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# Response of sprouting broccoli to foliar application of boron and molybdenum under terai region of West Bengal

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**ABSTRACT**

**The present experiment was conducted to standardize the foliar application of boron (0, 0.3% at 45 days after transplanting (DAT) and 0.3% at 30+45 DAT as borax) and molybdenum (0, 0.05% at 45 DAT and 0.05% at 30+45 DAT as ammonium molybdate) for expecting high yield with better quality of sprouting broccoli. Plant height, number of leaves per plant, different yield contributing characters, total yield per plant and quality increased with the increase in boron levels. Single application of ammonium molybdate @ 0.05% at 45 DAT gave maximum total yield per plant, ascorbic acid and chlorophyll content of head. Combined application of borax @ 0.3% at 30+45 DAT and ammonium molybdate @ 0.05 % at 45 DAT ($B_2M_1$) were found better in terms of total yield per plant along with ascorbic acid and chlorophyll content of head than their individual application over the control.**

**Key words:** Boron, molybdenum, yield, quality, sprouting broccoli.

## INTRODUCTION

Sprouting broccoli (*Brassica oleracea* L. var *italica* Plenck.) is an important member of cole group under the family Brassicaceae and is valued for its tender green bud, thick floral stalk and the secondary heads (spears). With the increasing awareness of nutritional security and quality produce as well as reasonable tourist influx in terai region, the traditional cauliflower growers are gradually adopting the broccoli cultivation in wider areas. But micronutrient deficiencies at different growth stages of plants drastically reduced the yield and other quality characteristics of this crop. Chattopadhyay and Mukhopadhyay (2) observed that boron and molybdenum deficiency symptoms are the predominant micronutrient disorders for cauliflower in the soils of terai region of W.B. Research work for micronutrient management of cole crops, especially foliar feeding of micronutrients for sprouting broccoli is still meagre for this zone.

Foliar feeding of micronutrients plays an important role in crop production (Martens and Westermann, 7). The nutrient solutions are sprayed on the foliage to feed the plants rather than through soil. Sharma *et al*. (12) have reported that the foliar spray of boron and molybdenum are often more effective than soil application for cole crops. Therefore the present study was designed to standardize the foliar application of boron and molybdenum for sprouting broccoli in the soils of terai region of West Bengal.

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## MATERIALS AND METHODS

The present experiment was conducted at the instructional farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal during *rabi* season of 2003-2004 and again repeated in 2004-05. The soil was well drained sandy loam having pH 5.13, organic carbon 0.94% and available N, $P_2O_5$, $K_2O$, B, Mo were 210.25 kg/ha, 18.25 kg /ha, 110.36 kg/ha, 0.36 ppm and 0.12 ppm respectively. The experiment composed of foliar spray of borax *viz*., $B_0$: control; $B_1$: 0.3% at 45 days after transplanting (DAT) and $B_2$: 0.3% at 30+45 DAT and ammonium molybdate *viz*., $M_0$: control; $M_1$: 0.05% at 45 DAT and $M_2$: 0.05% at 30+45 DAT alone and in combinations. Thus nine treatment combinations were laid out in factorial randomized block design with 3 replications. Broccoli (cv. Kabuki) was transplanted in 2.5 m x 1.8 m plots with a spacing of 45 cm within and between rows. The crops received a uniform dose of FYM @ 25 tonnes/ha and fertilizers @ 120 kg N, 60 kg $P_2O_5$ and 60 kg $K_2O$ per hectare. Recommended cultural and plant protection measures were followed equally in all the plots as and when required. The observations were recorded on ten randomly selected plants from each plot on different growth, yield and quality characters. Ascorbic acid content of the head was determined by colorimetric

method (Ranganna, 10). The total chlorophyll content of the head was determined by using colorimetric method (Srivastava and Kumar, 14). The data was analyzed statistically as suggested by Gomez and Gomez (3).

## RESULTS AND DISCUSSION

The growth of sprouting broccoli was significantly influenced by the application of various levels of boron and molybdenum. The data (Table 1) showed that different levels of boron was significant for most of the characters and borax @ 0.3% at 30+45 DAT ($B_2$) produced maximum plant height, number of leaves per plant, leaf length, central head weight, central head diameter, central head volume and secondary head weight per plant and subsequently reduced the deformed and disordered head development which in turn increased total yield per plant. This could be due to stimulating influence of boron enhancing the rate of absorption of NPK and other nutrients. Moreover, boron took part in sugar translocation which might lead to the increased head yield. This is in accordance with the findings of Katur (4) in cauliflower. In addition to total yield, ascorbic acid and chlorophyll content of head showed increasing trend with the increasing in boron levels (Fig. 1). These results are in conformity with the findings of Chattopadhyay and Mukhopadhyay (2) in cauliflower.

Increasing levels of molybdenum had significant effect on plant height, number of leaves per plant, leaf length central head volume, and total yield. The maximum yield was obtained by single application of ammonium molybdate @0.05% at 45 DAT ($M_1$). This finding also corroborates the findings of Mehrothra and Shrivastava (8) in cauliflower. The ascorbic acid and chlorophyll content (Fig. 2) increased for single

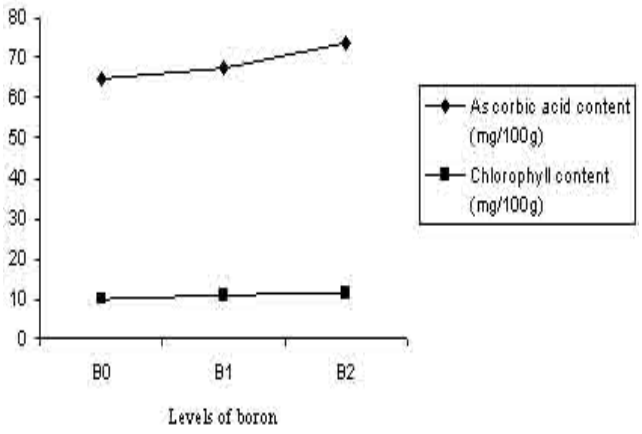


**Fig. 1.** Effect of foliar application of boron on ascorbic acid and chlorophyll content of head of sprouting broccoli.

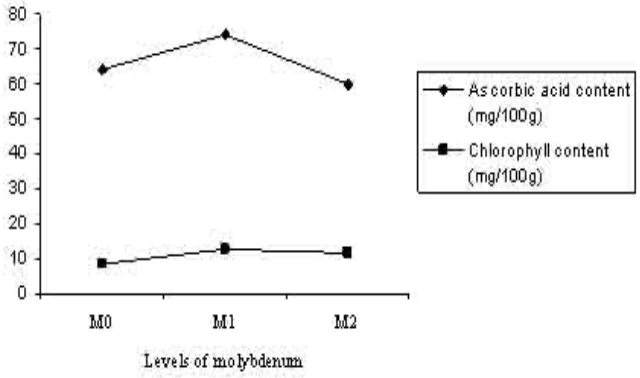


**Fig. 2.** Effect of foliar application of molybdenum on ascorbic acid and chlorophyll content of head of sprouting broccoli.

**Table 1.** Effect of individual foliar spray of boron and molybdenum on growth and yield characters of sprouting broccoli (mean data of 2 years).

| Treatment | Plant height (cm) | No. of leaves per plant | Leaf length (cm) | Central head wt. /plant (g) | Central head diameter (cm) | Central head volume ($cm^3$) | Secondary head wt. per plant (g) | Total yield per plant (g) |
|---|---|---|---|---|---|---|---|---|
| $B_0$ | 46.02 | 11.69 | 27.49 | 82.05 | 6.16 | 101.45 | 56.34 | 138.56 |
| $B_1$ | 49.42 | 13.74 | 25.06 | 139.00 | 8.03 | 166.70 | 93.35 | 232.36 |
| $B_2$ | 55.21 | 14.16 | 31.77 | 229.32 | 10.01 | 303.08 | 130.38 | 357.91 |
| CD at 5% | 1.63 | 0.87 | 3.35 | 23.40 | 0.65 | 13.78 | 29.50 | 30.68 |
| $M_0$ | 48.96 | 12.65 | 27.47 | 141.05 | 7.85 | 162.69 | 90.48 | 229.89 |
| $M_1$ | 50.26 | 13.26 | 27.87 | 150.94 | 8.08 | 195.05 | 106.33 | 257.28 |
| $M_2$ | 51.43 | 13.68 | 28.97 | 158.39 | 8.26 | 213.49 | 83.27 | 241.66 |
| CD at 5% | 1.63 | 0.87 | N.S | N.S | NS | 13.78 | N.S | 30.68 |

application but showing decreasing trend for twice application. The increase in ascorbic acid content of head was due to involvement of molybdenum in nitrogen metabolism and ultimately synthesis of ascorbic acid. Besides molybdenum act in enzyme system which brought about oxidation-reduction reaction which might lead to ascorbic acid formation. Similar result was reported in cauliflower by Sagave and Badhe (11). The increase in chlorophyll content was due to the fact that molybdenum is a part of the enzyme $NO_3^-$ reductase which primarily occurs in chloroplast of leaves and which in turn helps in chlorophyll formation. This result was in accordance with the findings of Murya *et al*. (9), and Katur (5) working with cauliflower. The excess levels of molybdenum decreased yield and other quality characters. This is due to fact that molybdenum toxicity caused yellowing of leaf and head and ultimately reduction in yield and quality (Anderson, 1).

Combined foliar application of borax @ 0.3% at 30 DAT and ammonium molybdate @ 0.05% at 30+45 DAT ($B_1M_2$) gave maximum number of leaves per plant where as other treatment did not show any significant difference for leaf length, central head weight per plant and central head diameter. The highest secondary head weight was obtained with the application of borax @ 0.3 % at 30+45 DAT and ammonium molybdate @ 0.05% at DAT ($B_2M_1$) and these ultimately leads to increased total yield per plant (Table 2). The percentage yield contribution and quality characteristics were higher than the individual application of boron and molybdenum. This might be due to combined application of boron and molybdenum at optimum levels under deficient condition increased uptake of major nutrients which resulted in sturdy plant growth and increased yield and quality. Singh (13), Chattopadhyay and Mukhopadhyay (2) and Katur (6) found maximum yield with combined foliar application of boron and molybdenum in cauliflower. The Ascorbic acid and chlorophyll content of head increased with the increasing in combined levels of boron and molybdenum and maximum was obtained by the application of borax @ 0.3 % at 30+45 DAT and ammonium molybdate @ 0.05% at DAT ($B_2M_1$) (Fig. 3). Thus keeping all the parameters in consideration it can be concluded that combined application of borax @ 0.3% at 30+45 DAT and ammonium molybdate @ 0.05% at 45 DAT ($B_2M_1$) may be suggested as the optimum level for improving yield and quality of sprouting broccoli under of terai region of West Bengal.

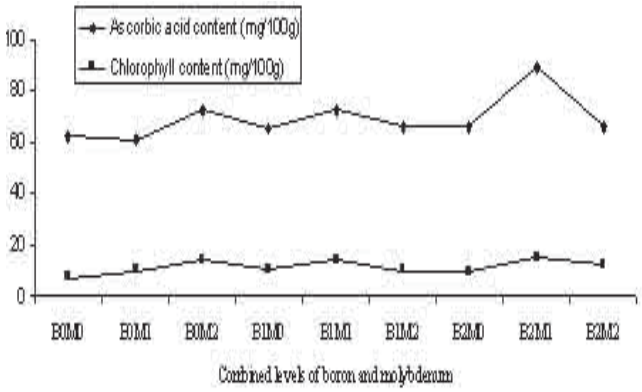


**Fig. 3.** Effect of combined application of boron and molybdenum on ascorbic acid and chlorophyll content of head of sprouting broccoli.

**Table 2.** Effect of interaction of boron and molybdenum on growth and yield characters of sprouting broccoli (mean data of 2 years).

| Treatment | Plant height (cm) | No. of leaves per plant | Leaf length (cm) | Central head wt. /plant (g) | Central head diameter (cm) | Central head volume ($cm^3$) | Secondary head wt. per plant (g) | Total yield per plant (g) |
|---|---|---|---|---|---|---|---|---|
| $B_0M_0$ | 44.34 | 11.60 | 25.43 | 69.47 | 5.73 | 76.16 | 64.45 | 134.43 |
| $B_0M_1$ | 48.41 | 11.97 | 28.20 | 89.39 | 6.42 | 100.91 | 57.09 | 146.49 |
| $B_0M_2$ | 45.31 | 11.51 | 28.83 | 87.30 | 6.32 | 127.26 | 47.48 | 134.78 |
| $B_1M_0$ | 46.47 | 13.21 | 25.06 | 124.54 | 7.69 | 128.68 | 71.89 | 196.43 |
| $B_1M_1$ | 46.42 | 13.14 | 25.08 | 129.06 | 7.99 | 169.61 | 107.60 | 236.66 |
| $B_1M_2$ | 55.37 | 14.86 | 25.03 | 163.40 | 8.41 | 201.82 | 100.57 | 263.98 |
| $B_2M_0$ | 56.06 | 13.13 | 31.92 | 229.13 | 10.13 | 283.23 | 135.09 | 358.82 |
| $B_2M_1$ | 55.96 | 14.68 | 30.34 | 234.38 | 9.83 | 314.64 | 154.30 | 388.68 |
| $B_2M_2$ | 53.61 | 14.66 | 33.05 | 224.47 | 10.06 | 311.39 | 101.76 | 326.23 |
| CD at 5% | 2.00 | 1.07 | N.S | N.S | NS | 16.88 | 36.14 | 37.58 |

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