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ROLE OF BORON, MOLYBDENUM AND ZINC APPLICATION ON VARIOUS SUGAR LEVELS OF *BRASSICA OLERACEA VAR. CAPITATA* L.

W. I. DEVI, G. S. DEVI and P. K. SINGH

Department of Life Sciences, Manipur University, Canchipur, Imphal-795003, Manipur, India.

Field experiments were carried out during the month of November to January 1994-1995 and 1995-1996 to improve the qualitative and quantitative characters of Cabbage (*Brassica oleracea* var. *capitata* L.) with soil and foliar application of Boron (B), Molybdenum (Mo), Zinc (Zn) and combination of the three as total micronutrients (TM) at different concentrations, in a randomised block design. Estimation of various levels of sugars from the dried leaf samples of various treatments was done at three intervals of 30, 60 and 90 days after transplantations (DAT). Significant value of total soluble sugars (TTS) was recorded in all the treatments with TM foliar sprayed plants. The levels of reducing sugar (RS) were increased gradually upto 90 DAT, and highest value was obtained in Mo soil treated plants at 90 DAT. The same trend was also noticed in case of non-reducing suger (NRS), with highest concentration of NRS at 90 DAT in Zn foliar sprayed plants. Among the treatments minimum level was recorded in control stages (T_1). In order to enhance the yield, micronutrients play an important role in sugar parameters, both in soil and foliar sprayed plants.

Keywords : Cabbage,Foliar and soil apllication ; Micronutrients ; Sugars.

Introduction

Micronutrients play a very important role in maintaining the optimum plant growth, yield and quality of vegetable. It also influence the physiological and biochemical parameters of plants. In vegetables the growing buds die off due to Boron (B) deficiency. B has been implicated in carbohydrate and nucleic acid metabolism cell wall metabolism along with Calcium (Ca). A constant ratio of Ca to B seems optimal for plant growth[1]. Molybdenum (Mo) is involved in enzyme systems particularly nitrate reductase, which is involved in the reduction of nitrate and nitrogenase. Whereas, Zinc (Zn) participates in Chlorophyll formation and promote RNA synthesis, which in turn is needed for protein production. The application of the micronutrients to plant becomes important for their efficient utilisation and better performance of the crop[2]. Hence an effort was made to find out the role of B, Mo and Zn application on various sugar levels of Cabbage (*Brassica oleracea* var. *capitata* L.).

Materials and Methods

The experiment was conducted in a farm at Kakwa, about 3 kms from Manipur University, during the month of November to January, 1994-1995 and 1995-1996. The plot was laid out in randomised block design with four replications each at the net plot size of 3.40 m^2. Number of plots were 32 with 8 treatments and a population of 640 plants. Spacing of the plant to plant was 40 cm and row was60 cm. B, Mo, Zn and combination of the three as total micronutrients(TM) were applied on the soil and foliage at different stages of the plant during the growing period. Application of these micronutrients on soil, was done before transplantation and 25 to 50 days after transplanting (DAT). They were T_1 (control, without micronutrients), T_2 (with Boron-Borax-10 kg/ha) ,T_3 (treated with Zinc-Zinc Sulphate-2 kg/ha) and T_4 (with Molybdenum-Ammonium Molybdate - 8 kg/ha), respectively. Foliar application was done with uniform spray with hand sprayer till the foliage was completely wetted with 0.1% of spraying reagents of B, Mo, Zn and TM(0.15% of plantaid). They are T_5(with Boron-Borax -10 kg/ha), T_6(treated with Zinc-Zinc-Sulphate - 2 kg/ha), T_7(with Molybdenum-Ammonium Molybdate-8 kg/ha), and T_8 TM(0.15% of plantaid), respectively. The crop was adequately protected from insect, pest and diseases.

Estimation of various levels of sugars of the leaf samples of different treatments was done by the following techniques : Anthron method[3] for the estimation Total soluble sugars (TSS), Nelson's method[4] for Reducing sugar (RS) and Malhotra and Sarkar's method for the estimation of Non-reducing sugar (NRS). The plants were transplanted, arranged in a randomised block design, representation and statistical analysis of experimental data were also worked out[6,7].

Results and discussion

The levels of TSS, increased gradually in all the treatments upto 90 DAT. The maximum values were obtained in T_8(5.20 mg/g) with TM foliar sprayed plants at 30 DAT. The same trend was observed at 60 and 90 DAT. In T_8 (13.84 mg/g) and T_8 (21.05 mg/g) respectively. Minimum value was recorded in the control plants of all stages (Table 1).

The levels of RS increased gradually in all the treatments upto 90 DAT. The highest accumulations were obtained in T_2 (0.67 mg/g) with B soil treated plants at 30 DAT, in T_4 (2.91 mg/g) with Zn soil treated plants at 60 DAT,and in T_3 (3.77 mg/g) with Mo soil treated plants. Minimum levels were also noticed in all the control plant stages (Table 2).

The levels of NRS increased gradually upto 90 DAT in all treatments. Highest concentrations were obtained in T_8, 4.76 mg/g, 11.14 mg/g at 30 and 60 DAT respectively, in TM foliar sprayed plants. AT 90 DAT, the highest level was also observed in T_7 (17.40 mg/g) with Zn foliar sprayed plant. The minimum level was obtained in all control plant stages(Table 3).

Among the carbon metabolites, carbohydrates constitute one of the basic components synthesised as a result of photosynthesis. B enhances uptake and translocation of nutrients of physiological processes and is implicated in carbohydrate metabolism. This might be the reason of higher grain weight and improvement of grain setting due to B application of wheat[8,9]. Under deficient conditions, B plays a vital role in carbohydrate balance[10]. The gradual increase of reducing and non-reducing sugars was observed with the increase level of B. The significant improvement on TSS, RS and NRS contents was noted by the application of 2 kg/ha of B. However, highest TSS, RS and NRS was found at higher rate of B at 10 DAT. B also affects the quality of tomato fruits[11]. The application of phosphorous is associated with several vital functions such as utilisation of sugar and starch, nucleus formation, cell division, photosynthesis and root growth[12]. The decrease in starch, TSS, RS and NRS is expected to be due to deficiency of photosynthetic pigments, the magnitude of which has been reported to be directly proportional to the rate of photosynthesis[13]. However, total soluble sugar and sugar contents were found to be decreased with Zn application to tomato cultivars[14].

The present finding shows the highest concentration of TSS in TM in foliar sprayed (0.15% of plantaid) plants of 30, 60 and 90 DAT with 116%, 54.8% and 61.17% respectively, over the control. The maximum concentration of RS was obtained in the treatments of T_2 (10 kg/ha), T_4 (2 kg of Zn/ha) and T_3 (8 kg of Mo/ha) in 30, 60 and 90 DAT with 123.3%, 277.92% and 21.61% respectively, more than control. Regarding NRS, the highest concentration was recorded in T_8 (0.15% of plantaid) at 30 and 60 DAT with 123% and 44.11% respectively, over the control. At 90 DAT, the maximum level of

Table 1. Effects of Boron (B), Molybdenum (Mo), Zinc (Zn) and Total micronutrients (TM) on Total soluble sugar (TSS) concentration at different stages of *Brassica oleracea* var. *capitata* L., during the two crop seasons-1994-95, 1995-96.

Treatments	Levels of TSS (mg/g leaf dry wt.)*		
	Plant Ages (Days)		
	30	60	90
T_1	2.40±0.080**	08.94±0.170	13.06±0.26
T_2	4.46±0.145	11.40±0.240	10.24±0.14
T_3	4.09±0.110	12.78±0.167	20.50±0.15
T_4	3.50±0.160	12.30±0.163	18.45±0.14
T_5	3.82±0.230	09.42±0.040	12.04±0.13
T_6	3.70±0.400	11.24±0.106	19.96±0.26
T_7	4.37±0.280	9.92±0.170	20.56±0.18
T_8	5.20±0.360	13.84±0.138	21.05±0.57
C.D. at 5%	0.194	0.226	0.329

* Mean value of the two crop seasons.
** Standard Error of the Mean (n=4).

Table 2. Effects of Boron (B), Molybdenum (Mo), Zinc (Zn) and Total micronutrients (TM) on Reducing sugar (RS) concentration at different stages of *Brassica oleracea* var. *capitata* L., during the two crop seasons-1994-95, 1995-96.

Treatments	Levels of RS (mg/g leaf dry wt.)*		
	Plant Ages (Days)		
	30	60	90
T_1	0.30±0.020**	0.77±0.044	3.10±0.029
T_2	0.67±0.010	1.57±0.022	3.30±0.035
T_3	0.48±0.024	2.28±0.016	3.77±0.085
T_4	0.63±0.022	2.91±0.098	3.27±0.092
T_5	0.51±0.025	1.68±0.055	3.72±0.058
T_6	0.49±0.035	0.88±0.036	3.44±0.022
T_7	0.57±0.005	1.57±0.035	3.09±0.041
T_8	0.44±0.022	2.68±0.062	3.11±0.050
C.D. at 5%	0.173	0.298	0.522

* Mean value of the two crop seasons.
** Standard Error of the Mean (n=4).

Table 3. Effects of Boron (B), Molybdenum (Mo), Zinc (Zn) and Total micronutrients (TM) on Non-Reducing sugar (NRS) concentration at different stages of *Brassica oleracea* var. *capitata* L., during the two crop seasons-1994-95, 1995-96.

Treatments	Levels of NRS (mg/g leaf dry wt.)*		
	Plant Ages (Days)		
	30	60	90
T_1	2.13±0.088**	7.73±0.010	8.27±0.012
T_2	3.69±0.098	9.82±0.015	16.84±0.029
T_3	3.68±0.032	10.5±0.057	16.74±0.029
T_4	2.86±0.016	9.34±0.075	15.12±0.045
T_5	3.31±0.012	8.172±0.014	9.97±0.063
T_6	3.21±0.009	10.36±0.023	16.54±0.029
T_7	3.77±0.012	8.35±0.028	17.40±0.057
T_8	4.76±0.009	11.14±0.012	14.92±0.015
C.D. at 5%	0.97	0.112	0.834

* Mean value of the two crop seasons.
** Standard Error of the Mean (n=4).

NRS was found in T_7 (0.1% of Zn) with 110.39%, over the control.

In the present investigation, NRS is increased due to the application of TM during the early and medium stages and Zn application in the late stages of the test plants. Due to the application of B, Zn and Mo, it is also significantly beneficial in the synthesis of RS at different stages of the test plants. Synthesis of total sugars which results in the yield product might be due to the application of the micronutrients. Analysis of the existing findings implies that, the application of B is helping in the production and translocation of reducing, non-reducing and total sugars in the plant body. However, the role of TM is very essential in the overall production of sugars. The findings are in conformity with the results of other workers [8,9,12,15].

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