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CONTRIBUTION OF BORON DOSES ON GROWTH AND YIELD OF DIFFERENT BROCCOLI GENOTYPES

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ABSTRACT

Islam M, Hoque MA, Reza MM, Rahman MM (2015) Contribution of boron doses on growth and yield of different broccoli genotypes. *Int. J. Sustain. Crop Prod.* 10(2), 14-20.

A field experiment comprising of four broccoli genotypes (G_1= Premium Crop, G_2= Early Green, G_3= Green Calabrese and G_4= Late Calabrese) with four different levels of boron (L_1= control or without boron, L_2= 1 kg/ha, L_3= 2 kg/ha and L_4= 3 kg/ha) was conducted at the experimental field of Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur during the winter (Rabi) season of 2012-13. Early Green performed the best regarding head diameter (19.04 cm), yield per plant (681.1 g) and total yield (27.24 t/ha). There was a significant and positive effect of boron application on the yield of broccoli. Control (without boron) treatment required highest days (48.92) for curd initiation but minimum days (61.75) for curd harvest. But L_3= 2 kg/ha treatment showed the opposite result. Result of maximum parameter revealed that, 2.0 kg B/ha was found to be an optimum rate. The genotype Early Green yielded the highest (32.19 t/ha) when boron was applied @ 2 kg/ha.

Key words: *broccoli, boron, yield, Bangladesh*

INTRODUCTION

Broccoli (*Brassica oleracea* var. *italica* L.) is an important herbaceous winter vegetable belonging to the family of Cruciferae. It is thought that broccoli is the first crop to be domesticated among 'Cole" crops but it was unfamiliar until 1930s (Gill 1993). Morphologically, broccoli resembles cauliflower. The terminal curd is rather loose, green in color and flower stalks are larger than cauliflower. Broccoli is originated from west Europe (Prasad and Kumar, 1999). It is one of the non-traditional and relatively new winter vegetables in Bangladesh. Although, originated from temperate region, it has been distributed in both the sub-tropical and tropical areas like Bangladesh in the course of time. At present cultivation of broccoli in our country are confined into a very limited area with a minimum production and its average yield is only about 10.5 metric tons per hectare (Anon. 2004) which is very low compared to other broccoli growing countries like 24 t/ha in Italy, 20 t/ha in Japan and 18 t/ha in Turkey (Ahmed *et al.* 2004). But broccoli has gained momentum in Bangladesh and has become increasingly popular with urban people as well as growers for last couple of years. Like other crops broccoli genotypes have also significant effect on yield and other qualities. The major broccoli producing countries of the world has already been recommended so many varieties for growing their own climatic conditions. But in Bangladesh, no varieties of broccoli has not yet been developed, which are capable to produce higher yield in our climatic conditions. Therefore, it is urgently needed to evaluate the performance of available broccoli genotypes in respect of yield and other nutritional quality in Bangladesh condition. Boron is considered as a potential micronutrient and carries out various functions for plant growth. It is essential for translocation of sugars, starch, nitrogen and sulphur. Among all the fertilizers, boron has a direct impact on productivity of Cole crops. Boron significantly improves the vegetative growth and quantitative parameters of Cole crops (Singh 2003). Its application to the soil increased head yield of broccoli (Yang *et al.* 2000). Application of boron significantly increases curd diameter, weight of curd, yield and quality of cauliflower (Kumar *et al.* 2002). Moreover, in cole crops like cauliflower and broccoli, boron requirement is high (Mengal and Kirkby, 1987). Investigations conducted by different workers also found that the application of different levels of boron influenced the growth and yield of various crops. Such as Panigrahi *et al.* (1990); Thakur *et al.* (1991); Mishra (1992); Talukder *et al.* (2000) and Noor *et al.* (2002) in cauliflower, Pregno and Armour (1992); Efkar *et al.* (1995); Porter *et al.* (1986) in potato, Talukder *et al.* (2001); Ali *et al.* (2001) in papaya, Hafiz Akter (2001) in wheat. Therefore, it is very much essential to optimize the dose of boron for successful cultivation of broccoli.

With this supportive background information and keeping these points in view, the present investigation was undertaken to identify high yielding genotype(s) of broccoli for growing in our country and also to find out the optimum dose of boron for increasing yield and quality of broccoli.

MATERIALS AND METHODS

The experiment was carried out at the Horticultural Research Farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur from October, 2012 to February, 2013. The experimental site was located at the centre of Madhupur Tract (24˚09´ N latitude and 90˚26´ E longitudes at 8.5 meter above the sea level) belongs to AEZ 28. The initial soil analysis results were shown in Table 1. The experiment was factorialand had 16 treatment combinations, a randomized complete block design with three replications. The treatment consisted of four broccoli genotypes, *viz.*, G_1= Premium Crop, G_2= Early Green, G_3= Green Calabrese

and G_4= Late Calabrese with four level of boron, *viz*., L_1= control (boron nil), L_2= 1 kg/ha, L_3= 2 kg/ha and L_4= 3 kg/ha that were applied to the soil as Solubor (20% B). Plot dimension was 2.0 m x 1.5 m and plant spacing was 50 cm x 50 cm. Manure and fertilizers were applied to the soil @ 15 tons well rotten cowdung, 210 kg urea, 120 kg TSP, 100 kg MP and 1 kg Molybdenum per hectare. The full amounts of cowdung, TSP, MP and molybdenum were applied during final land preparation, while the urea was applied in two equal installments at 15 and 30 days after transplanting. Treatment wise boron was applied during final land preparation.

Table 1. Physical and chemical properties of experimental soil prior to fertilizer application

Value	Textural class	g/cm^3		pH	Percentage			meq/100 g				ppm		
		Bulk density	Particle density		Soil porosity	OM	Total N	CEC	Ca	Mg	K	P	S	B
Analytical	Clay loam	1.36	2.65	6.2	48.7	0.79	0.119	19.87	7.9	2.36	0.49	13.9	16.9	0.1
Critical		-	-	-	-	-	0.075	-	2.0	0.8	0.2	14.0	14.0	0.2
Optimum		-	-	-	-	-	3.0	-	18.0	9.0	1.5	60.0	60.0	2.0

The seeds were sown in seed bed on 02 October, 2012. Because of heavy rainfall and unfavorable condition of the main field, forty days old healthy seedlings were transplanted in the experimental field on 11 November, 2012 in the afternoon. Harvesting was started on 7 January 2013 and 50% harvest was completed on 21 January 2013.

The data on leaves per plant, days to curd initiation, days to curd harvest, main curd diameter, secondary curd per plant, main curd weight, secondary curd weight, yield per plant and total yield were recorded from randomly selected five plants in each plot. All data were analyzed statistically with MSTATC and means were separated by Duncan's Multiple Ranges Test (DMRT) at 5% level of probability for interpretation of result.

RESULTS AND DISCUSSION

Analytical data of all the parameters except total yield are presented in Table 2.

Number of leaves per plant

Significant difference in number of leaves per plant was noticed among the genotypes. The maximum number of leaves per plant was recorded as 16.65 in the genotype Premium Crop which was statistically similar to Early Green (16.49), whereas Late Calabrese produced least number (14.94) of leaves. Such differences in number of leaves per plant might be due to genotypic variation of broccoli genotypes.

The results of the boron treatment showed highly significant variation in number of leaves per plant. Moniruzzaman *et al.* (2007); Ghosh and Hassan (1997) reported the similar result. Noor *et al.* (2000) obtained significantly maximum number of leaves per plant in case of cauliflower when boron was applied at 1.5 kg B/ha. The maximum numbers of leaves was noted in L_3 (2 kg B/ha) treatment having 17.02, while the minimum 14.98 was recorded in control treatment.

Interaction effect of genotypes and different levels of boron fertilizer on leaves number was found statistically significant. The maximum number of leaves of 17.87 were recorded in the treatment combination G_1L_3 (Premium crop and 2 kg B/ha). The lowest number of leaves of 14.13 was recorded with the treatment combination G_4L_1 (Late Calabrese and 0 kg B/ha).

Days to first curd initiation

Genotypic differences were observed on days to first curd initiation. Premium Crop required minimum (40.58) days after transplanting (DAT), the maximum days (49.58 DAT) to first curd initiation was recorded in genotype Green Calabrese which is statistically similar to Late Calabrese (48.92 DAT).

The application of boron fertilizers markedly influenced on the number of days to 1st curd initiation of broccoli. The maximum days (48.92 DAT) to curd initiation was recorded in the control treatment. The plants treated with L_3 (2 kg B/ha) treatment took the least days (43.92 DAT) to first curd initiation.

The required number of days to curd initiation varied from 38.33 to 52.00 DAT with the application of different levels of boron fertilizer on different genotypes of broccoli. The treatment combination of G_1L_3 (Premium Crop and 2 kg B/ha) took the lowest time (38.33 DAT) for first curd initiation which is statistically similar to G_1L_2 (Premium Crop and 1 kg B/ha) while the maximum days (52.00 DAT) was recorded with treatment combination of G_4L_1 (Late Calabrese and 0 kg B/ha).

Days to 50% curd initiation

Genotypic differences were observed on days to 50% curd initiation. Premium Crop required minimum days (43.67 DAT) for 50% curd initiation. The maximum days (55.92 DAT) to first curd initiation was recorded in genotype Green Calabrese.

Boron application also showed significant influence the number of days to curd initiation of broccoli. The highest significant days (53.08 DAT) to curd initiation was recorded in the control treatment. The plants treated with L_3 (2 kg B/ha) treatment took the least days (49.92 DAT) to first curd initiation.

The required number of days to 50% curd initiation varied from 41.67 to 57.33 DAT with the application of different levels of boron fertilizer on different genotypes of broccoli. The lowest number of days (41.67 DAT) was recorded with treatment combination of G_1L_3 (Premium Crop and 2 kg B/ha) for 50% curd initiation which is statistically similar to G_1L_2 (Premium Crop and 1 kg B/ha) on the other hand maximum days (57.33 DAT) was required to 50% curd initiation with the treatment combination of G_4L_1 (Late Calabrese and 0 kg B/ha).

Days to first curd harvest

Genotypic differences were observed on days to first curd harvest. Premium Crop required minimum time (57.75 DAT), for first curd harvest. The maximum time (66.50 DAT) to first curd harvest was recorded in genotype Early Green.

The application of boron fertilizers markedly influenced the number of days to curd harvest of broccoli. The lowest number of days (61.75 DAT) to curd harvest was recorded in the control treatment. The plants treated with L_3 (2 kg B/ha) treatment took the highest significant time (64.17 DAT) to first curd harvest.

The number of days required for first curd harvest showed significant response to interaction of genotypes and different levels of boron fertilizer. The required number of days to first curd harvest varied from 57.00 to 67.67 DAT with the application of different levels of boron fertilizer on different genotypes of broccoli. The treatment combination of G_1L_1 (Premium Crop and 0 kg B/ha) took the lowest number of days (57.00 DAT) for first curd harvest which is statistically similar to G_1L_2 (Premium Crop and 1 kg B/ha) and G_1L_4 (Premium Crop and 3 kg B/ha) while the highest number of days (67.67 DAT) was recorded with treatment combination of G_2L_3 (Early Green and 2 kg B/ha).

Days to 50% curd harvest

Genotypic differences were observed on days to 50% curd harvest. Premium Crop required minimum number of days (60.00 DAT), for 50% curd harvest. The maximum time (70.67 DAT) to first curd harvest was recorded in genotype Early Green.

Boron application also showed significant influence the number of days to 50% curd harvest of broccoli. The lowest number of days (66.08 DAT) to 50% curd harvest was recorded in the control treatment. The plants treated with L_3 (2 kg B/ha) treatment took the highest significant time (68.58 DAT) to 50% curd harvest.

The interaction effect of genotypes and different levels of boron fertilizer on the days to 50% curd harvest showed significant response. The required number of days to 50% curd harvest varied from 58.33 to 71.67 DAT with the application of different levels of boron fertilizer on different genotypes of broccoli. The lowest number of days (58.33 DAT) was recorded with treatment combination of G_1L_1 (Premium Crop and 0 kg B/ha) for 50% curd harvest on the other hand highest number of days (71.67 DAT) was required to 50% curd harvest with the treatment combination of G_2L_3 (Early Green and 2 kg B/ha).

Curd diameter (cm)

Curd diameter was significantly varied by genotypes, different levels of boron fertilizer and the interaction. The largest curd diameter obtained from the genotype Early Green (19.04 cm) while the smallest curd diameter (6.73 cm) was found from genotype Green Calabrese.

The application of boron caused significant effect on curd diameter. Adhikary *et al.* (2004); Prasad and Sing (1988) also recorded the similar result. The maximum diameter (13.37 cm) of curd was measured with treatment of L_3 (2 kg B/ha) which was statistically similar to L_4 (3 kg B/ha) and lowest curd diameter (11.57 cm) was obtained from the control treatment. Kumar *et al*. (2002) recorded significant increase in curd diameter of cauliflower due to application of molybdenum and boron.

The treatment combination G_2L_3 (Early Green and 2 kg B/ha) produced the highest curd diameter (20.37 cm) which was statistically similar to G_2L_4 while it was minimum (6.13 cm) in G_3L_2 (Green Calabrese and 1 kg B/ha).

Number of secondary curd per plant

The secondary curd was those, which develop after harvest of main curd. The result revealed that there was a variation in number of secondary curd among the genotypes. Number of secondary curd of broccoli per plant varied from 1.91 to 11.63. Maximum number of secondary curd per plant (11.63) was recorded in genotype Green Calabrese which was differed significantly from the other genotypes. The minimum number of secondary curd (1.91) was found in Early Green.

The result of boron fertilizer treatment showed significant variation on the number of secondary curd per plant of broccoli. The maximum number of secondary curd per plant (8.23) was obtained from the plants received boron fertilizer at the rate of L_3 (2 kg B/ha) and the lowest number of secondary curds (6.67) was recorded in the control L_1 treatment.

A significant variation on number of secondary curd per plant was observed due to interaction of genotypes and different levels of boron fertilizer. The maximum number of secondary curd per plant (12.67) was obtained from G_3L_3 (Green Calabrese and 2 kg B/ha) which was statistically identical to G_3L_2 (11.73). The minimum number of secondary curd (1.54) was observed in treatment G_2L_1 which was statistically identical to G_2L_2, G_2L_3 and G_2L_4.

Main curd weight (g)

Central curd weight significantly influenced by the genotypes, application of boron fertilizers and the interaction effects. The maximum weight was recorded from genotype Early Green (525.4 g) while it was minimum (122.3 g) in Green Calabrese. Genotype Early Green performed best in curd weight may be due to producing higher number of leaves and curd diameter. Srivastava (1960) reported that good curd depends on the number of leaves, their size (length and breadth) and ability to storage carbohydrates and other nutrients within a particular temperature range.

Curd weight varied due to application of boron fertilizers. The maximum curd weight (352.9 g) was measured with the treatment of L_3 (2 kg B/ha) and lowest curd weight (253.3 g) was obtained from the control treatment. Rakhsh and Golchin (2012) obtained maximum curd yield from 1.7 kg B/ha. Moniruzzaman *et al.* (2007), Adhikary *et al.* (2004), Ghosh and Hassan (1997), Prasad and Sing (1988) recorded significant increase in curd weight of broccoli due to application of boron.

Due to combined effect of genotype and application of boron fertilizer curd weight differed significantly ranged from 108.3 to 625.0 g. The maximum curd weight (625.0 g) was recorded from treatment combination G_2L_3 (Early Green and 2 kg B/ha) that was statistically similar with G_2L_4 (590.0 g). The minimum curd weight (108.3 g) was obtained from G_3L_1 (Green Calabrese and 0 kg B/ha).

Secondary curd weight per plant (g)

There was a significant variation on weight of secondary curd per plant among the genotypes. The highest weight (155.6 g) of secondary curd was found in Early Green and the minimum was in Late Calabrese (108.3 g). Secondary curd weight per plant differed significantly due to application of boron fertilizers ranged from 110.6 g to 142.1 g. The maximum weight of secondary curd (142.1 g) was measured with treatment of L_3 (2 kg B/ha) and lowest curd weight (110.6 g) was obtained from the control treatment.

The combined effect of genotypes and application of boron fertilizer was found significant on secondary curd weight per plant. The secondary curd weight varied from 83.33 to 179.8 g. The maximum weight (179.8 g) of secondary curd was obtained from treatment combination G_2L_3 (Early Green and 2 kg B/ha) while it was minimum (83.33 g) in G_1L_1 (Premium Crop and 0 kg B/ha).

Table 2. Effect of genotype and boron levels on different yield contributing characters of broccoli

Treatment	Leaves per plant	Days to curd initiation		Days to curd harvest		Main curd diameter (cm)	Secondary curd/plant	Main curd weight (g)	Secondary curd weight (g)	Yield per plant (g)
		1st	50%	1st	50%					
Effect of genotypic differences										
G_1 = Premium Crop	16.65 a	40.58 c	43.67 d	57.75 d	60.00 d	14.45 b	7.02 c	391.5 b	108.5 c	500.0 b
G_2 = Early Green	16.49 a	47.25 b	52.33 c	66.50 a	70.67 a	19.04 a	1.91 d	525.4 a	155.6 a	681.1 a
G_3 = Green Calabrese	15.33 b	49.58 a	54.17 b	61.75 c	68.75 c	6.73 d	11.63 a	122.3 d	125.4 b	247.7 d
G_4 = Late Calabrese	14.94 c	48.92 a	55.92 a	65.83 b	69.75 b	9.43 c	8.91 b	177.5 c	108.3 c	285.8 c
Effect of boron levels										
L_1 = 0 kg B/ha	14.98 d	48.92 a	53.08 a	61.75 d	66.08 c	11.6 c	6.67 c	253.3 d	110.6 c	363.9 c
L_2 = 1 kg B/ha	15.94 b	46.08 b	51.08 c	63.42 b	67.50 b	12.0 bc	7.33 b	289.3 c	127.3 b	416.6 b
L_3 = 2 kg B/ha	17.02 a	43.92 c	49.92 d	64.17 a	68.58 a	13.4 a	8.23 a	352.9 a	142.1 a	495.0 a
L_4 = 3 kg B/ha	15.47 c	47.42 b	52.00 b	62.50 c	67.00 b	12.7 ab	7.24 b	321.2 b	118.0 c	439.1 b
Interaction effect (Genotype X Boron level)										
G_1L_1	15.7 c-e	42.3 fg	45.7 f	57.0 h	58.3 i	13.13 d	6.27 f	351.7 c	83.33 j	435.0 f
G_1L_2	16.7 b	40.0 gh	42.7 g	58.0 gh	60.3 h	14.50 cd	7.05 ef	407.3 c	116.7 fgh	524.1 de
G_1L_3	17.9 a	38.3 h	41.7 g	58.7 g	61.3 h	15.37 c	7.99 de	416.7 c	139.4 bcd	556.1 d
G_1L_4	16.4 bc	41.7 g	44.7 f	57.3 h	60.0 h	14.80 cd	6.77 f	390.3 c	94.60 ij	484.9 ef
G_2L_1	15.5 d-g	49.7 a-d	53.7 cd	65.3 c	69.7 b-e	18.00 b	1.54 g	410.0 c	138.5 cd	548.5 de
G_2L_2	16.5 b	46.7 de	52.3 d	67.0 ab	70.7 a-c	18.20 b	1.85 g	476.7 b	154.9 b	631.6 c
G_2L_3	17.8 a	45.0 ef	50.7 e	67.7 a	71.7 a	20.37 a	2.24 g	625.0 a	179.8 a	804.8 a
G_2L_4	16.2 b-d	47.7 cde	52.7 d	66.0 bc	70.7 a-c	19.60 ab	2.00 g	590.0 a	149.4 bc	739.4 b
G_3L_1	14.7 g-i	51.7 ab	55.7 b	60.7 f	67.7 g	6.23 h	10.73 bc	108.3 f	117.1 fgh	225.4 h
G_3L_2	15.5 d-f	49.3 a-d	53.7 cd	62.0 e	69.0 d-g	6.13 h	11.73 ab	110.0 f	127.5 def	237.5 h
G_3L_3	16.6 b	47.0 cde	52.7 d	62.7 e	70.3 a-d	7.57 fgh	12.67 a	150.0 ef	135.4 cde	285.4 gh
G_3L_4	14.5 hi	50.3 abc	54.7 bc	61.7 ef	68.0 fg	7.00 gh	11.38 b	121.0 ef	121.6 efg	242.6 h
G_4L_1	14.1 i	52.0 a	57.3 a	64.0 d	68.7 efg	8.93 efg	8.15 de	143.3 ef	103.4 hi	246.7 h
G_4L_2	15.1 e-h	48.3 b-e	55.7 b	66.7 ab	70.0 b-e	9.27 ef	8.67 d	163.3 def	109.8 ghi	273.1 gh
G_4L_3	15.8 b-e	45.3 ef	54.7 bc	67.7 a	71.0 ab	10.17 e	10.00 c	220.0 d	113.7 fgh	333.7 g
G_4L_4	14.7 f-i	50.0 a-d	56.0 ab	65.0 cd	69.3 c-f	9.33 ef	8.82 d	183.3 de	106.3 ghi	289.7 gh
CV(%)	2.88	3.86	1.73	1.05	1.27	9.52	8.82	11.75	7.23	8.69

Means followed by same letter(s) in the same column do not differ significantly at 5% level by DMRT

Yield per plant (g)

Genotypes of broccoli differed significantly regarding yield per plant. The genotype Early Green produced maximum yield per plant (681.1 g) followed by Premium Crop (500.0 g). The minimum yield per plant (247.7 g) was found in Green Calabrese.

Yield per plant varied significantly with application of boron fertilizers. The maximum yield per plant (495.0 g) was measured with treatment of L_3(2 kg B/ha) and lowest yield (363.9 g) was obtained from the control treatment. Sharma and Tanuja (1991) mentioned that Leaf water potential, stomatal opening, transpiration rate, net photosynthesis and intercellular CO_2 concentration were greatly reduced by B deficiency. So yield per plant might be reduced because of B deficiency.

Significant variation was observed in yield per plant due to the combined influence of genotypes and boron. The highest yield per plant (804.8 g) was obtained from G_2L_3 (Early Green and 2 kg B/ha) while it was minimum (225.4 g) in G_3L_1 (Green Calabrese and 0 kg B/ha). The treatment combination G_2L_3 performed best may be due to the production of higher number of leaves, curd diameter, curd weight and secondary curd weight by the genotype Early Green in presence of good environmental condition.

Total yield (t/ha)

The total yield of broccoli consisted of the main curd and the secondary curd those developed after the removal of the main one. Although the core of stem is also edible, it was usually not included as part of the yield. However, significant variation in yield (t/ha) was observed among the genotypes (Fig. 1). The maximum yield (27.24 t/ha) was obtained from the genotype Early Green. This might be due to best performance of this genotype in curd diameter, curd weight and secondary curd weight. The lowest yield (9.91 t/ha) was recorded from Green Calabrese.

Boron fertilizer also had significant influence on the yield of broccoli. The maximum yield (19.80 t/ha) was measured with treatment of L_3 (2 kg B/ha). Moniruzzaman *et al.* (2007) also recorded maximum yield at 2 kg B/ha. Kumar *et al.* (2002) reported that Borax at 10 kg/ha increased yield by 32%. Kotur and Kumar (1990) and Firoz *et al.* (2008) found almost similar result. Alam (2006) showed that B at 2 kg/ha with NPKS increased cabbage head yield by 119% (on average) than NPKS alone. On the other hand, lowest yield (14.56 t/ha) was obtained from the control treatment.

Interaction effect of genotypes and application of boron fertilizer on yield per hectare was found significant. The plants of G_2L_3 (Early Green and 2 kg B/ha) produced maximum yield (32.19 t/ha) while the lowest yield (9.02 t/ha) was obtained from G_3L_1 (Green Calabrese and 0 kg B/ha).

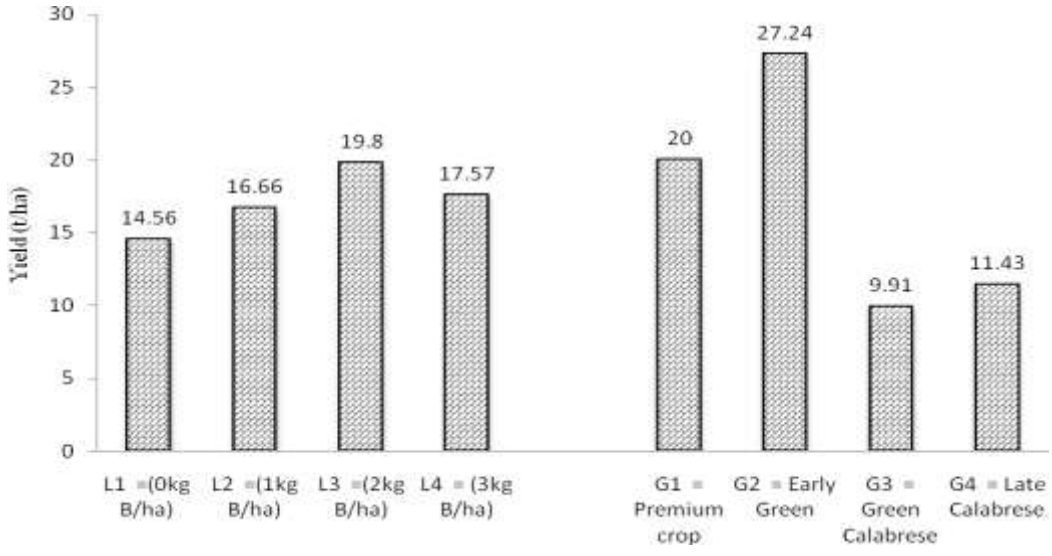

Fig. 1. Effect of boron levels and genotypes on yield

CONCLUSION

Genotype Premium Crop performed the best regarding short term crop variety of broccoli but Early Green yielded maximum among the four experimented genotype but Green Calabrese and Late Calabrese are not suitable for cultivation regarding low yield. Optimum rate of boron for broccoli cultivation was found as 2.0 kg B/ha for all the treatment.

REFERENCES

Adhikary BH, Ghale MS, Adhikary C, Dahal SP, Ranabhat DB (2004) Effects of Different Levels of Boron on Cauliflower (*Brassica oleracea* var. *botrytis*) Curd Production on Acid Soil of Pokhara. *Nepal Agric. Res. J.* 5, 25-36.

Ahmed MJ, Karim Q, Siddique W (2004) Effect of sowing dates on growth and yield of broccoli (*Brassica oleracea* var. *italica* L.) under Rawalakot conditions, Pakistan. *Asian J. of Plant Sci.* 3(2), 167-169.

Alam MN (2006) Effect of vermicompost and some chemical fertilizers on yield and yield components of selective vegetable crops. Ph.D. Thesis, Faculty of Agriculture, University of Rajshahi, Bangladesh. 122-176.

Ali MA, Islam MF, Karim MA, Monir MA, Karim MR (2001) Effect of added boron on the yield of papaya in High Ganges River Floodplain soil. *Bangladesh J. Agril. Sci.,* 28(2), 205-208.

Anonymous (2004) Annual Report 2003-04, Bangladesh Agricultural Research Institute. Joydebpur, Gaziour. 136.

Efkar A, Jan N, Kharttak SG, Khattak MJ, Ahmad E (1995) Potato yield as affected by boron fertilizer mixing with and without farm yard manure. *Sarhad J. Agril.,* 11(6), 725-728.

Firoz ZA, Jaman MM, Alam MS, Alam MK (2008) Effect of boron application on the yield of different varieties of Broccoli in Hill Valley. *Bangladesh J. Agril. Res.* 33(4), 655-657.

Ghosh SK, Hassan MA (1997) Effect of boron on growth and yield of cauliflower. *Ann. Agric. Res.* 18(3), 391-392.

Gill HS (1993) Improvement of cole crops. In: Advances in Horticulture. Vol. 5. Vegetable Crops. K.L Chadha and O.P. Pareek [eds.]. Malhotra Publishing House, New Delhi. India. p. 288.

Hafiz Akter AKM, Mamun AA, Altaf Hossain SM, Moula MG, Biswas M (2001) Effect of sowing date and Boron fertilization on the performance of wheat. *Bangladesh J. Agril. Sci.* 28(2), 317-322.

Kotur SC, Kumar S (1990) Response of cauliflower (*Brassica oleracea* var. botrytis) to boron in Chhotanagpur region. *Indian J. Agril. Sci.* 59(10), 640-644.

Kumar S, Chaudhury DR, Kumar S (2002) Effect of FYM, molybdenum and boron application on yield attributes and yields of cauliflower. *Crop Res. Hisar.* 24(3), 494-496.

Mengal K, Kirkby EA (1987) Principals of plant nutrition. International Potash Institute, Switzerland. p. 27.

Mishra HP (1992) Effect of nitrogen its time of application and boron on cauliflower seed production in calcareous soil, *Indian J. Hort.* 49, 83-86.

Moniruzzaman M, Rahman SML, Kibria MG, Rahman MA, Hossain MM (2007) Effect of boron and nitrogen on yield and hollow stem of Broccoli. *J. Soil Nature.* 1(3), 24-29.

Noor S, Farid ATM, Shil NC, Hossain AKM (2002) Integrated nutrient management for cauliflower. *Bangladesh J. Environ. Sci.* 8, 25-30.

Noor S, Rahman M, Shil NC, Nandy SK, Anwar MN (2000) Effects of boron and molybdenum on the yield and yield components of cauliflower. *Bangladesh Hort.* 24(1&2), 123-127.

Panigrahi UC, Phauhan NB, Das C (1990) A note on the effect of micro-nutrient on yield cauliflower seeds in acid red soil of Orissa. *Orissa J. Hort.* 18(1-2), 62-64.

Porter GA, Morrow LS, Murphy HJ (1986) Boron fertilization of Katahdin potatoes under acid soil conditions. Amer. *Potato J.* 63(8), 448.

Prasad S, Kumar U (1999) Principles of Horticulture. *Agrobotanica,* 4E 176. J. N. Vyas Nagar, India. p. 6.

Prasad MBNV, Singh DP (1988) Varietal screening in cauliflower against boron deficiency. *Indian J. Hort.* 45(3), 307-311.

Pregro LM, Armour JD (1992) Boron deficiency and toxicity in potato cv. Sevago on an oxisol of the Atherton, North Queensland. *Aust. J. Exp. Agri.* 32(2), 251-253.

Rakhsh F, Golchin A (2012) Effects of nitrogen and boron on growth, yield and nutrient concentrations in broccoli. *Int. J. Agric: Res. and Rev. Vol.,* 2(5), 646-651.

Sharma PN, Tanuja R (1991) Effects of boron deficiency and recovery on water relations and photosynthesis in cauliflower. *Indian J. Expl. Biol.* 29(10), 967-970.

Singh DN (2003) Effects of boron on the growth and yield of cauliflower in lateritic soil of western Orissa. *Indian J. Hort. Sci.* 60(3), 283-286.

Srivastava RC (1960) Three steps to a bumper cauliflower crops. *Indian Farming.* 9(11), 8-9.

Talukder ASMHM, Nabi SM, Anwar MN, Shaheed MMA, Ara MA (2001) Influence of Zn, B, and Mo on papaya in grey terrace soil. *Bangladesh J. Agril. Res.* 26(4), 471-478.

Talukder ASMHM, Nabi SM, Shaheed MMA, Karim MR, Goffar MA (2000) Influence of S, B, and Mo on cauliflower in grey terrace soils. *Bangladesh J. Agril. Res.* 25(3), 541-546.

Thakur OP, Sharma PP, Singh KK (1991) Effect of nitrogen and phosphorus with and without boron on curd yield and stalk rot incidence in cauliflower. *Veg. Sci.* 18(2), 115-121.

Yang X, Chen XY, Liu ZC, Yang X, Chen XY, Liu ZC (2000) Effects of boron and molybdenum nutrition on curd yield and active oxygen metabolism in broccoli (*Brassica oleracea* var. *italica*). *Acta Hort. Sinica*. 27(2), 112-116.