

# Effects of different levels of NK fertilizers and plant spacing on growth and yield of broccoli (*Brassica oleracea* L.)

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**Abstract:** Responses of broccoli (*Brassica oleracea* L.) cv. Premium to different levels of NK fertilizers and plant spacing were evaluated at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh during the period from October, 2010 to March, 2011. The two-factor experiment was laid out in randomized complete block design with 3 replications. The treatments were 4 levels of NK fertilizers, viz., F<sub>0</sub>: 0 kg N+ 0 kg K/ha, F<sub>1</sub>: 140 kg N + 160 kg K/ha, F<sub>2</sub>: 180 kg N + 210 kg K/ha, F<sub>3</sub>: 220 kg N + 260 kg K/ha and 4 levels of plant spacings viz., S<sub>1</sub>: 60x50 cm, S<sub>2</sub>: 60x40 cm, S<sub>3</sub>: 50x50 cm and S<sub>4</sub>: 50x40 cm. Data revealed that NK fertilizers, plant spacing and their interaction showed significant effect on the growth and yield of broccoli. The highest yield of broccoli curd (13.19 t/ha) was found from the highest dose of NK fertilizers (220 kg N + 260 kg K/ha) and in respect of spacing, the highest yield (12.88 t/ha) was obtained from the closest spacing (50 cm x 40 cm). Among the treatment combinations, F<sub>3</sub>S<sub>4</sub> (the highest dose of NK fertilizers and the closest spacing) gave the highest yield of broccoli (15.60 t/ha) that may be recommended at the farmers level for profitable production of broccoli.

**Key words:** Broccoli, NK fertilizers, plant spacing, growth and yield.

## Introduction

Broccoli (*Brassica oleracea* L.) is more nutritious than other cole crops like cabbage, cauliflower and kohlrabi (Nieuwhof, 1969). In Bangladesh broccoli is not so popular winter crop and its growth and yield are also not good like other countries. Application of balance fertilizer is the prerequisite for obtaining higher yield and better quality of broccoli (Brahma *et al.*, 2002). But in our country lack of judicious application of fertilizers and sub-optimal management practices followed by the growers are the main reasons for such poor growth and yield. Among the fertilizers, nitrogen and potassium appear to be more important. Plant density is an important viable for achieving maximum yields and uniform vegetable maturity. Differentiation of density of plants per unit of area gives possibility of regulation of the size of edible part of broccoli (Schellenberg *et al.*, 2009). Higher plant population reduced head size, lower average marketable head weight and delay maturity (Khan *et al.*, 1991). Its cultivation in Bangladesh has not yet been extended due to the lack of awareness regarding its nutritive value and appropriate method of planting time, spacing and fertilization. Therefore, the present study has been undertaken to find out a suitable combination of NK fertilizers and optimal plant spacing for higher growth and yield of broccoli.

## Materials and Methods

The field experiment was conducted at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh during the period from October, 2010 to March, 2011 to study the responses of different levels of NK fertilizers and plant spacing on growth and yield of broccoli cv. Premium. The two-factor experiment was laid out in the randomized complete block design with 3 replications. The treatments were 4 levels of NK fertilizers, viz., F<sub>0</sub>: 0 kg N+ 0 kg K/ha, F<sub>1</sub>: 140 kg N + 160 kg K/ha, F<sub>2</sub>: 180 kg N + 210 kg K/ha, F<sub>3</sub>: 220 kg N + 260 kg K/ha and 4 levels of plant spacings viz., S<sub>1</sub>: 60 x 50 cm, S<sub>2</sub>: 60 x 40 cm, S<sub>3</sub>: 50 cm x 50 cm and S<sub>4</sub>: 50 cm x 40 cm. Well decomposed cowdung and Triple super phosphate was incorporated into the soil during final land preparation at the rate of 20 t/ha and 150 kg/ha, respectively. Urea and Muraite of potash

were applied in three equal splits in ring method at 15, 30 and 45 days after transplanting. Twenty nine days old seedlings were transplanted in 48 experimental plots consisting 3 m x 2 m size of each. Ten plants from each plot were randomly selected and identified with tag for collection of data. All intercultural operations were done when necessary. After compilation and tabulation of data, the significance of difference between pairs of means was evaluated by the least significance difference (LSD) test at 1% and 5% level of probability (Gomez and Gomez, 1984).

## Results and Discussion

**Plant height:** An increasing trend in height of plant was observed due to increase of NK fertilizer levels. The height of plant increased gradually during the early stages of growth, rapidly between 30 to 45 DAT and later the plants grew rather slowly. The maximum height of plant (52.48 cm) was recorded at 60 DAT from the highest dose of NK fertilizer (220 kg N + 260 kg K/ha). Haque *et al.* (1996) also recorded the highest plant height by applying the highest dose of nitrogen. The plant height was also significantly influenced by plant spacing. The tallest plant (49.25 cm) was recorded from the widest spacing (60 cm x 50 cm). The variation in plant height as influenced by spacing was probably due to the proper utilization of nutrient, more space, moisture and light. Similar results were reported by Islam *et al.* (1990). The interaction effect was found statistically insignificant on all dates of observation and at 60 DAT. The highest plant height of broccoli (54.63 cm) was recorded in the treatment combination of highest dose of NK fertilizer (220 kg N + 260 kg K/ha) (Table 1).

**No. of leaves per plant:** The leaf production ability of plant was significantly increased by the application of NK fertilizer at different DAT. The maximum number of leaves per plant (17.60) were produced by the plants receiving highest dose of NK (220 kg N + 260 kg K/ha) fertilizer. The maximum number of leaves per plant (16.53) was obtained from the plant spacing of 60 cm x 50 cm and the lowest was (15.67) was found from the spacing 50 cm x 40 cm at 60 DAT (Table 1) which means the number of leaves was higher in plants with wider spacing

and was lower in closely spaced plants. These results are in agreement with the findings of Islam *et al.* (1990). The combination of NK fertilizers and plant spacing in the number of leaves per plant at different DAT were found statistically significant at 30, 45 and 60 DAT except 15

DAT (Table 1). The maximum number of leaves per plant (18.2) was obtained from the treatment combination of (220 kg N + 260 kg K/ha) with 60 cm x 50 cm plant spacing. Interaction effect was not significant in this respect.

**Table 1.** Combined effect of different levels of NK fertilizers and plant spacing on different days after transplanting of broccoli

Treatment combinations	Plant height (cm)				No. of leaves per plant				Crown spread			
	15	30	45	60	15	30	45	60	15	30	45	60
F <sub>0</sub> S <sub>1</sub>	10.89	19.39	30.22	42.35	4.49	7.02	12.37	14.94	11.56	23.83	33.67	46.22
F <sub>0</sub> S <sub>2</sub>	10.21	18.16	29.23	39.00	4.39	6.50	11.06	14.50	11.67	20.78	30.50	44.93
F <sub>0</sub> S <sub>3</sub>	10.39	18.72	30.39	40.76	4.22	6.50	11.83	14.78	12.06	21.89	30.61	45.89
F <sub>0</sub> S <sub>4</sub>	9.72	17.01	28.30	38.17	4.22	6.00	11.00	14.05	12.28	18.78	29.78	38.94
F <sub>1</sub> S <sub>1</sub>	12.00	19.89	35.47	48.83	4.50	8.10	12.29	15.98	12.68	25.66	37.94	50.26
F <sub>1</sub> S <sub>2</sub>	12.00	19.83	34.52	45.94	4.17	7.55	12.50	15.50	13.17	23.54	35.83	46.87
F <sub>1</sub> S <sub>3</sub>	11.94	19.51	34.83	48.10	4.33	8.00	12.33	15.78	11.70	24.06	35.76	48.72
F <sub>1</sub> S <sub>4</sub>	10.50	16.46	33.30	42.22	4.00	7.33	11.18	15.13	11.81	23.41	35.75	35.76
F <sub>2</sub> S <sub>1</sub>	11.02	20.83	39.31	51.20	4.60	8.93	13.90	17.00	12.50	26.38	40.34	54.72
F <sub>2</sub> S <sub>2</sub>	10.17	17.33	36.85	50.10	4.38	8.28	13.02	16.22	12.28	25.55	37.89	51.45
F <sub>2</sub> S <sub>3</sub>	10.95	20.57	39.31	50.50	4.77	8.71	13.72	16.64	13.50	25.78	40.17	53.95
F <sub>2</sub> S <sub>4</sub>	9.72	19.77	36.92	46.22	4.43	8.10	12.83	16.17	13.17	23.28	36.56	51.00
F <sub>3</sub> S <sub>1</sub>	11.40	23.67	43.13	54.63	4.67	8.93	15.54	18.20	13.13	29.50	43.49	61.34
F <sub>3</sub> S <sub>2</sub>	10.45	21.95	42.03	52.43	4.30	9.49	14.11	17.50	13.33	26.36	40.56	55.89
F <sub>3</sub> S <sub>3</sub>	10.78	22.66	42.11	50.83	4.40	8.67	14.95	17.33	14.22	27.17	41.61	59.69
F <sub>3</sub> S <sub>4</sub>	10.00	21.50	41.76	52.00	4.17	9.18	13.17	17.33	13.17	25.71	38.39	54.22
Level of sign.	**	**	**	**	NS	**	**	**	NS	**	**	**
LSD (0.01)	1.51	2.94	2.77	3.85	-	1.02	1.32	0.70	-	2.26	1.80	2.48

\*\* Significant at 1% level of probability, NS= Not significant, F<sub>0</sub>: 0 kg N+ 0 kg K/ha, F<sub>1</sub>: 140 kg N + 160 kg K/ha, F<sub>2</sub>: 180 kg N + 210 kg K/ha, F<sub>3</sub>: 220 kg N + 260 kg K/ha, S<sub>1</sub>: 60x50 cm, S<sub>2</sub>: 60x40 cm, S<sub>3</sub>: 50x50 cm and S<sub>4</sub>: 50x40 cm

**Crown spread of plant:** The crown spread of plant was significantly influenced by both the different levels of NK fertilizers and plant spacing. At 60 DAT, the maximum (57.79 cm) crown spread of plant was found from the treatment F<sub>3</sub> (220 kg N + 260 kg K/ha). The widest spacing (60 cm x 50 cm) produced the maximum crown spread (53.14 cm) whereas the closest spacing (50 cm x 40 cm) gave the minimum crown spread (44.98 cm) at 60

DAT. The combination of NK fertilizers and plant spacing had significant influence on crown spread of plant on all dates of observation except 15 DAT (Table 1). The widest crown spread of plant (961.34 cm) was found in the treatment combination of F<sub>3</sub>S<sub>1</sub> (220 kg N + 260 kg K/ha and 60 cm x 50 cm). The interaction effect between NK fertilizers and plant spacing on crown spread was statistically insignificant.

**Table 2.** Effect of different levels of NK fertilizers and plant spacing on growth and yield of broccoli

Treatments/ Plant spacing	Wt. of primary curd (g)	Wt. of secondary curds per plant (g)	Fresh wt. of leaves per plant (g)	% dry wt. of curd (g)	% dry wt. of leaves (g)	Fresh wt. of roots per plant (g)	Yield/ plant (g)	Yield/ plot (kg)
F <sub>0</sub>	189.15	26.20	30.68	7.19	10.65	51.92	214.72	5.30
F <sub>1</sub>	222.67	32.07	62.66	7.59	10.73	59.68	255.24	6.29
F <sub>2</sub>	230.86	49.84	70.96	8.11	12.00	70.72	280.71	6.94
F <sub>3</sub>	267.92	52.10	88.27	8.45	13.30	79.27	320.02	7.91
Level of sign.	**	**	**	**	**	**	**	**
LSD (0.01)	11.42	1.78	1.65	0.52	0.69	0.97	11.26	2.72
S <sub>1</sub>	230.54	39.51	66.57	8.01	12.08	68.35	270.05	5.40
S <sub>2</sub>	238.84	41.85	62.18	7.77	11.33	64.63	280.11	7.01
S <sub>3</sub>	223.01	40.06	64.19	7.93	11.84	66.35	263.09	6.31
S <sub>4</sub>	218.19	38.79	59.63	7.61	11.43	62.28	257.48	7.72
Level of sign.	**	**	**	NS	*	**	**	**
LSD (0.05)	8.48	1.32	1.22	-	0.518	0.72	8.36	2.02
(0.01)	11.42	1.78	1.65	-	-	0.97	11.26	2.72

\* Significant at 5% level of probability, \*\* Significant at 1% level of probability, NS= Not significant, F<sub>0</sub>: 0 kg N+ 0 kg K/ha, F<sub>1</sub>: 140 kg N + 160 kg K/ha, F<sub>2</sub>: 180 kg N + 210 kg K/ha, F<sub>3</sub>: 220 kg N + 260 kg K/ha, S<sub>1</sub>: 60x50 cm, S<sub>2</sub>: 60x40 cm, S<sub>3</sub>: 50x50 cm and S<sub>4</sub>: 50x40 cm, unit per plot = 3 m x 2 m.

**Weight of primary curd:** The maximum primary curd weight (267.92 g) was recorded with F<sub>3</sub> (220 kg N + 260 kg K/ha) treatment and the lowest central curd weight (186.15 g) was obtained in the control (Table 2). The present results were supported by the report of Mitra *et al.*

(1990). A significant variation was found in case of plant spacing and curd weight. Though highest spacing (60 cm x 50 cm) produced maximum curd diameter but weight was highest in case of S<sub>2</sub> (60 cm x 40 cm) spacing probably due to loose terminal head and longer flower stalks of

broccoli curds. Dufault (1985) also found the similar result in case of curd of broccoli. The combination effect of NK fertilizers and plant spacing in respect of weight of individual curd found to be significant. Maximum curd weight (275.11 g/plant) was obtained from the combination of F<sub>3</sub>S<sub>2</sub> (220 kg N + 260 kg K/ha and 60 cm x 40 cm). Interaction effect was insignificant in this respect.

**Weight of secondary curds per plant:** Weight of secondary curds per plant showed significant influence by both the application of different levels of NK fertilizers and plant spacing. The highest weight of secondary curds per plant (52.10 g) was found from the plants received highest levels NK fertilizers at the rate of F<sub>3</sub> (220 kg N + 260 kg K/ha). The maximum weight of secondary curds per plant (41.85 g) was obtained from the S<sub>2</sub> plant spacing (38.79 g) (Table 2). The highest weight of secondary curds per plant (53.23 g) was found from the treatment

combination F<sub>3</sub>S<sub>2</sub> (220 kg N + 260 kg K/ha and 60 cm x 40 cm). The interaction effect between NK fertilizers and plant spacing on weight of secondary curds per plant was found insignificant.

**Fresh weight of leaves per plant:** The application of different levels of NK fertilizers and also plant spacing showed highly significant influence on the fresh weight of leaf. The maximum response in the parameter was observed with the highest level of NK fertilizers F<sub>3</sub> (220 kg N + 260 kg K/ha) treatment having 88.27 g and from the widest spacing S<sub>1</sub> (60 cm x 50 cm) having 66.57 g (Table 2). The combined effect of NK fertilizers and plant spacing on fresh weight of leaf per plant (91.28 g) was found from the treatment combination of F<sub>3</sub> (220 kg N + 260 kg K/ha) with the widest spacing S<sub>1</sub> (60 cm x 50 cm) (Table 3). Interaction was insignificant in this respect.

**Table 3.** Combined effect of different levels of NK fertilizers and plant spacing on growth and yield of broccoli

Treatment combinations	Wt. of primary curd (g)	Wt. of secondary curds per plant (g)	Fresh wt. of leaves per plant (g)	Percent dry wt. of curd	Percent dry wt. of leaves	Fresh wt. of roots per plant (g)	Yield/ plant (g)	Yield/ plot (kg)
F <sub>0</sub> S <sub>1</sub>	190.00	25.43	33.06	7.51	11.23	55.21	215.43	4.31
F <sub>0</sub> S <sub>2</sub>	196.81	29.53	31.61	6.98	10.27	51.80	224.01	5.60
F <sub>0</sub> S <sub>3</sub>	188.71	25.50	29.56	7.31	10.43	52.33	214.21	5.14
F <sub>0</sub> S <sub>4</sub>	181.06	24.33	28.49	6.87	10.67	48.33	205.39	6.16
F <sub>1</sub> S <sub>1</sub>	117.67	31.17	65.90	7.67	10.70	63.88	258.84	5.18
F <sub>1</sub> S <sub>2</sub>	236.89	34.08	57.52	7.56	10.43	57.12	270.97	6.77
F <sub>1</sub> S <sub>3</sub>	214.67	32.33	64.28	7.60	11.10	61.70	247.00	5.93
F <sub>1</sub> S <sub>4</sub>	211.44	30.70	62.92	7.52	10.67	56.04	244.14	7.29
F <sub>2</sub> S <sub>1</sub>	235.89	49.86	76.05	8.24	12.57	73.17	285.79	5.71
F <sub>2</sub> S <sub>2</sub>	246.56	50.55	70.90	8.20	11.63	70.51	297.11	7.46
F <sub>2</sub> S <sub>3</sub>	221.27	50.07	73.87	8.23	12.37	71.23	271.34	6.51
F <sub>2</sub> S <sub>4</sub>	219.70	48.89	63.01	7.78	11.43	68.01	268.59	8.06
F <sub>3</sub> S <sub>1</sub>	268.61	51.55	91.28	8.63	13.83	81.13	320.14	6.40
F <sub>3</sub> S <sub>2</sub>	275.11	53.23	88.67	8.35	12.97	79.08	328.34	8.21
F <sub>3</sub> S <sub>3</sub>	267.41	52.40	89.05	8.60	13.47	80.13	319.81	7.68
F <sub>3</sub> S <sub>4</sub>	260.56	51.23	84.07	8.30	12.93	76.73	311.79	9.36
Level of sign.	**	**	**	**	**	**	**	**
LSD(0.01)	16.15	2.51	2.33	0.73	0.98	1.37	15.93	0.37

\*\* Significant at 1% level of probability, F<sub>0</sub>: 0 kg N+0 kg K/ha, F<sub>1</sub>: 140 kg N + 160 kg K/ha, F<sub>2</sub>: 180 kg N + 210 kg K/ha, F<sub>3</sub>: 220 kg N + 260 kg K/ha, S<sub>1</sub>: 60x50 cm, S<sub>2</sub>: 60x40 cm, S<sub>3</sub>: 50x50 cm and S<sub>4</sub>: 50x40 cm

**Percent dry weight of curd:** The production of dry matter of broccoli curd varied significantly due to the application of different levels of NK fertilizers treatment but plant spacing was not significant for the same. The maximum dry weight (8.5%) was recorded from the treatment F<sub>3</sub> (220 kg N + 260 kg K/ha) and the maximum dry weight (8.01%) was obtained from the treatment S<sub>2</sub> (60 cm x 40 cm). The combined of NK fertilizers and plant spacing on dry matter of broccoli was found statistically significant and the maximum dry weight of curd (8.6%) was found in the treatment combination of F<sub>3</sub>S<sub>3</sub> (220 kg N + 260 kg K/ha with 50 cm x 50 cm) (Table 3). Interaction was insignificant in this respect.

**Percent dry weight of leaves:** The present study revealed that there was a significant effect of NK fertilizers on total dry weight of leaves per plant but in respect of plant spacing it was not significant. The highest amount of dry weight of leaves per plant (13.3%) was found from the treatment F<sub>3</sub> (220 kg N + 260 kg K/ha) and the maximum dry weight (12.1%) was found from the treatment S<sub>1</sub> (60

cm x 50 cm). The combined effect of NK fertilizers and plant spacing was found statistically significant for dry weight of leaves per plant and the maximum dry weight of broccoli leaves (13.8%) was found from the treatment combination of F<sub>3</sub>S<sub>1</sub> (220 kg N + 260 kg K/ha with 60 cm x 50 cm) (Table 3). Interaction was insignificant in this respect.

**Fresh weight of roots per plant:** Fresh weight of roots per plant was significantly affected both by the application of different levels of NK fertilizers and plant spacing. The maximum response in the parameter was observed with the highest level of F<sub>3</sub> (220 kg N + 260 kg K/ha) treatment and the highest weight of roots per plant (68.35 g) was obtained from the treatment S<sub>1</sub> (60 cm x 50 cm). The fresh weight of roots per plant was increased linearly when the spacing was increased which had also been reported by Stofella and Fleming (1988). Both the combination and interaction effects of different levels of NK fertilizers and plant spacing in respect of fresh weight of roots per plant showed statistically significant. The maximum fresh

weight of roots per plant (81.13 g) was found from the treatment combination of F<sub>3</sub>S<sub>1</sub> (220 kg N + 260 kg K/ha with 60 cm x 50 cm).

**Yield per plant:** The effect of different levels of NK fertilizers, plant spacing and their combination was found significant on the per plant yield of broccoli. The maximum yield per plant (320.02 g) was recorded from F<sub>3</sub> (220 kg N + 260 kg K/ha) treatment and 280.11 g was produced by the plants grown at S<sub>2</sub> (60 cm x 40 cm). The highest yield per plant (328.34 g) was recorded from the treatment combination of F<sub>3</sub>S<sub>2</sub> (220 kg N + 260 kg K/ha with 60 cm x 40 cm). Interaction effect was significant in this respect.

**Yield per plot:** The yield of broccoli per plot as well as per hectare was significantly influenced by the application of different levels of NK application, plant spacing, their combination and interaction. The maximum yield per plot and per hectare (7.9 kg and 13.19 t) were recorded with the application highest levels of NK fertilizers F<sub>3</sub> (220 kg N + 260 kg K/ha) treatment and per plot 7.72 kg and per hectare 12.88 t was produced by the plants grown at closest spacing of S<sub>4</sub> (50 cm x 40 cm). The higher yield with closer spacing was also reported by Mitra *et al.* (1990). The maximum yield per plot (9.36 kg) and per hectare (15.60 t) were recorded from the treatment combination of F<sub>3</sub> (220 kg N + 260 kg K/ha) with closest spacing S<sub>4</sub> (50 cm x 40 cm). Pornsuriya *et al.* (1997) found highest main head yield in 60 cm x 40 cm than 60 cm x 60 cm spacing.

Considering all the conditions from the present experiment, it can be concluded that application of F<sub>3</sub> (220 kg N + 260 kg K/ha) with closest spacing of S<sub>4</sub> (50 cm x

40 cm) may be recommended at farmers' level for profitable production of broccoli.

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