The results showed that the plant height at different DAT was increased with the increase in spacing. This might be due to receiving sufficient amount of light and nutrients. The trend of the present results was agreed to that of Singh *et al*., (2007). The tallest plant at 30 DAT (17.14 cm), 45 DAT (33.29 cm) and 60 DAT (39.51 cm) were found from K_3 treatment and the shortest plants height at 30 DAT (15.84 cm), 45 DAT (27.84 cm) and 60 DAT (32.47 cm) were found in control treatment (Ko). The plant height increased with the increasing application of potassium fertilizer. Potassium fertilizer ensured favorable condition for the growth of cabbage with optimum cell division and elongation of cell and the ultimate results was the tallest plant (Table 1).

Table 1. Effect of spacing and potassium levels on plant height, stem length and number of leaves per plant of cabbage at different days after transplanting

Treatment (s)	Plant height (cm)			Stem length (cm)			Number of leaves per plant		
	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT
Spacing									
S_1	16.08 c	29.84 c	35.68 c	4.65 b	5.45 b	5.73 b	14.85	18.22 b	14.46 c
S_2	16.58 b	31.25 b	36.75 b	5.06 a	5.93 a	6.33 a	14.81	18.53 ab	16.51 b
S_3	17.22 a	32.17 a	37.70 a	5.22 a	6.13 a	6.55 a	15.33	19.52 a	17.96 a
LSD $_{(0.05)}$	0.443	0.697	0.776	0.340	0,391	0.428	--	1.005	0.338
Level of significance	**	**	**	**	**	**	NS	*	**
Potassium fertilizer									
K_o	15.84 c	27.84 c	32.47 c	4.68 b	5.52 c	5.83 b	14.51	17.87 b	14.14 d
K_1	16.48 b	30.51 b	35.96 b	5.09 a	5.98 ab	6.35 a	15.02	18.77 ab	16.30 e
K_2	17.04 a	32.70 a	38.89 a	5.24 a	6.15 a	6.54 a	15.51	19.61 a	16,99 b
K_3	17.14a	33.29a	39.51 a	4.89ab	5.70ab	6.09ab	14.94	18.78ab	17.80a
LSD $_{(0.05)}$	0.512	0.805	0.892	0.392	0.451	0.495	--	1.160	0.390
Level of significance	**	**	**	*	*	*	NS	*	**
CV (%)	8.17	6.63	10.50	8.07	7.91	I8.15	5.75	6.33	7.41

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability; NS: Not significant

Table 2. Combined effect of spacing and potassium levels on plant height, stem length and number of leaves per plant of cabbage at different days after transplanting

Treatment (s)	Plant height (cm) at			Stem length (cm) at			Number of leaves per plant at		
	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT
S_1K_0	14.97 c	26.97g	31.92 h	4.52 c	5.34 d	5.65 b	14.60	17.56 b	11.67g
S_1K_1	16.23b	29.40de	34.54fg	4.70 be	5.56 bcd	5.83b	14.70	18.15b	15.21 f
S_1K_2	1678 b	31.40 be	3758 de	4.72 be	5,48 ed	5.79 b	15.27	18.85 ab	15.17fs
S_1K_3	16.35 b	31.60 be	38.68 bcd	4.68 be	5.41 d	5.75 b	14.83	18.31 b	15.79 ef
S_2K_0	16.40 b	28.80 ef	33.02 gh	5.02 abc	5.93 abcd	6.30 ab	14.37	17.73 b	15.07 f
S_2K_1	16.77 b	31.50 bc	37.35 de	5.43 ab	6.33 abc	6.82 a	14.93	18.77 ab	16.43 de
S_2K_2	16.60 b	34.33 a	40.23 ab	5.57 a	6.59 a	6.99 a	15.33	19.27 ab	17.05 cd
S_2K_3	17.10 ab	33.93 a	39.64 abc	4.85 abc	5.67 bcd	6.09 ab	14.60	18.35 b	17.50 c
S_3K_0	16.17b	27.77 fg	32.47 h	4.50 c	5.29 d	5.54 b	14.57	18.31 b	15.70 f
S_3K_1	16.43b	30.63 cd	35.99 ef	5.15 abc	6.06 abcd	6.40 ab	15.43	19.40 ab	17.27 c
S_3K_2	17.73 a	32.27 b	38.30 cd	5.45 ab	6.38 ab	6.84 a	15.93	20.71 a	18.75 b
S_3K_3	17.97 a	34.43 a	40.79 a	5.13 abc	6.01 abcd	6.44 ab	15.40	19.69 ab	20.10 a
LSD $_{(0.05)}$	0.886	1.394	1.552	0.679	0.782	0.857	---	2.010	0.675
Level of significance	**	*	*	*	*	*	NS	*	*
CV (%)	8.17	6.63	10.50	8.07	7.91	8.15	5.75	6.33	7.41

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability; NS: Not significant

Similar findings also reported by Islam *et al*., (2017). The variation was recorded due to combined effect of plant spacing and different levels of potassium in terms of plant height at different DAT. The tallest plant at 30 DAT

(17.97 cm), 45 DAT (34.43 cm) and 60 DAT (40.79 cm) was recorded from S_3K_3 treatment combination. On the other hand, the shortest plant height at 30 DAT (14.97 cm). 45 DAT (26.97 cm) and 60 DAT (31.92 cm) were recorded from S_1K_0 treatment combination. The longest stem length at 30 DAT (5.22 cm). 45 DAT (6.13 cm) and 60 DAT (6.55 cm) were found in widest spacing treatment (S_3), the shortest stem length at 30 DAT (4.65 cm), 45 DAT (5.45 cm) and 60 DAT (5.73 cm) was found in the closest spacing treatment (S_1). Wider spacing produced the longest stem length at different DAT. The longest stems at 30 DAT (5.24 cm), 45 DAT (6.15 cm) and 60 DAT (6.54 cm) were found from K_2 treatment nevertheless, the shortest stem at 30 DAT (4.68 cm), 45 DAT (5.52 cm) and 60 DAT (5.83 cm) were recorded from control treatment (K_0). The stem length increased with the increasing of days after transplanting i.e. 30. 45 and 60 DAT and revealed that stem length increased with the K_2 treatment. This could be due to the positive effect of potassium because it enhanced vegetative growth of cabbage. Potassium also helped proper growth and ultimate results were the longest stem length of cabbage. This finding was reported by Chaubey *et al*., (2001). Combined effect of' plant spacing and levels of potassium in terms of stems length showed variation at different DAT (Table 2). The longest stem length at 30 DAT (5.57 cm), 45 DAT (6.59 cm) and 60 DAT (6.99 cm) were found from S_2K_2 treatment combination and the shortest stems length at 30 DAT (4.50 cm), 45 DAT (5.29 cm) and 60 DAT (5.54 cm) were found from S_3K_0 treatment combination.

Table 3. Combined effect of spacing and potassium levels on leaf length, leaf breadth and spreading of plant of cabbage at different days after transplanting

Treatment (s)	Leaf length (cm) at			Leaf breadth (cm) at			Spreading of plant (cm) at		
	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT
S_1K_0	17.07ab	26.52bc	31.50abc	10.22e	15.35d	19.70e	21.00e	30.45f	45.43e
S_1K_1	18.27ab	28.30 ab	32.89 ab	10.60cde	15.93bcd	21.55 cd	26.53 b	35.90 e	51.67 d
S_1K_2	19.33a	28.98a	33.84a	11.08abcde	17.I0abc	21.33cd	26.77b	37.79e	53.43d
S_1K_3	18.73ab	28.87 a	33.25 ab	10.39 de	15.61 cd	21.53 cd	26.83 b	37.12 e	54.43 d
S_2K_0	17.47ab	25.78 cd	29.97 be	10.65 bcde	116.34abcd	21.10 de	25.97 b	36.26 e	52.77 d
S_2K_1	18.90ab	27.90 ab	32.43 ab	10.82abcde	16.59 abcd	21.79 cd	26.80 b	44.01 e	64.30 b
S_2K_2	18.87ab	27.85abc	32.37 ab	11.90 ab	37.99 a	22.99 be	2767 ab	44.41 e	66.13 b
S_2K_3	19.10a	28.53ab	32.77ab	1l,52abcd	I7.34ab	22.96bc	28.53ab	45.87c	66.40b
S_3K_0	16.53 b	24.41 d	28.37 c	10.72abcde	16.44 abcd	21.19 de	26.38 b	40.40 d	59.50 c
S_3K_1	18.70ab	26.60bc	30.59abc	11.75abc	18.01 a	24.26ab	27.97ab	51.82b	76.50a
S_3K_2	19.13 a	27.57abc	32.50 ab	11.94 a	18.02 a	25.32 a	28.83 ab	53.87ab	77.53 a
S_3K_3	18.47ab	27.59abc	30.97abc	11.65 abcd	17.98 a	22.64 cd	31.37 a	54.47 a	79.97 a
LSD $_{(0.05)}$	2.141	1.857	3.000	1.105	1.482	1.486	3.792	2.381	3.732
Level of significance	*	*	*	**	**	*	*	**	**
CV (%)	6.88	8.02	5.57	9.88	5,18	7.22	8.27	6.67	8.34

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability; NS: Not significant

Table 4. Combined effect of spacing and potassium levels on yield contributing characters of cabbage

Treatment(s)	No. of loose leaf per plant	No. of compact leaf per plant	Wt. of loose leaf (gm/plant)	TDM of loose leaf (gm/plant)	Diameter of head (cm)	Thickness of head (cm)	Fresh wt. of head (kg/plant	TDM of head (g/plant)
S_1K_0	14.47 c	29.01g	532.00 f	5.13 g	14.62 c	9.56 c	0.64 g	4.51 f
S_1K_1	16.67 cd	32.30 f	680.00 def	6.56 ef	16.80 d	10.72bcde	0.82 f	5.95 e
S_1K_2	16.77 cd	33.83 ef	656.67 def	6.67 ef	16.97 d	10.00 de	0.87 f	6.00 c
S_1K_3	16.93 bcd	33.53 ef	690.00cdef	6.65 cf	17.16 cd	10.95 bcd	0.92 f	6.62 c
S_2K_0	16.99 bcd	37.53 cd	646.67 ef	5.90 fg	16.66 d	10.56 cdc	1.26 c	7.83 d
S_2K_1	18.33 abc	39.91 abc	710.00 cdc	7.18 dc	17.71 bcd	1 l.00bcd	1.42 d	9.22 c
S_2K_2	18.56 ab	39.06 bc	950.00 ab	8.83 ab	18.20 bcd	11.72 bc	1.69 c	10.98 b
S_2K_3	18.56 ab	40.40 abc	810.00 bcd	7.81 cd	18.24 bcd	11.33 bc	1.72 e	11.48 b
S_3K_0	16.33 d	35.56 dc	703.33 cdc	6.45 ef	17.26 cd	10.72bcdc	1.20 e	8.14 d
S_3K_1	17.79bc	38.73bc	893.33ab	8.61 bc	18.81 bc	I1.89 b	2.07ab	11.66 b
S_3K_2	18.89a	41.I2ab	843.33 bc	9.13ab	19.12b	11.67 bc	2.01 b	13.03 a
S_3K_3	19.46 a	42,36 a	1033.33 a	9.63 a	21.02 a	13.06 a	2.21 a	13.98 a
LSD $_{(0.05)}$	1.505	2.834	143.6	0.941	1.546	1.119	0.240	1.01
Level of Significance	**	**	**	*	**	**	**	**
CV (%)	5.07	9.11	11.09	7.48	5.14	5.94	5.99	6.83

The variation was recorded due to combined effect of plant spacing and levels of potassium in terms of leaf breadth at different DAT (Table 3). The highest leaf breadth at 30 DAT (11.94 cm), 45 DAT (18.02 cm) and 60 DAT (25.32 cm) were recorded from S_3K_2 treatment combination, the lowest leaf breadth at 30 DAT (10.22 cm), 45 DAT (15.35 cm) and 60 DAT (19.70cm) were observed from S_lK_0 treatment combination.

Statistically significant variation was recorded due to the combined effect of plant spacing and levels of potassium in terms of total dry matter of head per plant in cabbage (Table 4). The highest total dry matter of head per plant (13.98 g) was recorded from S_3K_3 treatment combination and the lowest (4.51 g) was found from $S_1K_{.o}$ treatment Combination. Yield of cabbage also significantly affected by combined effects of spacing and potassium levels

(Table 5). Highest gross and marketable yield of cabbage was found in treatment S_2K_3 and the values were 81.89 and 61.30 t/ha, respectively which was statistically similar with the values of gross and marketable yield of cabbage produced in the treatment S_2K_2 (Table 5). Lowest values of gross and marketable yield of cabbage was produced in the treatment S_1K_0 (Table 5).

Table 5. Combined effects of spacing and potassium levels on yield contributing characters and yield of cabbage

Treatment(s)	Diameter of stem (cm)	Length of stem (cm)	Fresh wt. of stem (g)	Length of root (cm)	Fresh wt. of root (g)	Gross yield (t/ha)	Marketable Yield (t/ha)
S_1K_0	2.93 d	8.22 de	35.31 c	14.46	20.79 d	45.22 h	35.47 h
S_1K_1	3.61 abc	9.33 ab	46.44 b	16.56	25.89 c	56.32 fg	42.44 fg
S_1K_2	3.72 abc	9.22 abc	46.11 b	16.45	25.11 c	60.41 ef	45.52 ef
S_1K_3	3.33 cd	9.56a	46.44 b	16.55	25.89 c	63.48 de	47.84 dc
S_2K_0	3.39 bcd	7.80 c	37.11 c	15.22	23.67 cd	55.40 fg	43.42 efg
S_2K_1	3.66 abc	8.17 de	48.22 ab	15.40	30.22 ab	67.34 cd	50.74 cd
S_2K_2	3.94 a	8.33 cde	50.11 ab	15.45	32.44 a	80.18 a	60.43 a
S_2K_3	3.89 ab	8.78 abcd	50.22 ab	16.58	33.33 a	81.89 a	61.30a
S_3K_0	3.33 cd	8.01 dc	38.55 c	15.34	26.33 bc	53.08 g	40.00g
S_3K_1	3.83 abc	8.50 bcde	50.56 ab	16.05	31.11 a	72.56 bc	53.71 bc
S_3K_2	3.83 abc	8.30 dc	50.11 ab	16.13	32.33 a	72.76 bc	53.99 bc
S_3K_3	3.95a	8.44 bcdc	52.33 a	16.33	34.55 a	76.28 ab	57,48 ab
LSD $_{(0.05)}$	0.461	0.817	5.058	-------	4.055	7.021	7.973
Level of significance	**	*	**	NS	**	*	**
CV (%)	7.47	5.62	6.48	7.60	8.38	5.07	5.49

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level, **Significant at 0.01 Level, *Significant at 0.05 level; NS: Not significant.

The study showed that the four levels of Potassium (K0, K_1, K_2 and K_3); K_3 is suitable for the improved growth and yield of cabbage with plant spacing (S_2, 60 cm×40 cm). So, the 150 kg K_2o/ha fertilizers in a 60 cm×40 cm spacing (S_2K_3) have the potential to enhance the best growth and yield of cabbage.

References

Bahadur, A.; Singh, J.; Singh, K.P, 2004: Response of cabbage to organic manure and biofertilizers. Indian Journal of Horticulture 61 278–279.

Bangladesh Bureau of Statistics (BBS), 2013: Statistical Year Book of Bangladesh; Statistical Division, Ministry of Planning: Dhaka, Bangladesh p. 39.

Chen,J.H, 2006 : The combined use of chemical and organic fertilizers and/or biofertilizer for crop growth and soil fertility. In Proceedings of the International Workshop on Sustained Management of the Soil-Rhizosphere System for Efficient Crop Production and Fertilizer Use, Bangkok, Thailand.

Food and Agriculture Organization (FAO), 2012: Production Year Book; Food and Agriculture Organization of the United Nations: Rome, Italy.

Gomez, K.A.; Gomez, A.A, 1984: Statistical Procedure for Agricultural Research, 2nd ed.; John Willy and Sons: New York, USA pp. 28–192.

Islam M.A, Ferdous G, Akter A, Hossain M.M , Nandwani D, 2017: Effect of Organic, Inorganic Fertilizers and Plant Spacing on the Growth and Yield of Cabbage, *Agriculture* 7 31.

Islam, M.A.; Islam, S.; Akter, A.; Rahman, M.H.; Nandwani, D, 2017: Effect of organic and inorganic fertilizers on soil properties and the growth, yield and quality of tomato in Mymensingh, Bangladesh. *Agriculture* 7 18.

Miah, M.U.Md.; Jahiruddin, M.; Islam, M.F.; Razia, S, 2012: *Fertilizer Recommendation Guide*; Bangladesh Agricultural Research Council: Dhaka, Bangladesh p. 113.

Muhibbullah, M.; Momotaz, S.; Chowdhury, A.T, 2005: Use of agrochemical fertilizers and their impact on soil, water and human health in the Khamargao Village of Mymensingh District, *Bangladesh Journal of Agron*omy 4 109–115.

Singh. J. P; Munib, K and Rakshanda. M. 2007: Effect of nitrogen levels and spacing on the growth and yield of cabbage. Environment and Ecology 25 1 153-155.