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Effect of cowdung and boron on growth and yield of broccoli (*Brassica oleracea)*

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ABSTRACT

An experiment was conducted at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh, during the period from October 2014 to February 2015 to study the effects of cow dung and boron on growth and yield of broccoli. The experiment consisted of two factors; Factor A: cow dung - 4 levels such as C_0: no cow dung (control), C_1: cow dung 10 ton/ha, C_2: cow dung 15 ton/ha and C_3: cow dung 20 ton/ha. Factor B: boron - 4 levels, such as B_0- no boron (control), B_1: boron 1 kg/ha, B_2: boron 2 kg/ha and B_3: boron 3 kg/ha. The experiment was laid out following a randomized complete block design (RCBD) with three replications. In case of cow dung the maximum plant height at 60 DAT (61.47 cm), spread of plant at 60 DAT (50.00 cm), number of leaves per plant at 60 DAT (11.39), length of the largest leaf at 60 DAT (57.69 cm), primary curd weight (374.58 g), yield per hectare (15.74 t/ha) were recorded from C_3 (cow dung 20 ton/ha) treatment and the lowest was recorded from the control (C_0) treatment. In case of boron the maximum plant height at 60 DAT (57.69 cm), spread of plant at 60 DAT (48.44 cm), number of leaves per plant at 60 DAT (11.21), length of the largest leaf at 60 DAT (54.45 cm), primary curd weight (286.78 g), yield per hectare (12.03 t/ha) and the minimum days required for curd initiation (51.17 DAT) were recorded from B_2 (boron 2kg/ha) treatment and the lowest was recorded from control (B_0) treatment. Regarding combination of cow dung and boron the maximum plant height at 60 DAT (63.11 cm), spread of plant at 60 DAT (52.33 cm), number of leaves per plant at 60 DAT (12.97), length of the largest leaf at 60 DAT (60.25 cm), primary curd weight (399.33 g), yield per hectare (16.71 t/ha) and the minimum days required for curd initiation (50.10 DAT), were recorded from C_3B_2 (cow dung 20 t/ha and boron 2 kg/ha) treatment and the lowest was recorded from C_0B_0 (no cow dung and no boron) treatment. The highest production of broccoli is obtained from 20 ton/ha cow dung and 2 kg/ha boron at Horticulture farm condition of Bangladesh Agricultural University, Mymensingh.

Key Words: *Brassica oleracea, Cow dung and Boron.*

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I. Introduction

Broccoli (*Brassica oleracea* var. *botrytis* L) is an important cole crop belongs to the family Brassicaceae. There are three classes of broccoli, i.e. green, white and purple. Among them, green type broccoli is the most popular (Shoemaker et al., 1962). Broccoli contains a high amount of vitamin A, ascorbic acid and appreciable amounts of thiamin, riboflavin, niacin, calcium and iron (Thompson and Kelly, 1957). Analytical data presented by (Nonnecke, 1989) showed that sprouting broccoli contains more vitamins and minerals than those of other cole crops. Therefore, it can be met up some degree of vitamin A and vitamin C requirement and can contribute to solve malnutrition problem in Bangladesh. Broccoli originated from west Europe (Prasad and Kumar, 1999). Although originated from the temperate region, it has been distributed in both the sub-tropical and tropical areas like Bangladesh. Broccoli is grown by a small percentage of home garden in Bangladesh during the winter season. Nutrients may be applied through two sources viz., organic and inorganic sources. Increased use of chemical fertilizers in crop field causes health hazards and creates problem to the environment by polluting water, air and soil (Smith, 1997). The continuous use of chemical fertilizers also badly affects the soil textures and structures. Decreased organic matter content of soil hampers, soil microbial activities. On the other hand, the cost of inorganic fertilizers is generally higher compared to those of organic fertilizer. Cow dung is available in the country, which is a good source of different nutrients. Use of cow dung also improves the organic matter status of the soil. A judicious application of cow dung and inorganic fertilizers might be helpful to obtain a good economic return from a crop, as well as from the subsequent crop, and to maintain good soil health (Abou El- Magd et al., 2006). In cole crops, like cauliflower and broccoli, the requirement of boron is high (Mengal and Kirkby, 1987). Boron deficiency causes many anatomical, physiological, and biochemical changes, making it difficult to identify a primary role for it. Boron deficiency causes nutritional disorders in vegetables like hollow stem in cauliflower and broccoli (Shelp et al., 1995). According to Magnifico et al., (1979) broccoli uptakes 411g Boron per hectare. It is essential for translocation of sugars, starch, nitrogen and sulphur (Pandhawa and Bhail, 1976). The production technology of broccoli has not yet been standardized in Bangladesh. The present study has therefore been undertaken to find out the appropriate dose and combined effect of cow dung and boron on growth and yield of broccoli.

II. Materials and Methods

Location of the experimental site

The experiment was carried out at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh during, the period from October 2014 to February 2015 to study the effect of cow dung and boron on the growth and yield of broccoli. The selected plot was a medium highland. The texture of the soil of the experimental area was silty loam and belonged to the Agro-Ecological Zone-9 (AEZ-9), Old Brahmaputra Flood plain (UNDP, 1988). The selected plot of the land was remained fallow during the previous season. The site of the experiment is located at 24°75' N latitude and 90°50' E longitude at a height of 18 m above the sea level. The microclimate of the experimental area (BAU Campus) is sub-tropical in nature, which is characterized by two distinct seasons, the monsoon or rainy season extending, from April to November (Edris et al., 1979).

Planting materials

The variety of broccoli used in this experiment was the Premium Crop, a Hybrid, which was produced by Takii& Co. Ltd. Kyoto, Japan. The seeds of the variety were procured from M/S Moushumi Biz Bitan, 58, Rambabu Road, Mymensingh.The seedlings of broccoli were raised at the Horticulture Farm, BAU, Mymensingh, under special care in two seedbeds of 3mx1m size. Decomposed cowdung was applied to the prepared seedbeds at the rate of 10 t/ha. Ten grams (10 g) of seeds were sown in each seedbed on 24th October 2014.

Treatments of the experiment

The two-factor experiment consisted of four doses of cow dung (Factor A) and four doses of boron (Factor B) as follows :

Factor A: C_0 : 0 ton/ha (control), C_1 : 10 ton/ha, C_2 : 15 ton/ha, C_3 : 20 ton/ha

Factor B: B_0 : 0 kg B/ha (control), B_1 : 1 kg B/ha, B_2 : 2 kg B/ha, B_3 : 3 kg B/ha

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Thus there were 16 treatment combinations. Boron fertilizer was used as the source of boron, respectively.

The two-factor experiment consisting of 16 treatment combinations was laid out in the randomized complete block design (RCBD) with three replications. The whole experimental area was marked with the measuring tape and rope. The total experimental area (40m x 7m) was divided into three equal blocks, representing the replications. The total number of plots was 48. The size of each unit plot was 2.4 m x 1.8 m. The distance between two adjacent blocks and plots were kept 50 cm and 25 cm, respectively. There were 16 plots in each block. The total area of the experimental plot was 280 m^2.

Methods of broccoli cultivation

The land of the experimental area was first opened on 6 November 2014 with a tractor and it was opened to the sun for few days prior to next ploughing. The soil was treated with insecticides (Cinocarb 3G @ 4 kg/ha) at the time of final land preparation to protect young plants from the attack of soil-inhabiting insects such as cutworm and mole cricket.

Organic manure viz. cow dung 10t/ha, 15t/ha and 20t/ha were applied to the field according to the treatment. Boron fertilizer is applied in the field for the source of boron. Boron (1kg/ha, 2kg/ha and 3kg/ha) were applied to the field as per treatment of the experiment. Inorganic fertilizer viz. 310 kg/ha Urea, 150 kg/ha TSP, 140 kg/ha MP were applied to the final land preparation. Urea and MP were applied in three instalments, the first instalment being applied 15 days after transplanting. The second and third instalments were top-dressed after 30 and 45 days of transplanting.

Healthy and uniform sized 20 days old seedlings were transplanted in the experimental plots on 14 November 2014. Each plot had 20 plants at the spacings of 60 cm x 45cm respectively. The transplants were given shade and watering was done for 5 days for their proper establishment. Weeding was done at 16, 32 and 48 days after transplanting to keep the plots free from weeds. Earthing up was done at 20 and 40 days after transplanting on both sides of rows by taking the soil from the space between the rows by a small spade. To prevent the rotting of stem the cut portions were slanted, so that rainwater could not stay on cutting portion of the stem. The curds were harvested in compact condition before the flower buds opened (Thomson and Kelly, 1957). The crop under investigation was harvested at first on 10 January 2015 and the last harvesting was done on 30 January 2015 when the experiment was terminated. Five plants were randomly selected from the middle rows of the unit plot for avoiding border effect, except yields of curds, which was recorded plot-wise data on the height of the plant and crown spread of the plant were collected at 30, 45 and 60 days after transplanting (DAT).

Statistical analysis

The data collected from the experimental plants per plot in respect of various characteristics were compiled and tabulated in proper form for statistical analysis. The means for all the treatments were calculated and the analysis of variances for most of the characters under consideration was performed by "F" variance test. The significance of the 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).

III. Results and Discussion

In respect of cow dung the highest plant height (61.47 cm) at 60 DAT, spread of plant (50.00 cm) at 60 DAT, number of leaves per plant (11.39), length of largest leaf per plant (57.69 cm) at 60 DAT, and fresh weight of leaves Per plant (61.44 g) at harvest, weight of primary curd (374.58 g), length of stem (19.72 cm), Diameter of stem (3.68 cm), Diameter of Primary curd (17.51 cm), Length of root (25.53 cm), Fresh weight of root (80.17 g), yields per plant (425.56 g), yield per plot (6.80 kg) and yield per hectare (15.74 ton) were recorded with C_3 (20 t/ha) treatment while the minimum yields per plant (215.22 g), per plot (3.44 kg) and per hectare (7.96 ton) were obtained from the control treatment of cow dung (Table 01). Higher cow dung gets the highest result and lower cow dung gets the lowest result it is occurred due to favourable environmental conditions.

In respect of boron the highest plant height (57.69 cm) at 60 DAT, spread of plant (48.44 cm) at 60 DAT, number of leaves per plant (11.21), length of the largest leaf (54.45 cm), weight of primary curd

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(286.78 g), diameter of primary curd (14.47 cm), diameter of stem (3.31 cm), fresh weight of leaves per plant (53.52 g), length of stem (15.53 cm), length of root (21.63 cm), fresh weight of root per plant (75.53 g), yields per plant (324.94 g), per plot (5.20 kg) and per hectare (12.03 ton) and the minimum days required for curd initiation (51.17 DAT) were obtained with the application of 2 kg boron/ha while those were lowest with control treatment of boron (Table 02). Most of the Similar findings have also been obtained from Pizetta et al., (2005) at Response of boron fertilization on broccoli, cauliflower and cabbage planted in sandy soil.

Combined effect of cow dung and boron found significant effect on Plant height, spread of plant, number of leaves per plant, length of the largest leaves, length of stem, diameter of stem, days required for curd initiation, diameter of primary curd, weight of primary curd, fresh weight of roots per plant, length of root, fresh weight of leaves, yield per plant, yield per plot and yield per hectare on broccoli production.

In the respect of combined effect the highest plant height (63.11 cm) at 60 DAT, spread of plant (52.33 cm) at 60 DAT, number of leaves per plant (12.97), length of the largest leaf (60.25 cm), length of stem (21.11 cm), diameter of stem (3.97 cm), diameter of primary curd (19.58 cm), weight of primary curd per plant (399.33 g), fresh weight of leaves per plant (62.56 g), length of root (26.89 cm) fresh weight of root per plant (81.44 g) yield per plant (451.11 g), yield per plot (7.22 kg) , yield per hectare (16.71 ton) and the minimum days required for curd initiation (50.10 DAT) were found in the treatment combination of C_3B_2 (20 t/ha cow dung and 2 kg/ha boron). The lowest yield per plant (144.33 g), yield per plot (2.31 kg) and yield per hectare (5.35 ton) were recorded from the treatment combination of no cow dung and boron (Table 03).

The reason behind this higher level of cow dung provided the plant with sufficient nutrients, moisture and other essentials component for proper growth and development which ultimately increased the yield of broccoli Per plant. The present findings are similar to the results as replied by Aktar et al., (1996).

On the other hand, the application of boron at different level was shown a different yield of broccoli. The highest yield has obtained the level of 2 kg boron per hectare in spite of 3 kg boron per hectare. The reason behind this yield performance in soil condition, excess boron increase toxicity of soil and other environmental condition. But different AEZ yield performance is different in different level of boron is shown which is reported by (Petrcek et al., 1987).

Table 1. Effect of cow dung on the yield and yield contributing characters of Broccoli

Cow dung	Length of stem (cm)	Diameter of stem(cm)	Days required to curd initiation	Diameter of primarycurd(cm)	Wt. of primary curd(g)	Fresh wt. of leaves(g)	Length of root(cm)	Fresh wt. of root/plant(g)	Yield/plant (g)	Yield/plot (kg)	Yield (t/ha)
C_0	12.75	2.87	53.81	11.44	199.50	48.44	18.21	70.31	215.22	3.44	7.96
C_1	13.64	2.98	53.14	11.99	200.75	50.74	19.00	73.44	242.47	3.87	8.96
C_2	15.00	3.26	53.08	14.21	270.50	51.46	22.11	76.06	294.25	4.71	10.90
C_3	19.72	3.68	52.42	17.51	374.58	61.44	25.53	80.17	425.56	6.80	15.74
LSD at 5%	0.27	0.09	0.23	0.27	4.45	0.37	0.23	0.43	2.53	0.09	0.31
LSD at 1%	0.36	0.12	0.30	0.36	5.99	0.50	0.31	0.58	3.41	0.12	0.42
Level of significance	**	**	**	**	**	**	**	**	**	**	**

**= Significant at 1% level and *= Significant at 5% level of probability, C_0 = Control, C_1 = 10 ton/ha, C_2 = 15 ton/ha, C_3 = 20 ton/ha.

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Table 2. Effect of boron on the yield and yield contributing characters of Broccoli

Boron	Length of stem (cm)	Diameter of stem(cm)	Days required to curd initiation	Diameter of primary curd(cm)	Wt. of primary curd(g)	Fresh wt. of leaves(g)	Length of root	Fresh wt. of root/ plant(g)	Yield/plant (g)	Yield/plot (kg)	Yield (t/ha)
B_0	14.69	3.13	56.28	13.20	220.53	52.14	20.83	74.36	223.25	3.57	8.26
B_1	15.50	3.18	53.47	13.32	271.69	53.16	21.31	74.69	310.83	4.97	11.50
B_2	15.53	3.31	51.17	14.47	286.78	53.52	21.63	75.53	324.94	5.20	12.03
B_3	15.39	3.18	51.53	14.16	266.33	53.26	21.08	75.39	318.47	5.09	11.78
LSD at 5%	0.27	0.09	0.23	0.27	4.45	0.37	0.23	0.43	2.53	0.09	0.31
LSD at 1%	0.36	0.12	0.30	0.36	5.99	0.50	0.31	0.58	3.41	0.12	0.42
Level of significance	**	**	**	**	**	**	**	**	**	**	**

**= Significant at 1% level and *= Significant at 5% level of probability ,B_0 = Control, B_1 = 1 kg/ha, B_2 = 2 kg/ha, B_3 = 3 kg/ha

Table 3. Combined effects of cowdung and boron on the yield and yield contributing characters of Broccoli

Treatment combination	Length of stem (cm)	Diameter of stem(cm)	Days required to curd initiation	Diameter of primary curd(cm)	Wt. of primary curd(g)	Fresh wt. of leaves(g)	Length of root(cm)	Fresh wt. of root/ plant(g)	Yield/plant (g)	Yield/plot (kg)	Yield (t/ha)
C_0B_0	12.00	2.44	54.67	10.27	144.33	47.22	17.06	68.56	144.33	2.31	5.35
C_0B_1	14.00	2.98	52.89	11.33	218.33	49.67	18.78	71.22	232.22	3.72	8.61
C_0B_2	13.00	2.88	50.44	10.89	213.00	49.56	18.22	70.22	222.00	3.55	8.21
C_0B_3	12.00	2.79	51.67	11.89	213.33	47.33	17.78	69.22	223.33	3.57	8.26
C_1B_0	13.44	3.05	57.89	12.06	147.44	50.94	19.02	74.11	150.89	2.41	5.57
C_1B_1	13.67	3.04	54.11	11.44	230.00	51.07	19.02	73.89	262.78	4.20	9.72
C_1B_2	13.56	3.08	52.00	12.22	230.00	50.83	19.30	73.33	278.89	4.46	10.32
C_1B_3	13.89	2.77	51.22	12.22	182.56	50.11	18.67	72.44	197.33	3.16	7.31
C_2B_0	14.33	3.14	56.67	13.72	210.44	53.28	22.11	74.89	283.33	4.53	10.48
C_2B_1	15.67	3.24	53.56	14.07	294.11	52.00	22.22	77.22	344.44	5.51	12.75
C_2B_2	14.44	3.32	51.78	13.94	305.78	50.11	22.11	77.11	347.78	5.56	12.87
C_2B_3	15.56	3.32	50.33	15.11	271.67	50.44	22.00	75.00	334.44	5.35	12.38
C_3B_0	19.00	3.48	55.89	15.84	357.89	61.20	24.11	79.22	403.44	6.45	14.93
C_3B_1	18.67	3.43	53.33	15.96	344.33	61.36	25.22	79.22	414.89	6.63	15.34
C_3B_2	21.11	3.97	50.10	19.58	399.33	62.56	26.89	81.44	451.11	7.22	16.71
C_3B_3	20.11	3.74	51.44	18.67	397.78	60.67	25.89	80.78	432.78	6.92	16.01
LSD at 5%	0.53	0.18	0.45	0.53	8.90	0.74	0.46	0.86	5.06	0.18	0.62
LSD at 1%	0.71	0.24	0.61	0.71	11.98	1.00	0.62	1.16	6.82	0.25	0.83
Level of significance	**	**	**	**	**	**	**	**	**	**	**

**= Significant at 1% level of probability, *= Significant at 5% level of probability, C_0 = Control, C_1 = 10 ton/ha, C_2 = 15 ton/ha, C_3 = 20 ton/ha, B_0 = Control, B_1 = 1 kg/ha, B_2 = 2 kg/ha, B_3 = 3 kg/ha .

IV. Conclusion

The application of cow dung and boron at 20 ton per hectare and 2 kg per hectare respectively exhibited the highest result. The highest yield was obtained from the treatment combination of 20-toncow dung/ha and 2 kg boron/ha (C3B2). So, it may be concluded that 20-toncow dung/ha and 2 Kg (C3B2) application is the best considering the growth and yield of broccoli.

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