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Studies on the effect of different levels of boron on vegetative growth, yield and yield components of broccoli (*Brassica oleracea* L. var. italica)

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Abstract
Sprouting broccoli (*Brassica oleracea* var. italica) belongs to the family Brassicaceae. An experiment was conducted at Indian Institute of Vegetable Research- 221305 U.P. (India) during winter season 2011-2012, on "Studies on the effect of different levels of boron on vegetative growth, yield and yield components of broccoli (*Brassica oleracea* L. var. italica)". The experiment was laid out in randomized block design with three replications and ten treatments with different boron level which is T1 (50 ppm), T2 (100 ppm), T3 (150 ppm), T4 (200 ppm), T5 (250 ppm), T6 (300 ppm), T7 (350 ppm), T8 (400 ppm), T9 (450 ppm) and T10 (Control). The observation revealed that the application of different boron level and the best result was observed during investigation plant height (70.20 cm), stem length (24.01 cm) stem thickness (44.13 mm) fresh weight (272.66 g)in T4 (200 ppm) and minimum was observed in T10 (control). In the case of leaves characters the maximum number of leaves per plant was counted 16.3, fresh weight of leave per plant 773.33 g, dry weight of leave per plant 58.003 g and canopy per plant was observed 86.67 cm in T4 (200 ppm) while the minimum result was observed in T10 (control).

Keywords: Vegetative growth, yield and yield components, *Brassica oleracea* L. var. italica

Introduction
Sprouting broccoli (*Brassica oleracea* var. italica) has originated in the Mediterranean region and commonly known as Harigobhi in Hindi and a member of cole group, belongs to the family Brassicaceae. While the broccoli derived its name from the Latin word Brachium meaning an arm or branch. It is used as curries, soups, and pickles, eaten as a salad and cooked as a single or mixed vegetable with potato (Thamburaj and Singh, 2001) [19]. Sprouting broccoli is high value exotic vegetable with a kind of terminal head consisting of green buds and thick fleshy flower stalks morphologically resembles the cauliflower except secondary heads, which develop in the axil of leaves and may contribute up to 50 percent of the total yield. It is one of the most nutritious cole crop and contains vitamin A (130 times and 22 times higher than cauliflower and cabbage, respectively), thiamin, riboflavin, niacin, vitamin C and minerals like Ca, P, K and Fe (Hazra and Som, 1999) [4]. It contains carbohydrates (5.5%), protein (3.3%), vitamin-A (3500 IU), vitamin-C (137 mg), vitamin-B-1 (0.05 mg), vitamin-B2 (0.12 mg), calcium (0.80 mg) and phosphorus (0.79 mg). Broccoli has 4.0, 2.5 and 2.0 times more riboflavin, calcium and ascorbic acid contents, respectively as compared to cauliflower (Thamburaj and Singh, 2001) [19]. It is also a rich source of sulforaphane, a compound associated with reducing the risk of cancer (Thamburaj and Singh, 2001) [19].
Broccoli (*Brassica oleracea* L. var. italica) the word broccoli derives from Latin word '*Brachium'* meaning arm of branch being a native of Italy. It was introduced by Italian immigrants ground 1925 in United of America (Nieuwhout, 1995) [21]. Broccoli is a high value heath promoting vegetable of Brassicaceae family. It contains high level of vitamins, proteins, and minerals beneficial to human health (Lisiewska and Kmiecik, 1997) [22]. The cultivation of sprouting broccoli has becoming increasing popular among Indian growers for the last couple of years, primarily due to its high nutritive values and export potentials.
The broccoli plant forms a kind of head consisting of green buds and thick fleshy stalk. The terminal head is rather loose and green colours and the stalks a larger than those of broccoli. The inter-node is long and the plant produces axillary flowering shoots in addition the terminal inflorescence. The colour of the flower buds forming the edible portion varies from white to green depending on cultivars.

The inflorescence is made of fully differentiated flower buds although, it is considered to be good quality vegetable. The sprouts of leaf axil develop strongly after removal of terminal head and the sprouts with bud clusters are consumed as human food.

Micronutrients are essential in plant nutrition, but are needed in relatively small amounts. In the past, these elements were called minor elements or trace elements. The term micronutrient is preferred because these elements are needed in small or micro amounts.

Boron is essential for plant growth and development. Its application to the soil increased head yield of broccoli (Yang Xian *et al*., 2000) [8]. The importance of boron as a plant nutrient was first demonstrated by Warington (1923) [17] with characteristic deficiency symptoms of die prematurely broad beans and later on by Brandenburg (1931) [1] found heart and dry rot in sugar beet and mangles, respectively. On the other hand, boron is also regarded as poisonous elements (Buchel and Bergmann, 1964) [23], because of its high potency, even small quantities gave damage to plants e.g. germination inhibition, root growth inhibition, shoot chlorosis and necrosis (Bergmann, 1984) [24].

Boron deficiency has been reported to be most pronounced on leguminous crop such as lucerne, red clover and alfalfa and cruciferous crops such as cabbage, cauliflower, broccoli, rutabagas, turnip and radish (Murphy and Walsh, 1972) [25], because of their relatively large boron demand. It is well documented in the literature that monocotyledons require less boron than dicotyledons, because the roots of monocotyledons had a lower capacity to adsorb boron than roots of dicotyledons (Tanaka, 1967) [26].

Materials and Methods

Experiment entitled "Studies on the effect of deferent levels of boron on vegetative of broccoli (*Brassica oleracea* L. var. italica), was planned to standardize the optimum level of boron for growth and yield of broccoli and executed at the Research Farm of the Indian Institute of Vegetable Research, Varanasi, U.P. during 2011-2012. The recommended fertilizer N @ 120 kg/ha, P @ 80 kg/ha and K @ 80 kg/ha was applied. The full dose of phosphorus and potassium and 1/3 dose of nitrogen was applied at the time planting in form of basal application and rest of the nitrogen was applied in two split application at 30 and 45 days after transplanting.

Results and Discussion

Effect of boron application on plant height

The data depicted in table showed that the plant height of broccoli significantly varied under the different levels of boric acid application. The maximum plant height (70.20 cm) was observed with 200 ppm. The minimum plant high (52.50 cm) was found under 450 ppm and control, respectively. It was noted that enhancement in concentration of boric acid above 200 ppm did not prove beneficial and the height of plant was reduced as the levels of boric acid application were increased.

Effect of boron application on stem length (cm) of broccoli

Stem length of broccoli plant influenced with the treatment of different levels of boric acid was measured and the mean values were subjected to statistical analysis. Results obtained after the analysis has been given in table and graphically presented in the fig (1). It is evident from the table that application of boron in from of boric acid significantly influenced the stem length of broccoli. However, the maximum stem length (24.10 cm) was recorded with the application of boric acid @ 200 ppm followed by 150 ppm of boric acid (24.00 cm). The minimum stem length (19.86 cm) was recorded under the control i.e. (19.86 cm). It is apparent from the table that increasing the concentration of boric acid above 200 ppm did not prove effective and the increased levels expressed reduced value of the parameters. Thus, among all the levels of boric acid, minimum value of stem length (19.86 cm) was measured at highest level of boric acid i.e. 450 ppm.

Effect of boron application of stem thickness

Application of boron in from of boric acid significantly influenced the stem thickness of broccoli. However, the maximum thickness of stem (44.13 mm) was recorded with the application of boric acid @ 200 ppm followed by 150 ppm of (43.53 mm) of boric acid. The minimum stem thickness (36.20 mm) was measured with control i.e. 36.20 mm. It is apparent from the table that increasing the concentration of boric acid above 200 ppm did not given any positive effect towards thickening of stem girth and it was noted that as the concentration was increased, stem thickness reduced.

Effect of boron application on fresh weight of stem

Observations regarding fine fresh weight of broccoli plant has been given in the table and graphically presented in the fig. (2). It is evident from the table that difference between fresh weights of stem was highly significant with the application of boric acid. However, the maximum fresh weight of stem (272.66 g) was noted with 200 ppm while minimum fresh weight of stem (210 g) was recorded under control. It was noted that treatment T.8 and T.9 were at par to control.

Table 1: Effect of boron application on vegetative growth of broccoli plant

Treatment level of boric acid	Plant height (cm)	Stem length (cm)	Stem thickness (mm)	Fresh weight (g)
T1-50 (ppm)	65.533	22.4	40.987	252
T2-100 (ppm)	66.133	23.167	42.385	261.333
T3-150 (ppm)	67.800	24.00	43.533	264.667
T4-200 (ppm)	70.200	24.1	44.133	272.667
T5-250 (ppm)	63.600	21.333	41.733	246.667
T6-300 (ppm)	60.933	21.267	40.633	243.333
T7-350 (ppm)	58.867	21.867	39.283	240
T8-400 (ppm)	56.100	21.493	38.467	221.667
T9-450 (ppm)	54.733	21.293	37.433	221.667
T10-control	52.500	19.867	36.200	210
CD @ of 5%	4.464	1.896	5.028	28.757

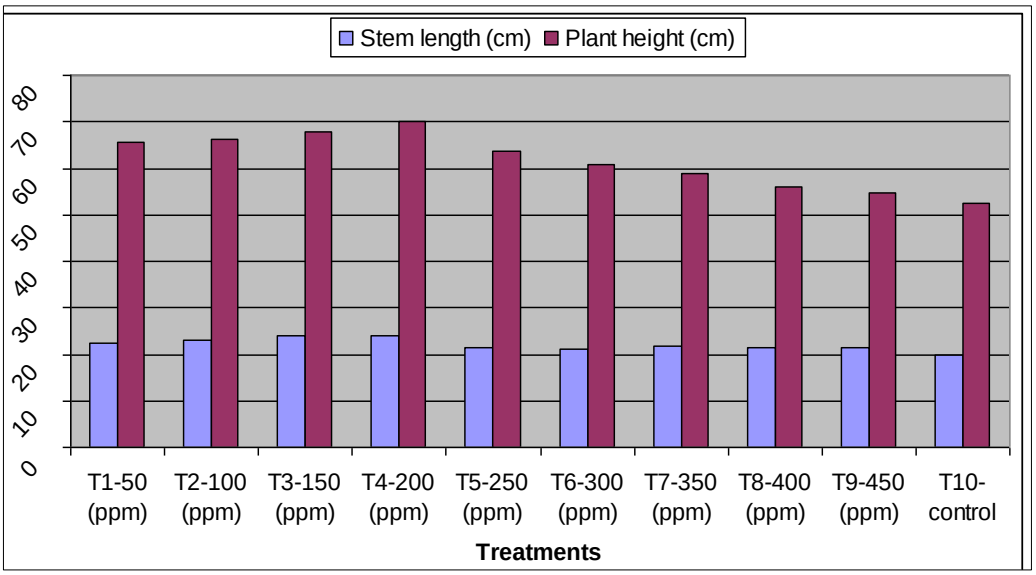

Fig 1: Effect of boron application on vegetative growth of broccoli plant

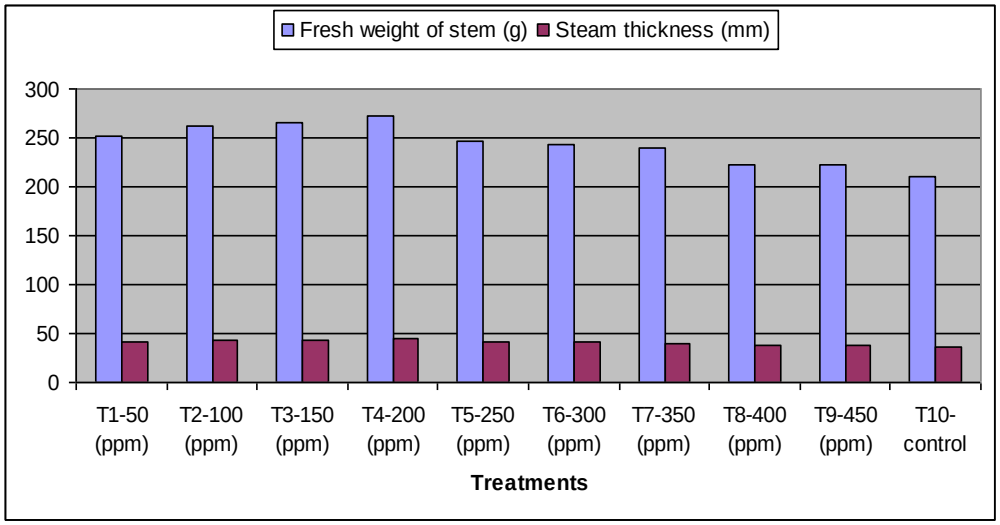

Fig 2: Effect of boron application on vegetative growth of broccoli plant

Effect of born application on number of leaves

Observation related to number of leaves in broccoli influenced with the application of boron were recorded. Mean values were analyzed for critical interpretation of the results as presented in the table.

Data recorded in the table indicates that the maximum number leaves (16.3 plants) was counted with the application of boric acid @ 200 ppm. The minimum number of leaves (11.61 plant) was counted under 450 ppm and control treatment, respectively. Increasing the concentration of boric acid above 200 ppm did not prove effective and number of leaves decreased as the concentration was increased. Among all the treatments of boric acid except 450 ppm, all the levels significantly increased the number of leaves.

Effect of boron application on fresh weight of leaves

Fresh weight of leaves of broccoli under all the treatments under each replication of randomly selected plants was recorded by electronic balance and the mean values were analyzed for interpretation of the results. Data has been presented in table and graphically presented in fig (3). It indicates that application of boron in form of boric acid significantly influenced the fresh weight of leaves of broccoli. However, the maximum fresh weight of leaves (773.33 g) was recorded with application of 200 ppm of boric acid followed by 150 ppm of boric acid (713.33 g). The minimum fresh weight of leaves (443.33 g) was observed with the control i.e. 443.33 g.

It is apparent from the table that increasing the concentration of boric acid above 200 ppm did not prove effective and fresh weight of leaves reduced as the concentration was increased. Among all the leaves of boric acid, 150 ppm and 200 ppm levels had significant edge over control and rest of the treatment levels.

Effect of boron application on dry weight of leaves

The data depicted in the table showed that the maximum dry weight of leaves (58.00 g) was observed with 200 ppm level of boric acid. The minimum dry weight of leaves (48.03 g) was obtained with the application of boric acid @ 450 ppm and it was at par with control. Increasing the concentration of boric acid above 200 ppm did not prove effective and dry weight of leaves reduced as the concentration of boric acid was enhanced beyond 200 ppm. Further, it was observed that increasing the concentration above 200 ppm did not prove beneficial and all the levels were at par to control.

Effect of boron application on canopy (cm^2) of broccoli

Canopy was measured by measuring the length and width of leaves and it was multiplied to express in area. Data shows that application of boron in form of boric acid significantly influenced the leaf length of broccoli. However, the maximum leaf length (86.56 cm) was obtained with application of 200 ppm of boric acid followed by 150 ppm of boric acid (85.46 cm).

The minimum canopy length (72.16 cm) was observed with the control i.e. (72.16 cm). It is apparent from the table that increasing the concentration of boric acid above 200 ppm did not prove effective and length of leaf reduced as the concentration was increased.

Table 2: Effect of boron application on various parameters related to leaf characters

Leaves of parameters				
Treatment level of boric acid	**No of leaves**	**Fresh weight of leave (g)**	**Dry weight of leaves (g)**	**Canopy (cm)**
T1-50 (ppm)	14.733	646	54.97	80.6
T2-100 (ppm)	15.333	673.333	55.873	84.4
T3-150 (ppm)	15.833	713.333	57.94	85.467
T4-200 (ppm)	16.3	773.333	58.003	86.567
T5-250 (ppm)	14.133	636	51.697	80.6
T6-300 (ppm)	13.667	632.667	50.903	79.567
T7-350 (ppm)	13.563	605.333	50.27	78.5
T8-400 (ppm)	12.733	576	49.523	76.333
T9450 (ppm)	11.61	536.667	49.1	74.933
T10-control	11.61	443.333	48.033	72.167
CD @ of/5%	1.079	61.079	4.037	6.177

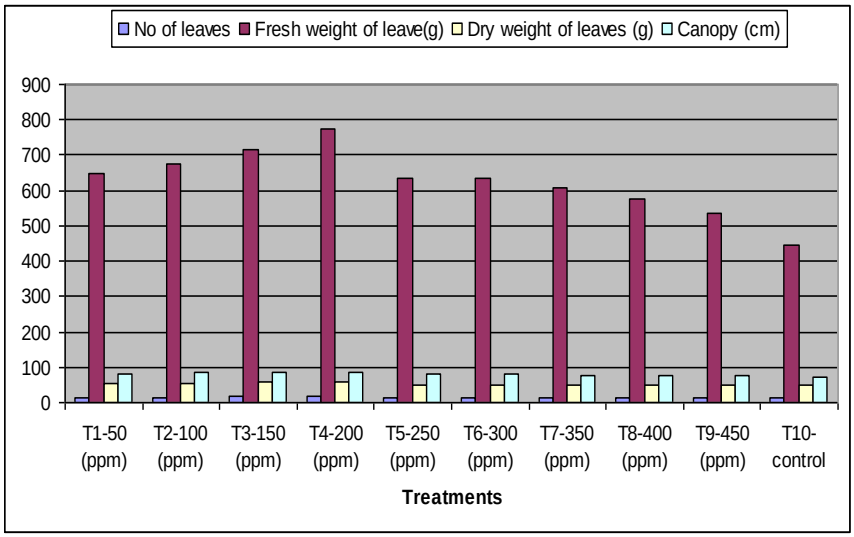

Fig 3: Effect of boron application on various parameters related to leaf characters

References

1. Brandenburg E. Heart and dry rot of beet-causes and treatment. Angew. Bot. 1931;14:194-228.
2. Kotur SC. Standardization of foliar spray of boron for correction of brown rot and for increasing yield of cauliflower (*Brassica oleracea* convar. *botrytis* var. *botrytis*) in Bihar plateau. Indian Journal of Agricultural Sciences. 1998;68:(4):218-221.
3. Kotur SC. Effect of season and of boron and lime application on curd yield, curd rot and utilization of boron by cauliflower (*Brassica oleracea* convar. *botrytis* var. *botrytis)* in an Alfisol. Indian Journal of Agricultural Sciences. 1992;62(4):286-289.
4. Kotur SC. Nitrogen-boron interaction in cauliflower (*Brassica oleracea* var. *botrytis* L.) on an Alfisol. Journal of the Indian Society of Soil Science. 1997;45(3):519-522.
5. Kotur SC. Synergistic interaction of lime, boron and molybdenum on curd rot and curd yield of cauliflower (*Brassica oleracea* convar *botrytis* var. *botrytis*) on an Alfisol. Indian Journal of Agricultural Sciences. 1998;68(5):268-270.
6. Marentes E, Shelp BJ, Vanderpool RA, Spiers GA. Retranslocation of boron in broccoli and lupin during early reproductive growth. Physiologia Plantarum. 1997;100(2):389-399.
7. Prasad VM, Dashrath Yadav. Effect of foliar application of boron and molybdenum on the growth and yield of cauliflower (*Brassica oleracea* var. *botrytis*) cv. Snowball-16. New Agriculturist. 2003;14(1/2):121-122.
8. Randhawa KS, Bhail AS. Growth, yield and quality of cauliflower (*Brassica oleracea*, var. botrytis) as influenced by nitrogen, phosphorus and boron. Food Science and Technology Indian Journal of Horticulture. 1976;33(1):83-91.
9. Shelp BJ, Vivekanandan P, Vanderpool RA, Kitheka AM. Translocation and effectiveness of foliar-fertilized boron in broccoli plants of varying boron status. Plant and Soil. 1996;183(2):309-313.
10. Shelp BJ, Penner R, Zhu Z. Broccoli (*Brassica oleracea* var. *italica)* cultivar response to boron deficiency. Canadian Journal of Plant Science. 1992;72(3):883-888.

11. Shelp BJ, Shattuck VI, McLellan D, Liu L. Boron nutrition and the composition of glucosinolates and soluble nitrogen compounds in two broccoli (*Brassica oleracea* var. *italica*) cultivars. Canadian Journal of Plant Science. 1992;72(3):889-899.
12. Singh KP, Mandal PN, Singh UK, Sharma RK. Studies on the effect of different boron levels and its methods of application on growth and yield of cauliflower (*Brassica oleracea* var. *botrytis* L.). Indian Agriculturist. 2010;54(3/4):147-150.
13. Thamburaj S, Singh N. Vegetables, tuber crops and spices. Directorate of Information and Publications of Agriculture, ICAR, New, Delhi; c2001. p. 137.
14. Thapa U, Das R, Mandal AR, Debanath S. Influence of GA3 and NAA on growth, yield and quality attributing characters of sprouting broccoli [*Brassica oleracea* (L.) var. Italica Plenck]. Indian Journal of Horticulture. 2013;46(1-3):192-195.
15. Yadav RL, Dhaka RS, Fageria MS. Effect of GA3, NAA and succinic acid on growth and yield of cabbage. Haryana Journal of Horticultural Sciences. 2000;29(3/4):269-270.
16. Singh AK, Singh SP, Vishakha Verma. Effect of micronutrients on growth, yield and quality of cauliflower (*Brassica oleracea* L. *var botrytis*). Environment and Ecology. 2010;28(1A):325-327.
17. Warington K. The effect of boric acid and borax on the broad bean and certain other plants. Ann. Bot. 1923;37:629-672.
18. Yang Xian, Chen Xiao, Yan Liu, Zhi Cai. Effects of boron and molybdenum nutrition on curd yield and active oxygen metabolism in broccoli (*Brassica oleracea* var. *italica*). Acta Horticulturae Sinica. 2000;27(2):112-116.
19. Moniruzzaman M, Rahman SML, Kibria MG, Rahman MA, Hossain MM. Effect of boron and Nitrogen on Yield and Hollowstem of Broccoli. J Soil. Nature. 2007;1(3):24-29
20. Kumar S, Kumar V, Yadav YC. Studies on effect of boron and molybdenum on growth, yield and yield attributing characters of cauliflower (*Brassica oleracea* var. *botrytis* L.) cv. Pusa Snowball K-1. Annals of Horticulture. 2012;5(1):53-57.
21. Lowis MJ, Nieuwoudt JM. The use of a cartoon rating scale as a measure for the humor construct. The Journal of psychology. 1995 Mar 1;129(2):133-144.
22. Lisiewska Z, Kmiecik W. Effect of freezing and storage on quality factors in Hamburg and leafy parsley. Food Chemistry. 1997 Dec 1;60(4):633-637.
23. Büchel L, Bergmann W. Der Einfluß verschiedener Umweltfaktoren auf den Borgehalt Thüringer Böden. Archives of Agronomy and Soil Science. 1964 Jan 1;8(8-9):635-648.
24. Bergmann G. Weak localization in thin films: a time-of-flight experiment with conduction electrons. Physics Reports. 1984 May 1;107(1):1-58.
25. Murphy LS, Walsh LM. Correction of micronutrient deficiencies with fertilizers. Micronutrients in agriculture; c1972.
26. Tanaka S, Lerner SA, Lin EC. Replacement of a phosphoenolpyruvate-dependent phosphotransferase by a nicotinamide adenine dinucleotide-linked dehydrogenase for the utilization of mannitol. Journal of Bacteriology. 1967 Feb;93(2):642-628.