AJH
eISSN- 0976-724X

THE ASIAN JOURNAL OF HORTICULTURE
Volume **10** | Issue 2 | December, 2015 | 246-250
Visit us -*www.researchjournal.co.in*

RESEARCH PAPER

DOI : 10.15740/HAS/TAJH/10.2/246-250

Article history :
Received : 15.10.2015
Revised : 02.11.2015
Accepted : 16.11.2015

Effect of pre-harvest foliar spray of nutrients and plant bio-regulators on shelf-life and quality of fruit of mango cv. DASHEHARI

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ABSTRACT : The present investigation was carried out in the orchard situated in District Saharanpur (U.P.) during the years 2010 and 2011 with an aim to improve the quality and shelf life of mango. The treatments were comprised of mulching, borax @ 0.5 and 1.0 per cent, potassium sulphate @ 0.5 and 1.0 per cent, calcium chloride @ 0.5 and 1.0 per cent, calcium nitrate @ 0.5 and 1.0 per cent, GA_3 @ 25ppm and 50 ppm, NAA @ 25ppm and 50 ppm in combination with mulching and water spray without mulching as control. The spray is to be done three times at different times at different stages during the year 2010 and 2011 which is given below-Ist spray on 15th January (*i.e.* before flower bud burst), IInd spray on 15th February (*i.e.* at panicle emergence) and IIIrd spray on 15th April (*i.e.* after fruit set). It may be concluded from the present studies that the application of $CaNO_3$ improves flowering parameters, increases the number of fruits and fruit yield and K_2SO_4 increase the physical characters of fruit.

KEY WORDS : Pre-harvest foliar spray, Nutrients, Bio-regulators, Mango

HOW TO CITE THIS ARTICLE : Chauhan, P., Singh, J.P., Kaushik, Himanshu, Singh, R.K. and Rajbeer (2015). Effect of pre-harvest foliar spray of nutrients and plant bio-regulators on shelf-life and quality of fruit of mango cv. DASHEHARI. *Asian J. Hort.*, **10**(2) : 246-250.

Mango is the choicest fruit among Indian table fruits having the premier place in the country. It is known for its versatility as all stages of fruit development is suitable for processing. The immature and unripe fruits can be processed into pickles, while the ripened fruits can be prepared as slices in syrup or in brine, mango juice concentrate and puree, jam, chutneys, pulp, fruit bar, mango wafer, mango powder and dehydrated mango slices. It is an overall source of nutrition, having rich, luscious and aromatic flavour with good amount of dietary fibre and carbohydrates. It contains no cholesterol or saturated fat, but, contains only about 0.6 g of total fat in a medium sized fruit. It is a rich source of vitamin A, also contains vitamin C, B_2, B_6 and E, minerals like potassium, calcium and phosphorus, low content of sodium and magnesium and traces of iron. Mango also has medicinal properties. Almost all the parts of the plant *viz.*, fruits, leaves, twigs and bark were used as medicine in one way or the other. Tender mango leaves are a good source of ascorbic acid which promotes digestion. The juice of fresh leaves is used to control chronic dysentery. The bark is used to relieve toothache, diarrhea, dysentery and piles. The ripe fruit is very good in nervous dyspepsia. The pulp is useful against hemorrhage problem. Unripe mangoes are also used in treating stomach problems and to stimulate bile formation and in treatment of blood related diseases. The ever increasing cost of chemical fertilizers and decline in soil

health due to excessive dependence on chemical inputs left us with other option of utilizing optimum doses of micro nutrients along with bio-regulators may reduce dependency on heavily used NPK fertilizers and increase the quality and shelf-life of mango fruit. The another option for decreasing the use of NPK fertilizers is change in the application method of nutrients so in this response foliar spray of fertilizers is the best option for judicious use of fertilizers. A very little information is available on nutrition of mango so far, particularly response of fertilizers and bio-regulators on quality and shelf-life is concern. Keeping these points in mind, the present investigation was, therefore, undertaken to study the response of pre-harvest foliar spray of nutrients and plant bio-regulators on shelf-life and quality of fruit of mango cv. DASHEHARI.

RESEARCH METHODS

The present investigation was carried out in the orchard situated in District Saharanpur (U.P.) during the years 2010 and 2011 with an aim to improve the quality and shelf life of mango. The experiment was conducted on 7 year old mango trees of cv. DASHEHARI. All the trees selected for experiments were almost uniform in growth and vigour. The experiment was laid out in Randomized Block Design with fourteen treatments and three replications. The treatments were comprised of mulching, borax @ 0.5 and 1.0 per cent, potassium sulphate @ 0.5 and 1.0 per cent, calcium chloride @ 0.5 and 1.0 per cent, calcium nitrate @ 0.5 and 1.0 per cent, GA_3 @ 25ppm and 50 ppm, NAA @ 25ppm and 50 ppm in combination with mulching and water spray without mulching as control. The spray was done three times at different stages during the year 2009 and 2010. Ist spray on 15th January (*i.e.* before flower bud burst), IInd spray on 15th February (*i.e.* at panicle emergence) and IIIrd spray on 15th April (*i.e.* after fruit set). The data were recorded for TSS, titrable acidity, ascorbic acid, TSS: acid ratio, total sugars reducing sugars and non-reducing sugars, fruit weight loss and fruit marketability. The data were subjected to the analysis of variance.

RESEARCH FINDINGS AND DISCUSSION

It has been found in present study that the data recorded on TSS of fruits at the harvest indicated that there was minimum TSS in control treatment, whereas, maximum TSS of fruits was observed with application of Borax @ 1.0 per cent + mulching which was followed by treatment T_3. While, at the end of storage period, maximum TSS of fruits were observed with application of Borax @ 1.0 per cent + mulching followed by treatment T_3. Similar results was also obtained by Jayachandran *et al*. (2005). The increase in TSS during storage period might be due to conversion of complex polymers into simple substances. An increase in T.S.S during storage of mango has been also reported by Deol (1985).

Data in Table 1 revealed on titrable acidity showed that control fruits gave minimum titrable acidity at the time of harvest and (0.28% and 0.29%) at the end of storage period during the first and second year. Although, at the time of harvest maximum titrable acidity was observed in treatment having NAA @ 25 ppm + mulching during both the years, respectively but at the end of storage period maximum titrable acidity was noticed in the treatment having $CaNO_3$ @ 0.5 per cent + mulching during both the years, respectively. Mishra *et al*. (2000) also reported that the pre harvest application of $CaNO_3$ had non-significant effect on acidity of guava fruit. There was a decrease in acid content during the storage period. This may be due to utilization of organic acids in respiration. The reduction in acidity level was probably due to more accumulation of sugar in fruits.

At the harvest, minimum TSS: acid ratio was observed with the treatment having NAA @ 25 ppm + mulching and $CaNO_3$ @ 1.0 per cent + mulching during first and second year while, maximum TSS: acid ratio was recorded with treatment having Borax @ 1 per cent + mulching during both the years. Although, at the end of storage, maximum TSS: acid ratio was observed in treatment having NAA @ 50 ppm + mulching and K_2SO_4 @ 0.5 per cent + mulching during first and second year, respectively while, minimum TSS: acid ratio was noticed in the treatment having $CaCl_2$ @ 0.5 per cent + mulching and GA_3 @ 25 ppm + mulching during first and second year.

A perusal of the data showed that the response of plant nutrients and plant growth regulators during both the years significantly increased the levels of ascorbic acid in the fruits. At the harvest, the treatment with Borax @ 0.5 per cent + mulching recorded maximum ascorbic acid content during both the years while, minimum ascorbic acid content was recorded in the control treatment during both the years. At the end of storage, the treatment with Borax @ 0.5 per cent + mulching recorded maximum ascorbic acid content during both the years while, minimum ascorbic acid content was

recorded in the control treatment during both the years. These chemicals probably retarded oxidation process and hence the rate of conversion of L-ascorbic acid slowed down. Higher level of ascorbic acid by the application of boron was due to higher sugar content as ascorbic acid is synthesized from sugar. Almost similar results were reported by Wahid *et al*. (1991) in guava.

Data in Table 2 indicate that the treatments during both the years increased the total sugars, reducing sugar and non- reducing sugar content of the fruits. Data showed that maximum total sugars, reducing sugar and non- reducing sugar were recorded with treatment having Borax @ 0.5 per cent + mulching and $CaCl_2$ @ 0.5 per cent + mulching during first and second year while, minimum total sugars, reducing sugar and non- reducing sugar was observed in control during both the years at

Table 1: Influence of pre-harvest foliar spray of nutrients and plant bio-regulators on TSS and acidity of fruit of mango cv. DASHEHARI

Treatments	Total soluble solids (^{0}B)				Titrable acidity				T.S.S : Acid ratio			
	At harvest		At end of storage period		At harvest		At end of storage period		At harvest		At end of storage period	
	I yr	II yr	I yr	II yr	I yr	II yr	I yr	II yr	I yr	II yr	I yr	II yr
T_1- Mulching (Organic)	15.55	15.59	20.44	20.47	0.49	0.51	0.29	0.31	31.73	30.56	70.48	66.03
T_2- Borax (0.5%)+ Mulching	16.44	16.45	21.14	21.25	0.53	0.52	0.32	0.33	31.01	31.63	66.06	64.39
T_3- Borax (1.0%)+ Mulching	16.32	16.34	21.02	21.11	0.50	0.51	0.30	0.31	32.64	32.04	70.07	68.09
T_4- K_2SO_4 (0.5%)+ Mulching	15.97	16.01	20.52	20.63	0.50	0.50	0.29	0.30	31.94	32.02	70.76	68.77
T_5- K_2SO_4 (1.0%)+ Mulching	15.17	15.21	20.39	20.46	0.52	0.53	0.29	0.31	29.17	28.70	70.31	66.00
T_6- $CaCl_2$ (0.5%)+ Mulching	14.79	14.85	20.29	20.35	0.48	0.50	0.35	0.34	30.81	29.70	57.97	59.85
T_7- $CaCl_2$ (1.0%)+ Mulching	15.62	15.66	20.22	20.27	0.52	0.53	0.33	0.32	30.04	29.55	61.27	63.34
T_8- $CaNO_3$ (0.5%)+ Mulching	16.19	16.26	20.59	20.62	0.52	0.54	0.35	0.35	31.13	30.11	58.83	58.91
T_9- $CaNO_3$ (1.0%)+ Mulching	15.59	15.62	20.04	20.04	0.56	0.56	0.28	0.30	27.84	27.89	71.58	66.80
T_{10}- GA_3 (25ppm) + Mulching	15.89	15.95	19.94	19.99	0.57	0.53	0.33	0.34	27.88	30.09	60.42	58.79
T_{11}- GA_3 (50ppm) + Mulching	16.07	16.04	20.18	20.23	0.56	0.52	0.30	0.32	28.68	30.85	67.27	63.22
T_{12}- NAA (25ppm) + Mulching	15.77	15.75	19.99	20.07	0.57	0.54	0.29	0.30	27.67	29.17	68.93	66.90
T_{13}- NAA (50ppm) + Mulching	15.47	15.52	20.19	20.24	0.49	0.53	0.28	0.31	31.57	29.28	72.11	65.29
T_{14}- Control (Water spray without mulching)	15.04	15.01	19.77	19.81	0.50	0.51	0.28	0.29	30.08	29.43	70.61	68.31
C.D. (P=0.05)	0.87	0.82	0.98	0.99	0.14	0.10	0.08	0.04	0.31	0.24	0.34	0.37

Table 2 : Influence of pre-harvest foliar spray of nutrients and plant bio-regulators on sugars of fruit of mango cv. DASHEHARI

Treatments	Total sugar				Reducing sugar				Non-reducing sugar			
	At harvest		At end of storage period		At harvest		At end of storage period		At harvest		At end of storage period	
	I yr	II yr	I yr	II yr	I yr	II yr	I yr	II yr	I yr	II yr	I yr	II yr
T_1- Mulching (Organic)	8.81	8.48	17.41	17.45	2.36	2.41	4.67	4.77	5.62	5.71	12.58	12.65
T_2- Borax (0.5%)+ Mulching	9.98	9.81	18.89	18.98	2.85	2.91	5.68	5.76	7.15	7.16	13.87	13.94
T_3- Borax (1.0%)+ Mulching	9.92	9.74	18.21	18.27	2.54	2.52	4.99	5.06	7.09	7.12	13.84	13.86
T_4- K_2SO_4 (0.5%)+ Mulching	9.61	9.48	17.75	17.86	2.58	2.61	5.16	5.19	6.64	6.71	13.19	13.25
T_5- K_2SO_4 (1.0%)+ Mulching	9.43	9.36	17.93	17.95	2.53	2.56	5.06	5.09	6.71	6.74	13.92	13.97
T_6- $CaCl_2$ (0.5%)+ Mulching	9.92	9.86	18.33	18.42	2.77	2.83	5.55	5.6	6.81	6.91	13.49	13.56
T_7- $CaCl_2$ (1.0%)+ Mulching	9.56	9.51	17.92	18.01	2.59	2.65	5.19	5.24	6.65	6.69	13.76	13.82
T_8- $CaNO_3$ (0.5%)+ Mulching	9.74	9.73	18.49	18.55	2.82	2.87	5.66	5.69	6.76	6.78	13.63	13.67
T_9- $CaNO_3$ (1.0%)+ Mulching	9.36	9.33	17.67	17.71	2.55	2.63	5.14	5.18	6.55	6.59	13.02	13.18
T_{10}- GA_3 (25ppm) + Mulching	9.42	9.38	17.32	17.36	2.45	2.53	4.98	4.98	6.74	6.79	12.87	12.94
T_{11}- GA_3 (50ppm) + Mulching	9.22	9.18	17.41	17.51	2.39	2.45	4.81	4.84	6.07	6.11	12.78	12.81
T_{12}- NAA (25ppm) + Mulching	9.08	9.01	17.72	17.78	2.34	2.38	4.69	4.72	6.17	6.21	13.59	13.66
T_{13}- NAA (50ppm) + Mulching	8.60	8.54	17.36	17.46	2.26	2.29	4.52	4.55	5.38	5.41	13.21	13.31
T_{14}- Control (Water spray without mulching)	8.00	8.06	16.68	16.71	2.24	2.26	4.43	4.50	5.31	5.38	12.71	12.77
C.D. (P=0.05)	0.025	0.023	0.039	0.031	0.45	0.80	0.82	0.65	0.25	0.24	0.26	0.27

the harvest. Although at the end of storage, maximum total sugars, reducing sugar and non- reducing sugar were recorded with treatment having Borax @ 0.5 per cent + mulching during both the year while, minimum total sugars, reducing sugar and non- reducing sugar was observed in control during both the years. These results elucidated the findings of Dutta (2004). The increase in sugar may be due to break down of complex polymers in to simple substances by hydrolytic enzymes. Boron facilitated sugar transport within the plant and it was also reported that borate react with sugar to form a sugar-borate complex (Gauch and Dugger, 1953).

It is obvious from data presented in Table 3 that fruits in all treatments showed 100 per cent marketability up to six days of storage at room temperature. On 8th days of storage the maximum percentage of marketable fruit was found in treatment of GA_3 @ 50 ppm + mulching followed by GA_3 @ 25 ppm + mulching as compared to control. The percentage of marketable fruit on 10th days of storage was maximum in treatment of GA_3 @ 50 ppm + mulching followed by GA_3 @ 25 ppm + mulching and minimum in control. It was also observed that on 12th days of storage, treatment of GA_3 @ 50 ppm in combination with mulching showed maximum percentage of marketable fruits followed by GA_3 @ 25 ppm + mulching and NAA @ 50 ppm + mulching whereas minimum in untreated control. Finally it was observed that treatment of GA_3 @ 50 ppm + mulching was most effective in maintaining the fruit marketability throughout storage period followed by the treatment of GA_3 @ 25 ppm along with mulching during first year. The results showed more or less same trends during second year also.

The increase in fruit marketability might be due decrease in production of ethylene which is responsible for the fast ripening of fruits improved fruit colour development and appearance (Cheour *et al.*, 1990). Almost similar results were obtained by the Khader, (1991) in Dashehari mango. Tirmazi and Wills (1981) have also observed longer shelf-life in mangoes from the post harvest application of growth regulators.

During the first and second year, minimum fruit weight loss after 12 days of storage was noticed in treatment having GA_3 @ 50 ppm + mulching and this trend was same after 6, 8 and 10 days of storage followed by treatment having GA_3 @ 25 ppm + mulching. The maximum weight loss was observed with treatment T_{14} *i.e.* control after 12 days of storage during both the years and this trend was also same after 6, 8 and 10 days of storage. Thus, a general trend has been observed between the concentrations of the chemicals used and the reduction in weight loss of fruit during storage, and it was observed that same chemical at one concentration was having same effects at different period of storage.

Table 3 : Influence of pre-harvest foliar spray of nutrients and plant bio-regulators on shelf-life and ascorbic acid of fruit of mango cv. DASHEHARI

Treatments	Per cent marketable fruit at different storage period (Days)				Physiological loss in weight (PLW) (%) after 12 days of harvesting		Ascorbic acid (mg/100g)			
	Up to 6 days	Up to 8 days	Up to 10 days	Up to 12 days			At harvest		At end of storage period	
	-	-	-	-	I yr	II yr	I yr	II yr	I yr	II yr
T_1- Mulching (Organic)	100	79.17	62.49	43.33	26.44	25.53	30.78	30.62	16.72	16.63
T_2- Borax (0.5%)+ Mulching	100	78.71	72.91	57.30	21.88	18.77	35.92	35.88	18.96	18.86
T_3- Borax (1.0%)+ Mulching	100	86.39	76.38	55.00	19.12	18.12	35.17	35.09	17.53	17.46
T_4- K_2SO_4 (0.5%)+ Mulching	100	83.09	72.91	56.57	18.48	18.54	32.97	32.89	17.61	17.54
T_5- K_2SO_4 (1.0%)+ Mulching	100	85.19	74.99	57.00	18.90	17.17	35.48	35.34	18.21	18.11
T_6- $CaCl_2$ (0.5%)+ Mulching	100	79.14	66.66	50.28	20.93	20.65	32.28	32.17	18.23	18.09
T_7- $CaCl_2$ (1.0%)+ Mulching	100	79.31	68.74	55.40	21.09	20.70	33.46	33.38	18.01	17.92
T_8- $CaNO_3$ (0.5%)+ Mulching	100	85.12	66.66	50.45	19.75	19.80	34.08	33.98	18.98	18.87
T_9- $CaNO_3$ (1.0%)+ Mulching	100	82.23	54.16	47.00	21.67	18.56	33.11	33.01	18.06	17.96
T_{10}- GA_3 (25ppm) + Mulching	100	90.56	79.16	61.66	15.57	14.22	35.35	35.29	17.67	17.56
T_{11}- GA_3 (50ppm) + Mulching	100	90.64	79.17	64.40	14.75	11.22	34.15	34.12	17.54	17.43
T_{12}- NAA (25ppm) + Mulching	100	81.00	73.19	58.41	18.10	16.80	33.99	33.91	17.75	17.69
T_{13}- NAA (50ppm) + Mulching	100	83.68	75.91	61.42	18.10	14.80	33.46	33.32	17.72	17.63
T_{14}- Control (Water spray without mulching)	100	71.94	54.16	39.90	31.82	31.66	29.98	29.89	16.23	16.18
C.D. (P=0.05)	-	6.73	13.65	15.79	-	-	3.12	1.06	1.41	1.09

The decrease in weight loss by the application of GA_3 and NAA may be due to its role in the maintenance of fruit firmness, retardation of respiratory rates and delayed senescence (Mika, 1983). Similar results have been obtained by Raychaudhary *et al.* (1992) in guava.

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