International Journal of Agricultural Sciences
Volume 14 | Issue 1 | January, 2018 | 92-96 ■ e ISSN-0976-5670
DOI:10.15740/HAS/IJAS/14.1/92-96
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RESEARCH PAPER

Effect of preharvest application of different chemicals and plant growth regulators on biochemical parameters of mango (*Mangifera indica* L.) var. Amrapali

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Abstract : The present investigation on effect of preharvest application of different chemicals and plant growth regulators on biochemical parameters of mango (*Mangifera indica* L.) var. Amrapali was carried out during summer season of the year 2016 at Anand. The plants of mango were preharvest sprayed with $CaCl_2$ 1 %, $CaCl_2$ 2 %, $Ca(NO_3)_2$ 1 %, $Ca(NO_3)_2$ 2 %, KNO_3 1 %, KNO_3 2 %, GA_3 25 mg/l, GA_3 50 mg/l, ethrel 0.1 ml/l and ethrel 0.2 ml/l. There were eleven treatment embedded in Completely Randomized Design replicated thrice. Thirty three uniform size tree of mango were selected. Fresh and mature fruits were harvested from trees which was preharvest sprayed with different chemicals and plant growth regulators and stored under ambient storage condition. Among all the treatment $CaCl_2$ 2 % recorded significantly highest total soluble solids, reducing sugar, total sugar, non-reducing sugar, ascorbic acid and minimum acidity consistently at harvest and every three days interval upto last ripening stage *i.e.* 4^{th} day, 8^{th} day, 12^{th} day and 16^{th} day under ambient storage condition.

Key Words : $CaCl_2$, GA_3, Fruit quality

View Point Article : Vishwakarma, Pradeep Kumar and Masu, M.M. (2018). Effect of preharvest application of different chemicals and plant growth regulators on biochemical parameters of mango (*Mangifera indica* L.) var. Amrapali. *Internat. J. agric. Sci.,* **14** (1) : 92-96, **DOI: 10.15740/HAS/IJAS/14.1/92-96.**

Article History : Received : 26.06.2017**; Revised :** 12.11.2017**; Accepted :** 25.11.2017

INTRODUCTION

Mango (*Mangifera indica* L.) is a premier fruit crop of India. 'Indian mango' is the only mango tree commonly cultivated in many tropical and subtropical regions (Bose *et al.,* 2001). Fruit quality at harvest depends on the combined net effect of energy, water and flow into and out of the fruit. The same principles apply to post harvest quality changes, since continued respiration and transpiration constitute net losses of energy and water from the harvested fruit that result in quality loss. This quality should be increased by various chemicals and plant growth regulators applied at certain period before harvesting of fruits for proper maintaining the balance of nutrient in the fruit so that fruit quality and shelf-life should be maintained for longer duration after harvest (Shewfelt and Prussia, 2009). Among various chemicals and plant growth regulators, calcium is known to be essential plant nutrient involved in a number

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of physiological processes concerning membrane structure, function and enzyme activity (Jones and Lunt, 1967). Calcium has received considerable attention in recent year due to its desirable effect in delaying ripening and senescence, increasing firmness, vitamin C and phenolic content, reduce respiration, extending storage life and reducing the incidence of physiological disorder and storage rots. Calcium chloride treatment to fruits protects against post-harvest deterioration by binding with hydrolysis such as galacturonase and promotes shelf life. Calcium is essential for structural integrity of both the cell wall and plasma membranes. Calcium treatments have known to delay softening and improve the fruit quality.

MATERIAL AND METHODS

The experiment was conducted on effect of preharvest application of different chemicals and plant growth regulators on biochemical parameters of mango (*Mangifera indica* L.) var. Amrapali was carried out at Horticultural Research Farm and P. G. Laboratory, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand during summer season of the year 2016. There were eleven treatments embedded in Completely Randomized Design replicated thrice. Thirty three uniform size tree of mango var. Amrapali were selected and preharvest sprayed with different chemicals ($CaCl_2$ 1 %, $CaCl_2$ 2 %, $Ca(NO_3)_2$ 1 %, $Ca(NO_3)_2$ 2 %, KNO_3 1 % and KNO_3 2 %) and plant growth regulators (ethrel 0.1 ml/l and ethrel 0.2 ml/l) and control at twenty days before anticipated date of harvest while, GA_3 25 mg /l and GA_3 50 mg /l were sprayed at marble stage. The mature and uniform sized fruits were harvested from the respective trees and kept in ambient storage condition where observations were recorded regarding the biochemical parameters of the fruits. The details of the treatments applied in the present investigation are T_1: $CaCl_2$ 1 %, T_2: $CaCl_2$ 2 %, T_3: $Ca(NO_3)_2$ 1 %, T_4: $Ca(NO_3)_2$ 2 %, T_5: KNO_3 1 %, T_6: KNO_3 2 %, T_7: ethrel 0.1 ml/l, T_8: ethrel 0.2 ml/l, T_9: GA_3 25 mg /l, T_{10}: GA_3 50 mg /l and T11: Control (No spray).

RESULTS AND DISCUSSION

The results obtained from the present investigation was conducted on the preharvest application of different chemicals and PGRs influenced on mango fruit under ambient storage condition are presented in Table 1 to 3.

The chemicals and plant growth regulators significantly influenced on total soluble solids (^{o}Brix) of mango at harvest and upto last ripening stage. Among all treatments, $CaCl_2$ 2% recorded significantly maximum total soluble solids consistently at harvest (7.72 ^{o}Brix), 4th day (16.00 ^{o}Brix), 8th day (20.97 ^{o}Brix), 12th day (21.68

Table 1: Effect of preharvest application of different chemicals and plant growth regulators on total soluble solids (^{o}Brix) and reducing sugar (%) of mango var. Amrapali

Treatments	Total soluble solids (^{o}Brix)					Reducing sugar (%)				
	Storage period (Days)					Storage period (Days)				
	At harvest	4th	8th	12th	16th	At harvest	4th	8th	12th	16th
T_1: $CaCl_2$ 1 %	6.80^{cd}	14.53^{cd}	18.64^{bc}	20.77^{bc}	17.70^{ab}	3.14^{b}	5.85^{de}	7.49^{a}	3.09^{b}	2.96^{b}
T_2: $CaCl_2$ 2 %	7.72^{a}	16.00^{a}	20.97^{a}	21.68^{a}	17.75^{a}	3.49^{a}	6.65^{a}	7.51^{a}	3.62^{a}	3.12^{a}
T_3: Ca $(NO_3)_2$ 1%	7.55^{a}	13.55^{e}	18.22^{cd}	19.83^{d}	17.37^{ab}	3.08^{b}	5.62^{f}	6.92^{d}	3.04^{bc}	2.95^{b}
T_4: Ca $(NO_3)_2$ 2%	6.05^{e}	13.55^{e}	17.87^{d}	19.00^{e}	16.00^{d}	3.44^{a}	6.00^{cd}	6.29^{f}	2.71^{c}	2.66^{c}
T_5: KNO_3 1 %	6.77^{cd}	15.33^{ab}	20.88^{a}	21.00^{b}	16.12^{d}	3.09^{b}	6.11^{bc}	6.16^{g}	2.51^{d}	2.42^{d}
T_6: KNO_3 2 %	6.60^{d}	12.08^{g}	18.53^{bc}	20.35^{cd}	17.10^{abc}	3.44^{a}	5.80^{e}	7.35^{bc}	3.03^{b}	2.91^{b}
T_7: Ethrel 0.1 ml/l	7.20^{b}	14.94^{bc}	18.98^{b}	20.67^{bc}	17.10^{abc}	3.47^{a}	6.26^{b}	7.22^{c}	3.50^{a}	3.11^{a}
T_8: Ethrel 0.2 ml/l	6.75^{cd}	15.97^{a}	20.53^{a}	21.05^{b}	16.50^{cd}	3.49^{a}	6.62^{a}	7.39^{ab}	3.58^{a}	2.93^{b}
T_9: GA_3 25 mg/l	6.60^{d}	14.18^{de}	17.95^{d}	18.45^{f}	17.05^{bc}	2.33^{d}	5.87^{de}	6.71^{e}	2.56^{d}	2.55^{c}
T_{10}: GA_3 50 mg/l	6.92^{bc}	12.83^{f}	16.53^{e}	18.87^{ef}	17.51^{ab}	2.81^{c}	5.81^{e}	6.24^{fg}	3.16^{b}	3.00^{ab}
T_{11}: Control	6.20^{e}	10.87^{h}	15.71^{f}	17.95^{g}	15.33^{e}	2.34^{d}	4.76^{g}	6.15^{g}	3.61^{a}	2.64^{c}
S.E. ±	0.09	0.21	0.16	0.16	0.20	0.04	0.05	0.04	0.04	0.04
F-test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
C. V. %	2.16	2.65	1.49	1.37	2.01	1.96	1.55	1.08	2.18	2.60

Note: Treatment means with the letter/letters in common are not significantly different by Duncan's new multiple range test at 5 % level of significance

°Brix) and 16th day (17.75 °Brix) under ambient storage conditions. The total soluble solid increased slowly during storage period upto 12th day and declined thereafter. It may be due to the increased in soluble sugars content and total soluble sugars caused by hydrolysis of polysaccharides like starch, cellulose and pectin substances in to simpler substances. The change in total soluble solids during storage period might be a result of the transformation of organic compound into total soluble solids throughout the enzymatic activities and reaction under calcium effect (Karemera and Habimana, 2014). A similar view was also shared by Kirmani *et al*. (2013) in plum and Yadav *et al.* (2009) in ber fruit.

There were significant effect of various chemicals and plant growth regulators observed on reducing sugar (%) of mango at harvest and every three days interval up to last ripening stage. $CaCl_2$ 2 % and ethrel 0.2 ml/l treatment recorded significantly maximum reducing sugar (%) at harvest (3.49 %) while, $CaCl_2$ 2% treatment obtained significantly maximum reducing sugar (%) at 4th day (6.65 %), 8th day (7.51%), 12th day (3.62%) and at 16th day (3.12%) as compared to rest of the treatments. The accumulation of reducing sugar was gradually increased in fruits preharvest treated with chemicals and growth regulators with a slight decline at the end of storage periods and it was significantly highest with $CaCl_2$ 2 (%) at harvest, 4th day, 8th day, 12th day and at 16th day as compared to rest of the treatments. The initial increase in reducing sugar might be due to the conversion of starch into reducing sugar and later on reduction could be possible due to utilization of sugar in the process of respiration. The percentage of reducing sugar increased slowly during storage period upto 8th day and declined thereafter. The increase in reducing sugar might be due to increased rate of starch degradation by amylase activity. The present findings are in agreement with Singh *et al.* (2007) in strawberry.

Total sugar (%) of mango were significantly influenced by various chemicals and plant growth regulators mango at harvest and upto last ripening stage. Among all treatments, $CaCl_2$ 2 per cent recorded significantly maximum total sugar consistently at harvest (6.30 %), 4th day (15.43 %), 8th day (18.57 %), 12th day (18.95 %) and 16th day (18.27 %) during storage period. The percentage of total sugar increased slowly during storage period upto 12th day and declined thereafter and total sugar was found to increase in calcium chloride treated fruits might be due to slowly conversion to sugar on storage reported by Bhalerao *et al.* (2010) in sapota. Whereas, calcium pectate is important components of the cell wall. Therefore, adequate amount of calcium may help to reduce conversion of acid into sugar reported by Lal *et al.* (2011) in apricot. Similar results were also reported Karemera and Habimana (2014) in mango,

Table 2: Effect of preharvest application of different chemicals and plant growth regulators on total sugar (%) and non-reducing sugar (%) of mango var. Amrapali

Treatments	Total sugar (%)					Non-reducing sugar (%)				
	Storage period (Days)					Storage period (Days)				
	At harvest	4th	8th	12th	16th	At harvest	4th	8th	12th	16th
T1: $CaCl_2$ 1 %	5.78b	14.34b	17.82c	17.93c	17.97b	2.64ab	8.49a	10.33cd	14.84b	15.01a
T2: $CaCl_2$ 2 %	6.30a	15.43a	18.57a	18.95a	18.27a	2.81a	8.78a	11.06a	15.33a	15.15a
T3: $Ca(NO_3)_2$ 1%	5.30c	12.66d	17.48d	17.59cd	16.96cd	2.22c	7.04d	10.56 bc	14.55b	14.01c
T4: $Ca(NO_3)_2$ 2%	6.24a	13.71c	17.28de	17.44d	17.20c	2.80a	7.71c	10.99a	14.73b	14.54b
T5: KNO_3 1 %	5.84b	12.78d	16.17f	16.46e	16.06e	2.75a	6.67d	10.01d	13.95cd	13.63de
T6: KNO_3 2 %	6.23a	13.56c	16.22f	16.59e	16.29e	2.79a	7.77c	8.87f	13.57f	13.39e
T7: Ethrel 0.1 ml/l	6.27a	15.04a	18.23b	18.82a	18.18ab	2.80a	8.78a	11.00a	15.32a	15.07a
T8: Ethrel 0.2 ml/l	6.29a	15.04a	18.38ab	18.34b	18.03ab	2.80a	8.41ab	10.99a	14.76b	15.10a
T9: GA_3 25 mg/l	5.11d	12.44d	15.98f	16.50e	16.30e	2.78a	6.57d	9.27e	13.94cde	13.74d
T10: GA_3 50 mg/l	5.38c	13.70c	16.99e	17.22d	16.83d	2.58b	7.89bc	10.75ab	14.05c	13.82cd
T11: Control	5.07d	11.35e	15.01g	15.47f	13.21f	2.72ab	6.60d	8.86f	11.86g	10.57f
S. E. ±	0.04	0.13	0.09	0.12	0.08	0.05	0.16	0.12	0.12	0.08
F-test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
C. V. %	1.21	1.66	0.95	1.23	0.81	2.98	3.66	2.05	1.52	1.03

Note: Treatment means with the letter/letters in common are not significantly different by Duncan's new multiple range test at 5 % level of significance

Mahajan and Sharma (2000) in peach.

There were significant effect of various chemicals and plant growth regulators observed on non-reducing sugar (%) of mango at harvest and upto last ripening stage. $CaCl_2$ 2 % recorded significantly maximum non-reducing sugar (%) consistently at harvest (2.81 %), 4th day (8.78 %), 8th day (11.06 %), 12thday (15.33 %) and 16th day (15.15 %) as compared to rest of the treatments. It was gradually increases during storage period upto 12th day and declined thereafter. The increase in the non-reducing sugar might be due to the hydrolysis of starch and conversion in the pectin substances from water insoluble to water soluble fractions. The increase in non-reducing sugar during storage was due to the conversion of starch into sugar as reported by Bhalerao *et al.* (2010) in sapota. These results are in accordance with the findings of Karemera and Habimana (2014) in mango and Jawandha *et al*. (2007) in ber.

The chemicals and plant growth regulators were significantly influenced on ascorbic acid (mg/100 g pulp) content of mango at harvest and every three days interval upto last ripening stage. Among all treatments, $CaCl_2$ 2 per cent recorded significantly maximum ascorbic acid (mg/100 g pulp) consistently at harvest (51.54 mg/100 g pulp), 4th day (45.83 mg/100 g pulp), 8th day (42.26 mg/100 g pulp), 12th day (39.63 mg/100 g pulp) and 16th day (35.42 mg/100 g pulp). $CaCl_2$ 2 per cent treatment was statistically superior over all other treatments. It was gradually decreased in fruits preharvest treated with chemicals and growth regulators at the end of storage periods. It might be due to calcium delayed the rapid oxidation of ascorbic acid. The highest retention of ascorbic acid during storage by calcium sprays might be due to continue synthesis of its precursor like Glucose-6-phosphate during conversion as starch into various sugars and slow rate of oxidation reported by Yadav *et al*. (2009) in ber. These results are in accordance with the finding of Jawandha *et al.* (2007) in ber and Lal *et al*. (2011) in apricot.

There were significant effect of various chemicals and plant growth regulators on acidity of mango at harvest and every three days interval up to last ripening stage. $CaCl_2$ 2 per cent treatment recorded significantly minimum acidity at harvest (0.352 %), 4th day (0.258 %), 8th day (0.199 %), 12th day (0.101 %) and 16th day (0.096 %) as compared to rest of the treatments. The decrease in the total titratable acidity might be due to increase in the total sugar content of the fruits. At the time of maturity, fruits will be having higher amount of acidity, but as the fruits advance towards ripening, acid content will decrease. These results are in line with findings of Ingle *et al.* (1982), who observed a decrease in acidity during ripening of sapota fruits. The acidity of mango fruits generally decreases with advancement of

Table 3 : Effect of preharvest application of different chemicals and plant growth regulators on ascorbic acid (mg/100 g pulp) and acidity (%) of mango var. Amrapali

Treatments	Ascorbic acid (mg/100 g pulp)					Acidity (%)				
	Storage period (Days)					Storage period (Days)				
	At harvest	4th	8th	12th	16th	At harvest	4th	8th	12th	16th
T1: $CaCl_2$ 1 %	45.53cde	38.78e	36.09de	33.15g	28.34ef	0.356f	0.292d	0.247c	0.118e	0.101d
T2: $CaCl_2$ 2 %	51.54a	45.83a	42.26a	39.63a	35.42a	0.352f	0.258e	0.199e	0.101g	0.096e
T3: $Ca(NO_3)_2$ 1%	46.11cd	41.92c	38.82b	35.65c	31.23c	0.411d	0.390a	0.278a	0.177a	0.122a
T4: $Ca(NO_3)_2$ 2%	46.37bc	41.28c	37.43c	34.85de	29.39de	0.380e	0.360b	0.251bc	0.143d	0.101d
T5: KNO_3 1 %	44.54e	38.85e	36.44d	33.92f	27.56f	0.377e	0.300cd	0.214d	0.111f	0.098de
T6: KNO_3 2 %	46.35bc	41.99c	39.03b	36.90b	32.84b	0.421cd	0.306c	0.201e	0.102g	0.098de
T7: Ethrel 0.1 ml/l	45.01de	38.77e	37.33c	34.23ef	29.75d	0.451b	0.353b	0.255b	0.149c	0.098de
T8: Ethrel 0.2 ml/l	42.34f	37.68f	35.52ef	31.90h	25.60g	0.354f	0.292d	0.200e	0.108f	0.097e
T9: GA_3 25 mg/l	45.49cde	39.92d	37.88c	34.90d	28.61def	0.353f	0.260e	0.202e	0.108f	0.108c
T10: GA_3 50 mg/l	47.41b	42.98b	39.00b	36.97b	31.98bc	0.431c	0.351b	0.256b	0.147c	0.101d
T11: Control	43.10f	37.65f	35.22f	32.01h	25.46g	0.474a	0.386a	0.272a	0.169b	0.112b
S.E. ±	0.34	0.28	0.22	0.20	0.37	0.005	0.003	0.002	0.001	0.001
F-test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
C. V. %	1.27	1.18	1.03	1.01	2.17	1.97	1.54	1.75	1.71	1.23

Note: Treatment means with the letter/letters in common are not significantly different by Duncan's New Multiple Range Test at 5 % level of significance

storage period. Decrease in acidity might be attributed to conversion of acids into sugars during respiration. These results are accordance with the findings of Kardum (2004) in fig, Jawandha *et al.* (2007) in ber and Kaundal *et al*. (2000) in plum fruits.

Conclusion:

The results obtained from present investigation concluded that, $CaCl_2$ 2 per cent treatment recorded maximum total soluble solids, total sugar, reducing sugar, non-reducing sugar and ascorbic acid content of mango fruit while, minimize the acidity of fruit under ambient storage condition.

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