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Effect of calcium, boron and sorbitol on fruit-set, yield and quality in mango cv. Himsagar

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ABSTRACT

An investigation was carried out to study the effect of foliar spray of micronutrients, *viz,* calcium and boron and sorbitol on fruit-set, yield and fruit quality in mango *(Mangifera indica* L*)*. cv. Himsagar, at Bidhan Chandra Krishi Viswavidyalaya, Regional Research Station, Gayeshpur. The experiment was laid out in Randomized Block Design (RBD), with three replications. Results revealed that boric acid (0.02%) + sorbitol (2.0%) were the most effective for enhancing fruit-set (1.58%), yield (48.51 kg tree-1), fruit weight (165.6 g), TSS (18.59°Brix), total sugars (14.92%) and ascorbic acid content (20.32 mg 100 g^{-1}), while, calcium nitrate (Ca-0.06%) + boric acid (B-0.02%) proved to be the most effective for increasing shelf life in mango cv. Himsagar, at ambient room temperature.

Key words: Mango, calcium nitrate, boric acid, sorbitol, fruit quality

INTRODUCTION

Mango (*Mangifera indica* L.) is the 'national fruit' of India. India is the largest producer of mango in the world, producing 184.31 lakh tonnes from an area of 25.16 lakh ha with a productivity of 7.3 mt/ha, and, shares about 45.1 % of the total mango production in the world. In the mango, several problems are associated with fruit-set, yield and quality due to an imbalance in supply of nutrients resulting in poor plant health, fruit quality and increase in fruit-drop. Further, unhealthy plants are more prone to attack from insect-pests and diseases. Attempts were made by several researchers earlier to enhance productivity and quality of mangoes through foliar application of nutrients. Calcium spray is known to increase productivity of mango, basically due to reduced abscission (Kumar *et al*, 2006; Wahdan *et al*, 2011). Jutamanee *et al* (2002), Singh and Maurya (2004) and Singh *et al* (2013) showed enhanced mango productivity with boron application. Boron treatment also resulted in improved fruit quality in terms of weight, TSS, total sugars and colour (Pandey and Singh, 2007; Dutta, 2004; Abd-Allah, 2006). The effects seen may be attributed to boron on enhanced pollen germination, pollen-tube growth and sugar synthesis/accumulation. Therefore, keeping in view the importance of nutrients on fruit-set, yield and quality, this study was undertaken in mango cv. Himsagar with the objective of finding the most effective and optimum concentration of micro – nutrients tested to improve fruit-set, yield and quality of fruits.

The experiment was conducted at Regional Research Station, Gayeshpur, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal, during 2011-2013. Twelve-year-old trees of mango cv. Himsagar of uniform vigour and size, planted at 10m X 10m distance and maintained under uniform cultural practices, were selected for the study. Seven treatments comprising calcium nitrate (0.06%), boric acid (0.02%), sorbitol (2.0%) alone or in combination (i.e., calcium nitrate @ 0.06% + boric acid @ 0.02%; calcium nitrate @ 0.06% + sorbitol @ 2.0%; and, boric acid @ 0.02% + sorbitol @ 2.0%) and Control (water spray) were tested as foliar spray solutions by applying at about 50% initiation of panicles in the tree. Treatments were laid out in Randomized Block Design,

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with three replications. Data were recorded on per-cent fruit-set, yield (kg tree^{-1}), fruit weight (g), total soluble solids in °Brix (with the help of a digital refractrometer), acidity (calculated by titrating the fruit pulp aliquot against 0.1N NaOH, as suggested in A.O.A.C., 1984, ascorbic acid (by reduction of 2,6-dichlorophenol indophenol dye) and total sugars (Ranganna, 1986).

Results presented in Table 1 indicate that application of micronutrients and sorbitol significantly increased fruit-set. Highest fruit-set (1.90) was recorded with boric acid (B-0.02%) + sorbitol (2%), followed by boric acid (B-0.02%) (1.83); and, the lowest (1.54) was observed in Control. Increase in fruit-set with application of boron and carbohydrates was also been observed by Stino *et al* (2011) and Singh *et al* (2013). Table 1 also shows that plants sprayed with boric acid (0.02%) + sorbitol (2.0%) gave the highest yield (39.82 kg/tree), whereas Control recorded the lowest yield (32.13 kg/tree). Similar results were obtained by Negi *et al* (2010) and Singh *et al* (2013). Boron improves pollen grain germination and pollen-tube elongation, consequently leading to higher fruit-set and, finally, the yield (Abd-Allah, 2006). Further, it is evident from Table 1 that highest average fruit-weight (234.33g) was recorded with calcium nitrate (Ca-0.06%) + sorbitol (2%), which was at par with boric acid (B-0.02%) + sorbitol (2%) (231.75g); whereas, lowest average fruit weight (202.83g) was recorded in Control.

It is seen in Table 2 that total soluble solids content in the fruit was significantly affected by various treatments with micronutrients and sorbitol. Pooled data for the two years showed that maximum TSS was recorded with boric acid (B-0.02%) + sorbitol (2%) (19.15 °Brix),and, the minimum TSS (16.50°Brix) was recorded in Control. Data presented in Table 2 indicate that acidity was not affected significantly by application of micronutrients or sorbitol. However, pooled data shows that the highest acidity (0.22%) was recorded in Control, and, the lowest (0.11%) with boric acid (B-0.02%) + sorbitol (2%). These results are in close conformity with finding of Sanna and Abd El-Megeed (2005). Negi *et al* (2009) pointed out that increase in TSS by boron could be due to a more rapid translocation of sugars from the leaves to the developing fruits. Further, our treatments significantly increased total sugars content in the fruit (Table 2). Pooled data reveals that maximum total sugars (15.30%) were recorded in plants treated with boric acid (B-0.02%) + sorbitol (2%), which was significantly higher than total sugars content in all the other treatments, including Control (13.36%). These findings are in conformity with findings of Banik *et al* (1997) and Negi *et al* (2009). Increase in total sugar content may be due to a breakdown of complex polymers into simple substances by hydrolytic enzymes. Boron facilitates sugar transport within a plant, and it is reported that borate reacts with sugars to form a sugar-borate complex that is more easily available to the transverse membrane (Gauch and Duggar, 1954).

It is obvious from Table 2 that ascorbic acid content of the fruits significantly increased with application of micronutrients and sorbitol. Maximum ascorbic acid content (28.39 mg/100g pulp) was observed in fruits treated with calcium nitrate (Ca-0.06%) + boric acid (B-0.02%) followed by calcium nitrate (Ca-0.06%) + sorbitol (2%) (26.55 mg/100g pulp), whereas, the lowest (23.09 mg/100g pulp) was recorded in Control. Similar findings were reported by Negi *et al* (2009) and Singh *et al* (2013). Higher level of ascorbic acid with application of boron may be due to higher sugar content in the fruit as, ascorbic acid is synthesized from sugars.

It is clear from Table 1 that shelf-life (number of days, at ambient room temperature) of fruits recorded highest (9 days) in calcium nitrate (Ca-0.06%) + boric acid (B-0.02%), whereas, the lowest was observed in Control which was, however, statistically at par with boric acid (B-0.02%) (5 days). The increase in shelf-life by calcium treatment may be due to the action of calcium in imparting firmness to the fruit, and maintenance of structure and function of the cell wall, thereby leading to enhanced shelf-life (Ramkrishna *et al*, 2001).

Thus, it may be concluded that in our studies, boric acid (B-0.02%) + sorbitol (2%) is the most effective treatment in improving fruit set, yield, fruit weight, TSS and total sugars, while, calcium nitrate (Ca-0.06%) + boric acid (B-0.02%) proved to be the most effective for increasing ascorbic acid content and shelf-life in mango cv. Himsagar.

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Table 1. Effect of calcium, boron and sorbitol on fruit-set, fruit weight and yield in mango cv. Himsagar

Treatment	Initial fruit-set(no./panicle)			Final fruit-set(no./panicle)			Average fruit weight (g)			Fruit yield (kg/tree)		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
T_1	49.31	46.83	48.07	1.58	1.55	1.57	208.17	216.67	212.42	38.40	30.33	34.43
T_2	51.89	49.89	50.89	1.85	1.82	1.83	228.67	234.83	231.75	42.73	35.22	39.03
T_3	49.91	47.69	48.79	1.69	1.67	1.68	216.67	221.67	219.17	39.45	32.57	36.05
T_4	50.33	49.46	49.89	1.73	1.70	1.72	221.50	227.43	224.47	40.90	33.89	37.45
T_5	49.67	47.04	48.35	1.63	1.60	1.61	232.00	236.67	234.33	42.68	35.11	38.93
T_6	52.83	50.33	51.58	1.91	1.90	1.90	231.00	235.00	233.00	43.54	36.03	39.82
T_7	49.16	46.52	47.84	1.55	1.52	1.54	202.33	203.33	202.83	36.01	28.23	32.13
SEm±0.08	0.05	0.07	0.005	0.006	0.005	1.07	0.88	0.65	0.21	0.16	0.11	
CD *(P=0.05)*	0.26	0.17	0.22	0.02	0.02	0.02	3.32	2.71	2.02	0.66	0.49	0.34

T_1: Calcium nitrate (Ca-0.06%); T_2: Boric acid (B-0.02%); T_3: Sorbitol (2%); T_4: Calcium nitrate (Ca-0.06%) + Boric acid (B-0.02%); T_5: Calcium nitrate (Ca-0.06%) + Sorbitol (2%); T_6: Boric acid (B-0.02%) + Sorbitol (2%); T_7: Control (water spray)

Table 2. Effect of calcium, boron and sorbitol on quality and shelf-life in mango cv. Himsagar fruits

Treatment	Total soluble solids (°Brix)			Titratable acidity (%)			Total sugars (%)			Ascorbic acid (mg/100g)			Shelf life (nos. of days)		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
T_1	19.17	17.20	18.18	0.14	0.16	0.15	14.33	14.04	14.19	28.03	23.27	25.65	7	7	7
T_2	19.40	17.68	18.54	0.14	0.12	0.13	15.40	14.13	14.77	27.80	23.40	25.60	5	5	5
T_3	18.80	17.40	18.10	0.16	0.18	0.17	15.20	13.79	14.50	27.53	22.80	25.17	6	6	6
T_4	17.60	16.40	17.00	0.18	0.22	0.20	14.57	12.90	13.74	30.17	26.60	28.39	9	9	9
T_5	18.30	16.80	17.55	0.17	0.20	0.19	15.20	13.55	14.38	28.53	24.57	26.55	7	7	7
T_6	20.10	18.20	19.15	0.10	0.12	0.11	16.10	14.50	15.30	27.63	22.60	25.12	7	7	7
T_7	16.90	16.10	16.50	0.20	0.24	0.22	14.03	12.69	13.36	25.27	20.90	23.09	5	5	5
SEm±0.14	0.14	0.08	0.01	0.008	0.009	0.12	0.11	0.07	0.45	0.36	0.22	0.21	0.17	0.14	
CD *(P=0.05)*	0.46	0.44	0.26	0.04	0.02	0.03	0.39	0.34	0.22	1.40	1.13	0.70	0.65	0.53	0.44

T_1: Calcium nitrate (Ca-0.06%), T_2: Boric acid (B-0.02%), T_3: Sorbitol (2%), T_4: Calcium nitrate (Ca-0.06%) + Boric acid (B-0.02%), T_5: Calcium nitrate (Ca-0.06%) + Sorbitol (2%), T_6: Boric acid (B-0.02%) + Sorbitol (2%), T_7: Control (water spray)

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