EFFECT OF BORON AND NITROGEN ON YIELD AND HOLLOWSTEM OF BROCCOLI

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ABSTRACT

Moniruzzaman, M., Rahman, S. M. L., Kibria, M. G., Rahman, M. A. and Hossain, M. M. 2007. *Effect of Boron and Nitrogen on Yield and Hollowstem of Broccoli.* **J .Soil .Nature .1(3): 24-29**

A field experiment comprising six levels of boron (B) (0. 0.5, 1, 1.5, 2 and 2.5 kg/ha) and two levels of nitrogen (N) (100 and 200 kg/ha) was conducted at the Agricultural Research Station, Raikhali, Rangamati Hill District during the winter (rabi) seasons of 2004-05 and 2005-06 to find out the suitable doses of B and N for higher yield and good quality head of broccoli. There were twelve treatments replicated three times. Boron application increased plant height, number of leaves per plant, length and width of the leaf, plant spread, main head weight and head yield both per plant and per hectare significantly up to 1.5 kg/ha. Nitrogen application at higher dose (200 kg/ha) also significantly gave higher values for all growth and yield attributes as well as yield. Interaction effect of these nutrients was also found significant on all growth parameters except width of leaf, yield attributes and yield. Maximum yield per hectare was obtained at 2 kg B plus 200 kg N per hectare which was at par with 1.5 kg B plus 200 kg N per hectare and 1.5 kg B plus 100 kg N per hectare. The latter combination (1.5 kg B/ha + 100 kg N/ha) gave the lowest hollow stem in broccoli during both years. Response curve indicates 1.59 kg B/ha as optimum dose for this crop.

Key word: Hollowstem, yield, quality of broccoli

INTRODUCTION

Broccoli, (*Brassica oleracea* var. *italica* L.) belonging to the family of Cruciferae is a delicious vegetable and more nutritious than any other vegetables of the same genus (Rashid, 1999). There is a good scope of its cultivation in Bangladesh for increasing vegetable diversification and to meet vegetable demand of the country's people. Boron is essential for plant growth and development. Its application to the soil increased head yield of broccoli (Yang Xian *et al*., 2000). Broccoli has a great demand to nitrogenous fertilizer. The early and rapid vegetative growth of the plant is necessary for soft and succulent head and stem for a quality crop that is influenced by the nitrogenous fertilizer. Investigations carried out by different workers have showed that the head yield of broccoli is greatly influenced by N application (Haque *et al.*, 1996; Anwar *et al*., 2000; Singh *et al*., 2000).

Hollow stem is a quality defect in broccoli, which shows this disorder in the stem extending from below the head or curd when the stem is normally cut. It is an abiotic disorder, which becomes an important quality factor, particularly for fresh market broccoli because the hollow stem area is visible at the base of the stem when displayed at the produce center (Hipp, 1974; Hudson *et al*., 1988). The disorder has been to be most severe when individual plants grow rapidly such as: wide spacing, high N fertilizer levels, warm weather, adequate moisture and, B deficiency (Vigier and Cutcliffe, 1985). There is potential for infection and spoilage after harvest in the walls of the cavities of hollow stem. This disorder is corrected by judicious application of B and nitrogenous fertilizer (Hipp, 1974; Trembalay, 1989). The requirement of fertilizer, which varies according to environmental conditions, has to be determined by actual field trial for any particular soil and climate. Therefore, the present study was undertaken to work out the optimum dose of B and N for yield maximization of broccoli in brown hill soils of Rangamati.

MATERIALS AND METHODS

The experiment was conducted at the Agricultural Research Station, Raikhali in the district of Rangamati during the rabi seasons of 2004-05 and 2005-06. The experimental field belongs to AEZ 29 with the Piedmont plain soil having medium loamy to moderately fine texture (sandy clay loam). The initial soil analyses' results were given in Table 1.The experiment was laid out in a randomized complete block design with three replications having six boron levels (B_0 = 0, $B_{0.5}$= 0.5, B_1 =1.0, $B_{1.5}$ = 1.5, B_2 = 2.0 and $B_{2.5}$ = 2.5 kg/ha), and two nitrogen levels (N_{100} = 100 and N_{200} = 200 kg/ha)) There were 12 treatment combinations all together. The unit plot size was 4 m × 2.4 m and the plant spacing was 60 m x 50 m. Manures and fertilizers were applied to the soil @ 10 tones well rotten cowdung, 70 kg P_2O_5, 105 kg K_2O, 20 kg S per hectare and N and B as treatment wise. The sources of nitrogen, P_2O_5, K_2O, S and B were urea, triple supper phosphate (TSP), muriate of potash (MP), gypsum and borax, respectively. The total amount of cowdung, TSP and gypsum and one-third amount of urea and MP were applied 5 days prior to planting seedlings.

Table 1. Some physical and chemical properties of the soil of experimental plots prior to fertilizer application

Year	Texture	pH	OM %	meq $100g^{-1}$			$\mu g\ g^{-1}$						
				Ca	Mg	K	NH4 -N	P	S	B	Cu	Mn	Zn
2004-05	Sandy clay loam	5.6	0.47	2.1	1.4	0.19	17	30	18	0.1	7	40	7
2005-06	Sandy clay loam	5.5	0.51	2.4	1.5	0.19	16	31	17	0.2	9	42	6
Critical level	-	-	-	2.0	0.8	0.2	75	14	14	0.2	1	33	2

Full amount of borax was applied in pit and the remaining quantity of urea and MP was top dressed into two equal installments 30 and 45 days after transplanting. Thirty days old seedlings were transplanted on 10 November and 7 November in 2004 and 2005, respectively. Broccoli harvest was started on 11 January 2005 and 9 January 2006 and completed on 15 February 2005 and 14 February 2006. All the recommended cultural and plant protection measures were followed throughout the experimental period.

The data on plant height, plant spread, number of leaves per plant, leaf size (length and width of the biggest leaf), diameter of head, primary head weight/plant, secondary shoot weight /plant, head yield/plant and hollow stem area were recorded from randomly selected 10 plants from the inner rows of each plot. The plot (9.6 m^2) yield was calculated and then it was converted to per hectare yield. Data were analyzed statistically and the treatment means were separated by LSD at 5% level of significance for interpretation of results.

RESULTS AND DISCUSSION

Effect of B

The effect of B on different growth parameters was found to be significant during both years (Table 2). There was an increasing trend in the plant height, number of leaves/plant, length and width of the biggest leaf and plant spread with every ascending level of N up to 1.5 kg B/ha and their highest values were recorded at 1.5 kg B/ha during both years of study. The values obtained at 1.5 kg B/ha for length and width of the biggest leaf and plant spread were statistically similar to 2.0 kg B/ha in both years. Beyond 1.5 kg B/ha plant height as well as number of leaves decreased significantly. On the other hand the increase in B level beyond 2.0 kg/ha caused to decrease for length and width of the biggest leaf and plant spread significantly. Noor *et al*. (2000) obtained significantly maximum plant height, number of leaves/plant in cauliflower when boron was applied at 1.5 kg B/ha.

Yield attributes and head yield of broccoli are presented in Table 3. Maximum head diameter, main head weight, head yield both per plant and per hectare were obtained from the application of 2.0 kg B/ha closely followed by the application of 1.5 kg B/ha in both years. Secondary shoot weight/plant was recorded maximum at 1.5 kg B/ha in 2004-05 while in 2005-06 at 2.0 kg B/ha. But there was no significant difference between 1.5 and 2.0 kg B/ha in respect of secondary shoot weight/plant during both years. All yield attributes viz. head diameter, main head weight, secondary shoot weight/plant increased with the increase in B level up to 2.0 kg/ha beyond which their values declined. Head yield both per plant and per hectare showed the same trend. The highest head yield per plant (462.38 g in 2004-05 and 487.8 g in 2005-06) and per hectare (15.44 t and 16.26 t in 2004-05 and 2005-06, respectively) was obtained at 2.0 kg B/ha that was closely followed by the application of 1.5 kg B/ha. The increase in head yields from the application of 1.5 kg B/ha over control was 23.55% and 28.45% higher in the first and 2nd year, respectively. The result is in agreement of Noor *et al*. (2000) who got 45.07% in curd yield of cauliflower by the application of 1.5 kg B/ha over no B application.

Hollowness of stem decreased with the increase of B up to 1.5 kg B/ha and then slightly increased (Figure 1). Significantly the highest area of hollowness was obtained when B was not applied and the lowest from the application of 1.5 kg B/ha. But no significant difference was observed among the application of 1, 1.5, 2 and 2.5 kg B/ha. The result is in consonance of Vigier and Cutcliffe (1985).

Regression analysis of head yield as an average of two years was done to fit in the quadratic response function for estimating the optimum dose of boron (Figure 3). The optimum dose came out to be 1.59 kg B/ha.

Effect of nitrogen

Application of 200 kg N/ha gave significantly maximum values for all the growth parameters viz. plant height; number of leaves/plant, length and width of the biggest leaf and plant spread over 100 kg N/ha during both years (Table 2). Haque *et al*. (1996) also found significantly higher plant height, number of leaves per plant and size of the biggest leaf at 180 kg N/ha than 120 kg N/ha in both years. All the yield attributes and yield of broccoli presented in Table 2 were also significantly higher at 200 kg N/ha than 100 kg N/ha. The increase in head yield per hectare obtained at 200 kg N/ha was 4.48% and 5.72% in 2004-05 and 2005-06, respectively over 100 kg N/ha. Haque *et al*. (1996) also found the highest curd yield at 180 kg N/ha than at 120 kg N/ha. Research findings from the works of Gorski and Armstrong (1985), Dufault (1988), Trembalay (1989) and Anwar *et al*. (2000) revealed that within certain limits the head yield of broccoli is proportional to the quantities of nitrogenous fertilizer applied. Evaraarts *et al*. (1999) suggested to apply 270 kg N/ha for higher yield of broccoli head. Karitonas (1999) got the highest yield at 240 kg N/ha.

Significantly maximum area of hollowness was recorded from the application of 200 kg N/ha compared to 100 kg N/ha (Figure 2). This is in perfect agreement with Trembalay et *al*. (1989) and Vigier and Cutcliffe (1985) who reported that hollowstem increased with the increase of nitrogen.

The above results described for boron and nitrogen indicated that the treatment in which was best for vegetative growth also proved to be the same for yield. It indicates that increased vegetative growth was reflected in increased yield of broccoli head.

Table 2. Effect of boron and nitrogen on growth characters of broccoli (cv. Green Sprouting)

Treatment	Plant height (cm)		Leaves/plant (no.)		Length of the biggest leaf (cm)		Width of the biggest leaf (cm)		Plant Spread (cm)	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Boron (kg/ha)										
B_0	73.14	75.33	15.60	15.55	47.67	48.00	24.25	24.10	59.36	60.78
$B_{0.5}$	73.84	76.05	16.02	15.97	48.71	49.20	25.06	24.80	62.33	62.95
B_1	74.04	76.22	16.25	16.20	48.96	49.56	25.14	25.44	65.88	67.39
$B_{1.5}$	75.82	78.05	16.91	16.87	49.92	50.92	25.58	25.50	71.18	72.60
B_2	74.94	76.84	16.52	16.48	49.89	50.40	25.23	25.34	71.02	72.43
$B_{2.5}$	73.24d	75.09	16.19	16.00	48.36	48.85	24.74	24.84	65.29	66.54
LSD (0.05)	0.65	0.59	0.28	0.27	0.72	0.85	0.64	0.51	2.09	1.53
Nitrogen (kg/ha)										
N_{100}	73.91	77.60	16.04	16.20	48.63	50.81	24.86	24.80	63.60	66.78
N_{200}	74.43	78.15	16.31	16.39	49.14	51.34	25.13	25.35	68.15	71.56
LSD (0.05)	0.38	0.35	0.16	0.17	0.42	0.42	0.37	0.44	1.20	1.31
CV (%)	7.74	6.74	3.75	5.25	5.64	6.27	9.85	5.10	9.77	4.15

B_0 = 0 kg B/ha, $B_{0.5}$ = 0.5 kg B/ha, B_1 = 1.0 kg B/ha, $B_{1.5}$ = 1.5 kg/ha, B_2 = 2.0 kg B/ha and $B_{2.5}$ = 2.5 kg B/ha
N_{100} = 100 kg N/ha and N_{200} = 200 kg N/ha

Table3. Effect of boron and nitrogen on yield attributes and head yield of broccoli (cv. Green Sprouting)

Treatment	Head diameter (cm)		Main head weight (g)		Secondary shoot weight/plant (g)		Head yield/plant (g)		Head yield (t/ha)	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Boron (kg/ha)										
B_0	15.83	15.88	273.32	277.42	99.82	101.34	373.14	378.76	12.44	12.62
$B_{0.5}$	16.24	16.36	292.67	297.35	129.82	131.80	408.73	429.15	13.62	14.30
B_1	16.97	17.05	305.51	312.54	122.70	132.15	428.34	444.69	14.27	14.82
$B_{1.5}$	17.18	17.20	327.97	350.97	133.33	135.36	461.32	486.33	15.37	16.21
B_2	17.25	17.24	329.35	352.45	133.04	135.41	462.38	487.86	15.41	16.26
$B_{2.5}$	16.60	16.59	301.16	322.45	112.49	114.50	413.65	436.75	13.79	14.56
LSD (0.05)	0.35	0.32	6.75	7.01	10.25	9.89	8.6	9.01	0.28	0.31
Nitrogen (kg/ha))										
N_{100}	16.38	16.71	299.53	305.52	115.84	119.32	415.41	424.84	13.84	14.16
N_{200}	16.85	17.13	310.46	317.60	127.89	131.73	433.77	449.33	14.46	14.97
LSD (0.05)	0.19	0.21	3.89	4.01	5.91	6.49	4.96	5.31	0.16	0.18
CV (%)	7.74	6.74	3.75	5.25	5.64	6.27	9.85	5.10	9.77	4.15

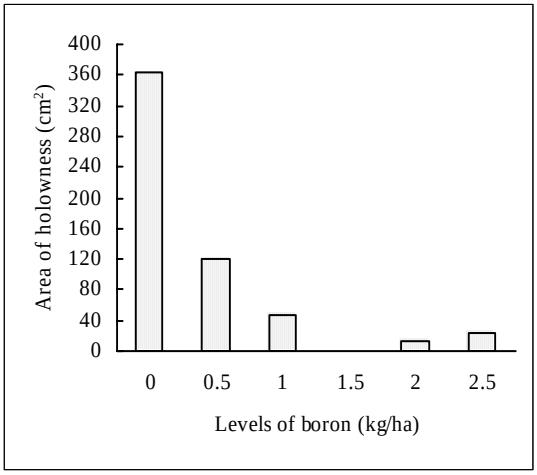


Figure 1. Effect of boron on hollowstem of broccoli (pooled)

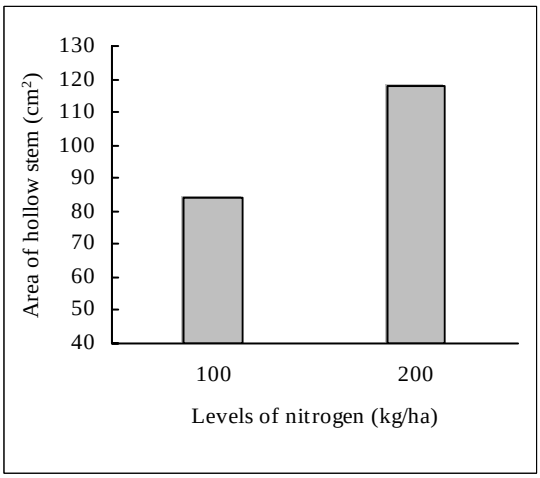
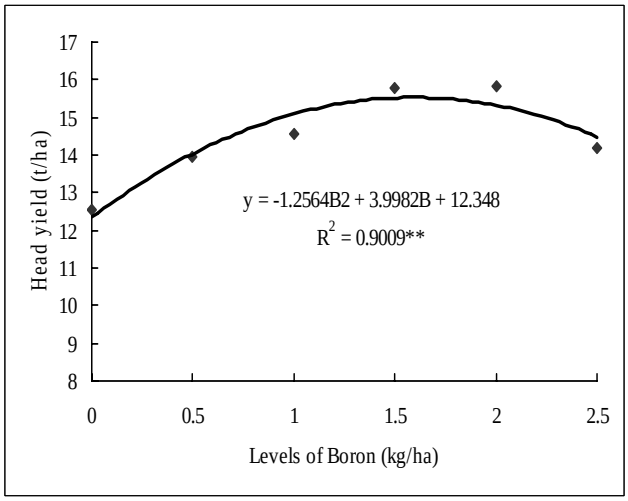


Figure 2. Effect of nitrogen on hollowstem of broccoli (pooled)



Optimum dose: 1.59 kg/ha

Figure 3. Yield response of broccoli to boron fertilization (pooled)

Combined effect of boron and nitrogen

The maximum plant height (76.10 cm in 2004-05 and 78.12 cm in 2005-06) was recorded at 1.5 kg B/ha + 200 kg N/ha ($B_{1.5}N_{200}$) closely followed by 1.5 kg B/ha + 100 kg N/ha ($B_{1.5}N_{100}$) (Table 4). The combination of 2.0 kg B and 200 kg N/ha (B_2N_{200}) produced the number of leaves per plant (16.73 and 16.70 in the first and second year, respectively), maximum plant spread (79.00 cm in 2004-05 and 80.28 cm in 2005-06) and length of the biggest leaf (50.30 cm in 2004-05 and 51.08 cm in 2005-06) that were statistically at par with $B_{1.5}N_{200}$ and $B_{1.5}N_{100}$ treatment combinations. Yield attributes (head diameter, main head weight and secondary shoot weight) and yield/plant were also found maximum from B_2N_{200} which was statistically identical to $B_{1.5}N_{200}$ and $B_{1.5}N_{100}$ (Table 5). The highest head yields of 15.67 and 16.81 tons per hectare were obtained in the year 2004-05 and 2005-06, respectively with B_2N_{200}. This treatment was closely followed by $B_{1.5}N_{200}$ and $B_{1.5}N_{100}$. However, only 12.11 and 12.59 t/ha head yields were recorded from B_0N_{100}. The highest dose of 2.0 B + 200 kg N per hectare reduced the head yields significantly.

The lowest hollow stem area (0.00 and 1.2 cm^2 in 2004-05 and 2005-06, respectively) was found from $B_{1.5}N_{100}$ and the highest (418.8 cm^2 in 2004-05 and 350.6 cm^2 in 2005-06) from B_0N_{100}.

The interaction between boron and nitrogen and its application revealed that the best treatment is the combination of 1.5 kg B and 100 kg N per hectare for maximum quality head production of broccoli in AEZ-29.

Table 3. Combined effect of Boron and Nitrogen on growth characters of broccoli (cv. Green Sprouting)

Treatment combination		Plant height (cm)		Leaves/plant (no.)		Length of the biggest leaf (cm)		Width of the biggest leaf (cm)		Plant Spread (cm)	
N (kg/ha)	B (kg/ha)	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
N_{100}	B_0	72.65	74.57	15.45	15.30	46.88	47.61	23.84	24.13	58.92	61.13
	$B_{0.5}$	73.69	75.64	15.90	15.95	49.03	49.79	25.00	25.30	60.34	62.83
	B_1	73.87	75.82	16.10	16.25	48.30	49.05	25.27	26.13	63.93	66.56
	$B_{1.5}$	75.54	77.85	16.40	16.39	49.79	50.56	25.42	26.28	78.23	79.04
	B_2	74.79	76.77	16.33	16.36	49.47	50.23	24.95	25.80	77.04	78.98
	$B_{2.5}$	72.90	74.84	16.08	16.01	48.29	49.04	24.69	25.53	63.13	65.73
N_{200}	B_0	73.62	75.57	15.75	15.71	48.07	48.81	24.62	25.46	60.19	62.66
	$B_{0.5}$	74.00	75.96	16.15	16.35	48.40	49.15	25.11	25.96	64.33	66.98
	B_1	74.20	76.18	16.40	16.42	49.65	50.42	25.01	25.86	67.83	70.62
	$B_{1.5}$	76.10	78.12	16.63	16.68	50.04	50.81	25.73	26.60	78.13	79.18
	B_2	75.10	77.09	16.73	16.70	50.30	51.08	25.50	25.38	79.00	80.28
	$B_{2.5}$	73.57	75.52	16.23	16.21	48.44	49.19	24.79	25.63	67.44	70.22
LSD (0.05)		0.92	0.97	0.39	0.45	1.02	1.01	0.91	1.01	2.95	2.55
CV (%)		7.74	6.74	3.75	5.25	5.64	6.27	9.85	5.10	9.77	4.15

Table 4. Combined effect of Boron and Nitrogen on yield attributes, head yield and hollow stem of broccoli (cv. Green Sprouting)

Treatment combination		Head diameter (cm)		Main head weight (g)		Secondary shoot weight (g)		Head yield/plant (g)		Head yield (t/ha)		Hollow stem area (cm^2)	
N (kg/ha)	B (kg/ha)	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
N_{100}	B_0	15.42	15.72	268.3	277.64	95.13	100.15	363.4	377.8	12.11	12.59	345.3	312.2
	$B_{0.5}$	15.98	16.45	285.2	295.30	110.0	112.98	395.2	408.3	13.17	13.61	104.1	100.1
	B_1	16.38	16.79	296.8	306.31	118.9	122.11	416.0	428.4	13.86	14.28	33.0	30.0
	$B_{1.5}$	16.99	17.52	327.0	340.12	132.6	136.20	459.6	476.3	15.32	15.87	0.00	1.2
	B_2	16.97	17.36	325.0	335.51	129.7	133.21	454.7	468.7	15.15	15.62	4.1	4.2
	$B_{2.5}$	16.56	16.94	294.8	305.24	108.7	112.64	403.5	417.9	13.45	13.92	10.8	9.8
N_{200}	B_0	16.25	16.57	278.3	286.84	104.5	107.42	382.8	394.3	12.76	13.14	418.8	350.6
	$B_{0.5}$	16.51	16.99	300.1	310.70	122.1	125.40	422.3	436.1	14.37	14.54	127.3	121.2
	B_1	16.76	17.18	314.2	325.10	126.5	129.91	440.7	455.0	14.69	15.17	62.9	61.6
	$B_{1.5}$	17.38	17.92	329.0	345.65	134.1	137.72	463.0	483.4	15.43	16.11	1.4	2.5
	B_2	17.55	17.95	333.7	345.53	136.4	140.10	470.1	485.4	15.67	16.18	15.1	14.4
	$B_{2.5}$	16.65	17.03	307.5	318.40	116.3	120.15	423.8	438.6	14.13	14.62	35.0	31.3
LSD 0.05)		0.49	0.47	9.54	9.31	14.49	15.17	12.16	10.38	0.40	0.37	10.00	9.8
CV (%)		5.01	4.97	5.16	4.62	3.56	5.78	3.86	3.76	3.94	3.98	10.3	4.8

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