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FOLIAR APPLICATION OF POTASSIUM, CALCIUM, ZINC AND BORON ENHANCED YIELD, QUALITY AND SHELF LIFE OF MANGO

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ABSTRACT: Mango, the national fruit of India, has developed its own importance all over the world. Being a useful and delicious fruit, it is the part of culture and religion since long time, and now, it is recognized as one of the best fruits in the world market. Calcium and potassium amongst major nutrients as well as zinc, boron amongst micro nutrients have been found to play a major role in maintenance of mango fruit quality. Moreover, for rapid response and correction of deficiencies of mineral nutrients, foliar spray of nutrients especially Ca, B, Zn and K have been used singly or in combination. The experiment was conducted on mango cv. Dashehari at Horticulture Research Centre, Patharchatta, G.B. Pant Univesity of Agriculture and Technology, Pantnagar. The experiment involved the pre-harvest foliar spray of nutrients at 'marvel stage' of mango fruits. The treatments included $CaCl_2$@1.2%, Borax@0.5%, K_2SO_4 @ 0.5%, Ca $(NO_3)_2$@1.0%, $ZnSO_4$@0.5%, $ZnCl_2$@0.3% and control. The results obtained indicated that the trees sprayed with 0.5% borax showed maximum fruit yield, fruit weight, fruit volume, T.S.S., reducing sugar, non reducing sugar and ascorbic acid content, however, this treatment found to be at par with 1% $Ca(NO_3)_2$. While with regard to maintenance of post harvest fruit quality in mango, the minimum physiological loss in weight was reported in 1.0% $Ca(NO_3)_2$ followed by $CaCl_2$ (1.2%) up to the end of 12th day. Other quality parameters like fruit TSS, sugar and ascorbic acid content were best maintained by borax, calcium and potassium treatments.

Keywords: *Foliar application, Ca, B, Zn, K, mango, quality, shelf life.*

Mango is the national fruit of India and is the major fruit of Asia. It has developed its own importance all over the world. Being a useful and delicious fruit, it is the part of culture and religion since long time. From ancient time, it has been the favourite of the kings and commoners because of its nutritive value, taste, attractive fragrance and health promoting qualities and now, it is recognized as one of the best fruits in the world market. Calcium is an important nutrient, plays a crucial role in several physiological functions viz., fruit firmness retention, protecting the plant against salinity stress, callus friability and somatic embryogenesis. Romero *et al.* (18) found that the application of calcium as pre-harvest spray increased fruit quality of mango fruit. Singh *et al.* (22) reported that the Calcium nitrate at lower concentration i.e. 1.0% showed beneficial effects in prolonging the storage life of guava fruits. Boron also affects fruit maturity and quality. According to Chapman *et al.* (6), the fruits from the boron deficient papaya plants ripen unevenly and have low sugar content. Aly and Isamail (1) reported that boron as pre harvest spray has beneficial effect on quality of guava fruits. Moreover, for rapid response and correction of deficiencies of mineral nutrients, foliar feeding of nutrients especially Ca, B, Zn, and K, singly or in combination, is beneficial for accelerating development of growth characters, flowering, fruiting, quality and shelf life of fruits.

MATERIALS AND METHODS

The present investigation was carried out at Horticulture Research Centre, Patharchatta of G.B. Pant University of Agriculture and Technology, Pantnagar during 2008 (January to July). The pre-harvest foliar spray of nutrients on 6 years old trees of mango cv. Dashehari was done at marvel stage of fruits, planted at a distance of 10x10m. The experiment was consisted of eight treatments viz. T_1-1.2% $CaCl_2$, T_2-0.5% Borax, T_3-0.5% K_2SO_4, T_4 -1.0% $Ca(NO_3)_2$, T_5-0.5% $ZnSO_4$, T_6-0.3% $ZnCl_2$, and T_7-control with three replications in randomize block design. There was single tree per treatment

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per replication. The fruits were harvested at mature stage and five fruits were taken from each tree for recording data on physical and chemical attributes of fruits. Physiological loss in fruit weight (PLW) and chemical attributes were recorded at every 2 days interval up to the end of shelf life at ambient storage. The T.S.S. of fruit was recorded at room temperature using hand refractometer and it was expressed in °Brix and chemical quality attributes were determined as per standard procedure decribed in AOAC (2).

RESULTS AND DISCUSSION

Effect on fruit weight, fruit volume and fruit yield

The data presented in Table 1 revealed that significantly higher fruit weight (167.29 g) and fruit volume (164.52 ml) were observed with the treatment of 0.5% borax which was found statistically at par with treatment 1.0% $Ca(NO_3)_2$ (163.41g and 160.11ml) and 1.2% $CaCl_2$ (157.86g and 154.84 ml), while minimum (143.99 and 139.04 ml) was in control. Appreciable improvement in fruit weight by borax application has been also reported by Dutta *et al.* (8) in litchi and Dutta (7) in mango cv. Himsagar. The increase in fruit weight with the sprays of borax was might be due to the involvement in hormonal metabolism, increase in cell division and expension of cell. Boron is also known to stimulate rapid mobilization of water and sugar in the fruit.

The maximum fruit yield (28.52 kg/tree) was recorded with the treatment of 0.5% borax as compared to other treatments and minimum in control. Bhatia *et al.* (5) reported maximum fruit weight and consequently the yield of guava with the application of 1.0% H_3BO_3. Increase in fruit weight, fruit volume and fruit yield in mango cv. Dashehari as pre-harvest application of 0.5% borax was reported by Gaya (9). The significant increase in yield by boron application may be accredited to the positive effect of boron on increasing the rates of carbohydrate and RNA metabolism (Parr and Loughman, 16).

Effect on T.S.S., reducing sugar, non reducing sugar and ascorbic acid

A perusal of Table 2 showed that foliar sprays of nutrients had significant effect on TSS content of mango fruits for different treatments. Maximum T.S.S content (17.8 °B) was recorded in 0.5% borax, whereas, it was found minimum in control (14.65 °B). Similar results have also been obtained by Dutta (7) in guava and Gaya (9) in mango. The increase in T.S.S. up to certain period signified the period of active synthesis of carbohydrates in fruits, while declining trend in T.S.S followed thereafter, indicated the degradation and fermentation of sugars signaling the onset of senescence stage (Ryall and Pentzer, 19).

Data indicate the maximum reducing sugar content (6.42 per cent) in treatment with 0.5% borax which was found statistically at par with 0.5% $ZnSO_4$ (5.64 per cent) and 1.2% $CaCl_2$ (5.5 per cent), respectively (Table 3) and minimum in control (4.30 per cent). Similar results have been obtained by Gaya (9). Kahlon and Uppal (11) suggested that conversion of starches and polysaccharides into simple sugar with the advancement of storage was responsible for the increase of reducing sugar, and onward decline was due to the utilization of sugar in evapo-transpiration and other biochemical activities.

Non reducing sugar was reported to be maximum (9.29 per cent) in fruits treated with 0.5% borax which was found statistically at par with 1.2% $CaCl_2$ (8.86 per cent), 1.0% Ca $(NO_3)_2$ (8.73 per cent) and 0.5% $ZnSO_4$ (8.36 per cent) whereas, it was found to be minimum (6.58 per cent) in control (Table 4). These results elucidated the findings of Babu and Singh (3) and Dutta (7). It was observed that the proportion of reducing sugar content was less as compared to non reducing sugar both at ripe and at the end of shelf life supporting the findings of Sudhavani and Ravisankar (23).

It is revealed from the Table 5 that significantly maximum ascorbic acid content (34.05 mg/100g pulp) was recorded in 0.5% borax

Table 1: Effect of pre harvest foliar spray of nutrients on fruit yield and physical quality attributes of mango cv. Dashehari.

Treatment	Fruit weight (g)	Fruit volume (ml)	Fruit yield (Kg/Tree)
T_1 $CaCl_2$ (1.2%)	157.86	154.84	25.73
T_2 Borax (0.5%)	167.29	164.52	28.52
T_3 K_2SO_4 (0.5%)	149.74	144.03	23.86
T_4 $Ca(NO_3)_2$ (1.0%)	163.41	160.11	26.67
T_5 $ZnSO_4$ (0.5%)	154.72	149.06	24.22
T_6 $ZnCl_2$ (0.3%)	147.95	143.12	22.54
T_7 Control	143.99	139.04	20.95
C.D. (P = 0.05)	11.73	12.32	1.06

Table 2: Effect of pre harvest foliar spray of nutrients on PLW of mango cv. Dashehari at ambient storage.

Treatments		Initial fruit weight (g)	Physiological loss in weight (%) at different storage period (days)						
			3 days	4 days	6 days	8 days	10 days	12 days	Mean
T_1	$CaCl_2$ (1.2%)	160.44	5.67	9.26	11.73	18.42	25.59	30.33	16.83
T_2	Borax (0.5%)	183.96	5.92	10.27	14.22	22.12	27.48	34.62	19.11
T_3	K_2SO_4 (0.5%)	154.05	6.32	8.76	12.65	17.87	26.28	32.75	17.44
T_4	$Ca(NO_3)_2$ (1.0%)	175.39.	5.40	8.60	11.61	17.36	25.12	30.22	16.39
T_5	$ZnSO_4$ (0.5%)	146.98	6.42	10.41	14.51	20.17	26.73	33.46	18.62
T_6	$ZnCl_2$ (0.3%)	138.08	6.77	10.71	14.77	19.30	27.84	33.87	18.88
T_7	Control	125.14	7.50	11.77	15.23	22.81	28.43	36.36	20.35
Mean		—	6.29	9.97	13.53	19.72	26.78	33.09	
		Storage days			Treatment		Storage days x Treatment		
C.D. (P=0.05)		0.79			0.85		NS		

Table 3: Effect of pre harvest foliar spray of nutrients on TSS (°Brix) of mango cv. Dashehari at ambient temperature.

Treatments		Storage period						
		0 day	2 days	4 days	6 days	8 days	10 days	Mean
T_1	$CaCl_2$ (1.2%)	9.53	12.67	17.60	20.27	19.23	18.67	16.32
T_2	Borax (0.5%)	11.40	15.40	18.73	21.67	20.03	19.57	17.80
T_3	K_2SO_4 (0.5%)	9.33	12.40	15.70	18.60	17.50	16.67	15.03
T_4	$Ca(NO_3)_2$ (1.0%)	10.20	13.80	16.53	19.87	18.27	17.80	16.07
T_5	$ZnSO_4$ (0.5%)	8.40	14.04	18.23	20.03	19.80	18.00	16.47
T_6	$ZnCl_2$ (0.3%)	8.16	13.57	17.30	19.30	18.17	17.40	15.65
T_7	Control	7.47	12.00	16.30	18.17	17.40	16.56	14.65
Mean		9.21	13.46	17.20	19.70	18.62	17.80	
		Storage days		Treatment		Storage days x Treatment		
C.D.(P=0.05)		1.07		1.15		NS		

Table 4: Effect of pre harvest foliar spray of nutrients on reducing sugar (%) of mango cv. Dashehari at ambient storage.

Treatments		Storage period						
		0 day	**2 days**	**4 days**	**6 days**	**8 days**	**10 days**	**Mean**
T_1	$CaCl_2$ (1.2%)	2.19	3.34	6.30	7.54	7.12	6.92	5.57
T_2	Borax (0.5%)	2.97	5.82	7.25	7.78	7.55	7.15	6.42
T_3	K_2SO_4 (0.5%)	2.06	4.09	4.84	6.64	6.31	6.19	5.02
T_4	$Ca(NO_3)_2$ (1.0%)	2.17	4.46	5.49	7.23	6.37	6.28	5.33
T_5	$ZnSO_4$ (0.5%)	1.59	5.55	6.62	6.83	6.65	6.57	5.64
T_6	$ZnCl_2$ (0.3%)	1.73	4.83	7.13	6.30	5.86	5.47	5.22
T_7	Control	1.54	3.38	4.16	5.80	5.77	5.12	4.30
Mean		2.04	4.50	5.97	6.87	6.52	6.24	
C.D.(P=0.05)		Storage days 0.99		Treatment 1.07		Storage days Treatment NS		

Table 5: Effect of pre harvest foliar spray of nutrients on non reducing sugar (%) of mango cv. Dashehari at ambient storage.

Treatments		Storage period						
		0 day	**2 days**	**4 days**	**6 days**	**8 days**	**10 days**	**Mean**
T_1	$CaCl_2$ (1.2%)	5.30	7.45	9.10	10.98	10.46	9.85	8.86
T_2	Borax (0.5%)	5.38	7.85	9.33	11.86	10.91	10.42	9.29
T_3	K_2SO_4 (0.5%)	4.26	5.65	7.87	9.74	9.48	8.94	7.66
T_4	$Ca(NO_3)_2$ (1.0%)	4.46	6.94	8.73	11.13	10.78	10.32	8.73
T_5	$ZnSO_4$ (0.5%)	4.30	6.67	8.55	10.74	10.13	9.78	8.36
T_6	$ZnCl_2$ (0.3%)	3.75	5.33	7.58	10.50	9.87	8.14	7.53
T_7	Control	3.10	5.24	6.56	8.84	8.31	7.40	6.58
Mean		4.36	6.45	8.25	10.54	9.99	9.26	
C.D. (P=0.05)		Storage days 0.92		Treatment 1.00		Storage days x Treatment NS		

Table 6: Effect of pre harvest foliar spray of nutrients on ascorbic acid (mg/100 g pulp) of mango cv. Dashehari at ambient storage.

Treatments		Storage period						
		0 day	**2 days**	**4 days**	**6 days**	**8 days**	**10 days**	**Mean**
T_1	$CaCl_2$ (1.2%)	44.62	39.09	34.24	26.50	22.79	18.63	30.98
T_2	Borax (0.5%)	47.62	42.22	37.46	31.26	25.53	20.19	34.05
T_3	K_2SO_4 (0.5%)	43.73	37.58	33.69	25.62	20.46	18.36	29.91
T_4	$Ca(NO_3)_2$ (1.0%)	45.49	42.31	35.37	29.53	24.39	19.73	32.80
T_5	$ZnSO_4$ (0.5%)	43.21	36.68	32.65	24.77	20.68	18.24	29.37
T_6	$ZnCl_2$ (0.3%)	42.31	34.56	31.51	23.30	19.18	17.38	28.04
T_7	Control	40.78	32.77	30.23	21.49	18.13	16.75	26.69
Mean		43.97	37.09	33.59	26.07	21.59	18.47	
C.D.(P=0.05)		Storage days 1.37		Treatment 1.489		Storage days x Treatment NS		

which was found statistically at par with 1.0% $Ca(NO_3)_2$ (32.80 mg/100g pulp), whereas it was found to be minimum (26.69 mg/100g pulp) in control. Higher level of ascorbic acid by application of boron was due to higher content of ascorbic acid as synthesized from sugar. Almost similar results were also reported by Kar *et al.* (2) in pineapple. Losses in ascorbic acid content of fruits were directly proportional to the length of storage period. Mapson (14) suggested that loss in ascorbic acid on prolonged storage is attributed to the rapid conversion of L-ascorbic acid into dehydro-ascorbic acid in presence of ascorbinase enzyme.

Effect on physiological loss in weight

The data presented in Table 6 clearly revealed that minimum loss in weight (16.39 per cent) was recorded in treatment with 1.0% $Ca(NO_3)_2$ which was statistically at par with 1.2% $CaCl_2$ (16.83 per cent PLW), while the maximum loss in weight (20.35 per cent) was reported in control. Similar results have also been obtained by Roychaudhary *et al.* (17) in guava, Saha *et al.* (20) in litchi and Gaya (9) in mango cv. Dashehari. The increase in evapo-transpiration changes with progress of storage period might be responsible for high PLW of fruits as reported by Khader *et al.* (13). The decrease in weight loss by the application of calcium may be due to its role in the maintenance of fruit firmness, retardation of respiratory rates as well as transpiration and delayed senescence (Bangirth *et al.,* 4; Jones *et al.,* 10; Mika, 15; Singh *et al.,* 21).

The pre-harvest foliar spray of nutrients at marvel stage of fruits found to be effective for increase in yield, quality and shelf life of mango cv. Dashehari. However, spray of borax @ 0.5% was effective for yield and quality, while $Ca(NO_3)_2$ @ 1.0% was effective for shelf life of shelf life of mango fruits.

REFERENCES

1. Aly, E.Z. and Isamail, H.A. (2000). Effect of preharvest GA_3, $CaCl_2$ and boron treatments on quality and enzymatic browning in Balady guava fruits. *Ann. Agric. Sci.,* **38** (2): 1101-1108.
2. A.O.A.C. (1980). *Official Methods of Analysis*. Association of Official Analytical Chemist, Benjaminn Franklin Station, Washington, D.C.
3. Babu, N. and Singh, A.R. (2001). Effect of foliar application of boron, zinc and copper on chemical characteristics of litchi (*Litchi chinensis* Sonn.) fruits. *Bioved.,* **12** (1-2): 45-48.
4. Bangirth, P., Dilley, D.R. and Dewey, D.H. (1972). Effect of post harvest calcium treatment on internal break down and respiration of apple fruits. *J. Amer. Soc. Hort. Sci.,* **97:** 679-682.
5. Bhatia, S.K., Yadav, S., Ahlawat, V.P. and Dahiya, S.S. (2001). Effect of foliar application of nutrients on the yield and fruit quality of winter season guava cv. L-49. *Haryana J. Hortic. Sci.,* **30** (1/2): 6-7.
6. Chapman, H.D., Glennil, J.D., Aquilizan, F.A. and Paxton, B.F. (1978). Boron deficiency in papayas. *Quansland Agr. J.* **104**: 31-34.
7. Dutta P. (2004). Effect of foliar application on panicle growth, fruit retention and physico-chemical characters of mango cv. Himsagar. *Indian J. Hort.,* **61**(30): 265-266.
8. Dutta, P., Banik, A. and Dhua, R.S. (2000). Effect of different concentrations of boron on fruit set, fruit retention and fruit quality of litchi cv. Bombai. *Indian Hort.,* **57** (4): 287-290.
9. Gaya (2008). Effect of pre harvest foliar spray of nutrients on fruit quality and shelf life of mango cv. Dashehari. *M.Sc. Thesis,* G.B. Pant Univ. of Agric. & Tech., Pantnagar.
10. Jones, R., Wyn, G. and Lunt, O.R. (1970). The function of calcium in plant. *Bot. Review,* **36**: 407-423.
11. Kahlon, P.S. and Uppal, R.S. (2005). Effect of post harvest treatments on shelf life of mango cv. Chausa. *Haryana J. Hortic. Sci.,* **34**(1-2) : 51-53.

12. Kar, P.L., Sema, A., Maiti, C.S. and Singh, A.K. (2002). Effect of zinc and boron on fruit and quality traits in pineapple (*Annanas comosum* L.). *South Indian Hort.,* **50**(1-3): 44-49.
13. Khader, S.E.S.A., Singh, B.P. and Khan, S.A. (1988). Effect of GA_3 as post harvest treatment of mango fruits on ripening, amylase and peroxidase activity during storage, *Scientia Hort.,* **36:** 261-266.
14. Mapson, L.W. (1970). Vitamins in fruits. Stability of L-ascorbic acid. (In) *Biochemistry of fruits and their products,* Vol. 1, pp. 376-377 HUME, A.C. (Ed). Acad. Press, London.
15. Mika, A. (1983). Studies on calcium penetration in to apple fruits after post harvest treatment with calcium chloride. *Acta Hort.,* **138:** 15-21.
16. Parr, A.J. and Loughman, B.C. (1983). Boron and membrane functions in plants. In 'Metals' and micronutrients: uptake and utilization by plants *Annu. Proc. Phytochem. Soc. Eur. No.* **21**; D.A. Roff and W.S. pierpoint, eds. Academic Press, London. pp. 87-107.
17. Roychaudhary, R., Kabier, J., Dutta, P. and Dhua, R.S. (1992). Effect of calcium on fruit quality of guava. *Indian J. Hort.* **49**(1): 27-30.
18. Romero, N.R., Saucedo, C., Garcia, P.; Alcazar, J.; Hernandez, V.M. and Sanudo, R. (2006). Foliar application of calcium: Physiology and fruit quality of Haden mango. *Terra,* **24** (4): 521-527.
19. Ryall, A.L. and Pentzer, W.T. (1974). *Handling and transportation and storage of fruits and vegetables.* The AVI Publishing Company, Inc., Westport, Connecticut.
20. Saha, D.P., Sharma, R.K. and Maurya, K.R. (1998). Influence of pre harvest spray of calcium salts on chemical composition of litchi (*Litchi chinensis*) fruits during storage. *J. Applied Biol.,* **8** (1): 62-66.
21. Singh, B.P., Gupta, O.P. and Chauhan, K.S. (1982). Effect of pre harvest spray of calcium nitrate on the storage life of peach. *Indian J. Agri. Sci.,* **52**(4): 235-239.
22. Singh, R., Chaturvedi, O.P., Gaur, G.S. and Singh, G. (2007). Effect of pre harvest spray of zinc, calcium and boron on the storage behavior of guava fruits cv. Allahabad safeda. *Acta Hort.,* **735:** 633-638.
23. Sudhavani, V. and Ravishanker, C. (2002). Effect of pre harvest spray on the shelf life and quality of mango fruits under cold storage. *South Indian Hort.,* **50** (1-3): 173-177.