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Influence of pre-harvest treatments of paclobutrazol and calcium chloride on biochemical and sensory attributes of mango cv. Amrapali

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Abstract
A field experiment was conducted during 2017-18 to study the influence of pre-harvest application of paclobutrazol and calcium chloride on biochemical and sensory attributes of mango cv. Amarapali. The experiment was laid out in a completely randomized design (CRD) with twelve treatments and three repetitions. Paclobutrazol and $CaCl_2$ were sprayed at 75 days after full bloom and 15 days before harvest, respectively on 10 years old mango orchard planted at 2.5 m × 2.5 m spacing. Paclobutrazol at 100 mg/l with $CaCl_2$ at 1.5 per cent significantly increased TSS (20.70 °B), total sugar (17.65%), reducing sugar (7.16%), ascorbic acid (41.08 mg/100 g), total carotenoids (0.99 mg/100 g) and phenol (86.53 mg/100 g) of mango cv. Amrapali. The same treatment significantly reduced titratable acidity (0.13%) of mango cv. Amarapali fruits.

Keywords: Paclobutrazol, $CaCl_2$, mango cv. amrapali

1. Introduction
Mango, the choicest fruit of India, is said to be the ‘King of fruits’. No other fruit is so intimately connected with history, literature and life of Indians as mango. Mango is having good nutritional value. It is considered one of the best fruits in the world market due to its excellent aroma, beautiful colour, delicious and juicy fruit with richest source of vitamin A. In India, highest area under fruit crops is covered by mango. Thereare number of cultivars and hybrids of mango under cultivation. Amrapali (Dashehari × Neelum) is a well known, dwarf, late maturing and regular bearer, which possesses quality par excellence with oblong fruit shape. Due to dwarf nature the cultivar is recommended for high density planting and kitchen gardens. (Ray, 1999) [1]. Fruits are green to apricot yellow, small to medium sized, sweet in taste having fibreless flesh. In spite of above good characters, problems of fruit drops and undersized fruits have been observed. Pre-harvest application of growth regulators and nutrients can modify the place and direction of physical and biochemical changes in developing fruit and has potential to transform its quality at harvest.
Paclobutrazol, a triazole derivative, has been effectively used to induce and manipulate flowering, fruiting and tree vigour in several perennial fruit crops. However its use in mango is quite common.It can be applied to trees as a foliar spray or as soil drench. (Tongumpai *et al*., 1991) [2]. It is an antagonist of gibberellin and hence is referred as ‘antigibberellin’. (Hedden, 1983) [3]. It is very active in low rates and taken up into the xylem through the leaves, stems or root and translocate to growing sub apical meristems. (Hamid and Williams 1997, Wang *et al*. 1986) [4, 5]. It results in retardation of vegetative growth and diversion of assimilates to reproductive organs there by enhances the bud break and improves the fruit yield and quality. Paclobutrazol application probably lengthens both flowering and fruit filling up periods in mango and provide adequate assimilates by hastening photosynthetic activities for fruit development. (Burondkar and Gunjate, 1993) [6]. It has been effectively used for flower regulation, yield and quality improvement in various perennial fruit crops. (Nartvaranant *et al*. 2000, Koukourikou-Petridou 1996, Adato 1990) [7-9].
Calcium chloride is an important calcium salt that has many household and industrial applications. Pre-harvest spray of $CaCl_2$ reduces the weight loss, delays the ripening of fruits,

increases the shelf life, physico-chemical parameters and organoleptic quality of mango fruits. (Karemera and Habimana, 2014) [10]. It also increases the calcium content, thus improving nutritional value of the fruit. Calcium is a key plant nutrient that has a significant role in cell functions, reduces softening and senescence of fruits. (Barker and Pibeam, 2007, Jones and Lunt, 1967) [11, 12]. Pre harvest spray of calcium increases the productivity of mango due to reduction of abscission and it enhances the fruit quality by increasing the fruit firmness and by maintaining the turgidity of middle lamella cells. (Kumar *et al*., 2006, Wahdan*et al*., 2011) [13, 14]. Calcium spray during fruit development provides a safe mode of supplementing endogenous calcium to fresh fruits. (Gerasopoulos *et al*. 1996; Tzoutzoukou and Bouranis 1997; Raese and Drake 2000) [15-17]. The aim of this work was to determine the effect of pre-harvest foliar spray of paclobutrazol and calcium chloride on biochemical and sensory attributes of Amrapali mango.

2. Materials and Methods

The present investigation was conducted during 2017-18 at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat. The experimental site was situated at 20º 57' North latitude, 72º 54'East longitude and has altitude of 10 meters above the mean sea level. The climate of this area was characterized by three well defined seasons viz., monsoon, mild winter and summer. The experiment was laid out in a completely randomized design (CRD) with twelve treatments and three repetitions. Paclobutrazol and $CaCl_2$ were sprayed at 75 days after full bloom and 15 days before harvest, respectively on 10 years old mango orchard planted 2.5 m × 2.5 m spacing. The solution of paclobutrazol of desired concentration was prepared by dissolving required quantities of its commercial formulations (Cultar having 24.2 *a.i.* paclobutrazol) in water. The solution of calcium chloride was prepared by accurately weighing the calcium chloride on a digital balance and then dissolving it in required quantity of water. The spray applications were performed during the morning hours. The various treatments followed for the investigation were as follows: T_1 = Control, T_2 = 1.0% $CaCl_2$, T_3 = 1.5% $CaCl_2$, T_4 = 100 mg/l PBZ, T_5 = 200 mg/l PBZ, T_6 = 300 mg/l PBZ, T_7 = 100 mg/l PBZ + 1.0% $CaCl_2$, T_8 = 100 mg/l PBZ + 1.5% $CaCl_2$, T_9 = 200 mg/l PBZ + 1.0% $CaCl_2$, T_{10} = 200 mg/l PBZ + 1.5% $CaCl_2$, T_{11} = 300 mg/l PBZ + 1.0% $CaCl_2$and T_{12} = 300 mg/l PBZ + 1.5% $CaCl_2$.Observations on various bio-chemical attributes were recorded by using standard methods. The total soluble solids (TSS) of the pulp were determined with the help of Hand Refract meter (0-32ºB). The titratable acidity, reducing and total sugars, total carotenoids, ascorbic acid, pectin content, starch content and phenol content were determined by method as suggested in[18]Ranganna, 2004.The sensory parameters were taken through organoleptic evaluation for assessing the appearance, flavour, texture and overall acceptability of mango fruit was done after ripening of fruits. It was done by a panel of ten judges by using 9 hedonic score to each characters.

3. Results and Discussion

The results obtained from the present investigation on different biochemical and sensory attributes of mango fruits are summarized below:

3.1 TSS (°B)

Significantly higher TSS (20.70 °B) of mango cv. Amarapali was recorded T_8. It might be attributed to the direct effect of paclobutrazol on increasing photosynthetic activity and sink strength of fruit, which caused an increase in the rate of assimilate transfer towards the fruits. Several workers obtained similar result as Khader (1990) [19]; Reddy and Kurian (2008) [20] in mango. An increase in TSS of mango cv. Amarapali by $CaCl_2$might be due to transformation of organic matter of fruits to soluble solids under enzymatic activities affected by calcium. Similar results were observed by Karemera and Habimana (2014) [21]; Singh *et al*. (2017) [22] in mango.

3.2 Fruit firmness (kg/cm^2)

It is observed from the result that T_8 had significantly higher fruit firmness (3.62 kg/cm^2) of mango cv. Amarapali. It might be due to calcium interacts with pectic acid in the cell wall to form calcium pectate, thereby having a direct influence on fruit firmness. Fruit firmness was higher when trees were sprayed with 1.5 per cent $CaCl_2$than those of which were sprayed with 1.0 per cent $CaCl_2$, because pectin degradation is higher with high calcium content in fruit. Similar results were observed by Singh *et al*. (2017) [22] in mango, Bhalerao *et al*. (2009) [23] in sapota.

3.3 Titratable acidity (%)

Titratable acidity of mango cv. Amarapali was recorded significantly lower (0.13%) in T_8. It might be because of synergetic effect of both of them with each other. Calcium influences the change of acid into sugars under enzyme invertase, which might cause reduction in titratable acidity. These results are in conformity with Karemera *et al*. (2014) [21]; Singh *et al*. (2017) [22] in mango.

3.4 Total sugars and reducing sugars (%)

The higher total sugars (17.65%) and reducing sugars (7.16%) of mango cv. Amarapali were recorded in T_8. This might be attributed to the direct effect of paclobutrazol on increasing photosynthetic activity and sink strength of fruit, which cause an increase in the rate of assimilate transfer towards the fruits as discussed previously. Similar findings were obtained by Khader (1990) [19] in mango; Prasad (2004) [24] in peach. Calcium chloride increased total and reducing sugars because of transformation of organic matter of fruits to soluble solids under enzymatic activities affected by calcium. Similar results were found by Karemera *et al*. (2013) [25] in mango.

3.5 Total carotenoids (mg/100 g)

Total carotenoids of fruits were recorded significantly higher (0.99 mg/100 g) in T_8. Paclobutrazol increased total carotenoids in mango cv. Amarapali might be attributed to polyphenol oxidase catalyses the oxidation of mono and diphenols to o-quinones, which polymerize to produce brown pigments. Similar finding was reported by Khader (1990) [19] in mango.

3.6 Ascorbic acid (mg/100 g)

The ascorbic acid content (41.08 mg/100 g) of mango cv. Amarapali was found in T_8. Calcium chloride treatments had a significant effect on retaining ascorbic acid content in fruits. This might be because the concentrations of $CaCl_2$ delayed the rapid oxidation of ascorbic acid. Similar finding was obtained by Patel *et al*. (2015) [26] in mango. Application of paclobutrazol with $CaCl_2$ can produce effects on ascorbic acid contents of mango and that may be due to synergetic effect of both of them with each other.

3.7 Pectin content (%)
Pectin content was not found significant for any of the pre-treatments.

3.8 Starch (g/100 g pulp)
Starch content was not affected significantly by any of treatments.

3.9 Phenol content (mg/100 g)
Phenol content of mango cv. Amarapali was recorded significantly higher (86.53 mg/100 g) in T_8. It might be due to paclobutrazol stimulated phenylalanine ammonia lyase activity with consequent production of the main phenolic compounds and the synthesis of new polyphenolic substances. Similar finding was reported by Khader (1990) [19] in mango.

3.10 Sensory parameters
Sensory parameters *viz*., appearance, texture, flavour and overall acceptability of mango cv. Amarapali were reached the level of significance due to applications of paclobutrazol with $CaCl_2$. The highest organoleptic score for appearance, texture and overall acceptability was obtained in the application of 200 mg/l Paclobutrazol and 1.5 per cent $CaCl_2$. Whereas, highest organoleptic score for flavour was found in the application of 100 mg/l Paclobutrazol and 1.5 per cent $CaCl_2$. Retention of better quality in fruits treated with paclobutrazol and $CaCl_2$ might be due to reduction in physiological weight loss, respiration rates of fruits and consequently a reduction in the rates of utilization of respirable substrates, as such fruits contained relatively higher TSS and sugar contents, eventually resulting in better acceptability rating of such fruits. This findings had close conformity with Patel *et al*. (2015) [26] in mango.

Table 1: Effect of different pre-harvest treatments on TSS, titratable acidity, total sugar, reducing sugar, total carotenoids, ascorbic acid, pectin, starch and phenolof mango cv. Amrapali

Treatments	TSS (°B)	Titable acidity (%)	Total sugar (%)	Redu-cing sugar (%)	Total carote-noids (mg/ 100g)
T_1 : Control	18.46	0.23	14.54	4.98	0.86
T_2 : 1.0% $CaCl_2$	19.46	0.18	16.13	5.43	0.91
T_3 : 1.5% $CaCl_2$	20.22	0.16	16.41	6.15	0.93
T_4 : 100 mg/l PBZ	18.56	0.21	15.42	5.11	0.94
T_5 : 200 mg/l PBZ	18.57	0.19	15.62	5.33	0.94
T_6 : 300 mg/l PBZ	19.30	0.19	15.53	5.38	0.95
T_7 : 100 mg/l PBZ + 1.0% $CaCl_2$	19.62	0.17	16.21	5.92	0.95
T_8 : 100 mg/l PBZ + 1.5% $CaCl_2$	20.70	0.13	17.65	7.16	0.99
T_9 : 200 mg/l PBZ + 1.0% $CaCl_2$	19.56	0.18	16.27	6.24	0.96
T_{10} : 200 mg/l PBZ + 1.5% $CaCl_2$	20.23	0.15	17.08	7.00	0.97
T_{11} : 300 mg/l PBZ + 1.0% $CaCl_2$	19.60	0.17	16.21	6.33	0.95
T_{12} : 300 mg/l PBZ + 1.5% $CaCl_2$	19.98	0.16	16.71	6.61	0.95
SEm±	0.29	0.005	0.28	0.11	0.01
CD at 5%	0.86	0.01	0.81	0.34	0.02
CV%	2.64	5.01	3.01	3.41	1.10

Table 2: Effect of different pre-harvest treatments on ascorbic acid, pectin, starch and phenolof mango cv. Amrapali

Treatments	Ascorbic acid (mg/100g)	Pectin (%)	Starch (g/100g)	Phenol (mg/100g)
T_1 : Control	34.48	0.42	2.51	75.53
T_2 : 1.0% $CaCl_2$	37.95	0.42	2.50	78.83
T_3 : 1.5% $CaCl_2$	38.38	0.42	2.49	79.43
T_4 : 100 mg/l PBZ	36.39	0.42	2.50	81.80
T_5 : 200 mg/l PBZ	36.52	0.42	2.49	83.77
T_6 : 300 mg/l PBZ	36.51	0.42	2.49	84.13
T_7 : 100 mg/l PBZ + 1.0% $CaCl_2$	37.51	0.42	2.50	84.47
T_8 : 100 mg/l PBZ + 1.5% $CaCl_2$	41.08	0.42	2.48	86.53
T_9 : 200 mg/l PBZ + 1.0% $CaCl_2$	39.25	0.43	2.50	84.17
T_{10} : 200 mg/l PBZ + 1.5% $CaCl_2$	40.40	0.43	2.49	85.00
T_{11} : 300 mg/l PBZ + 1.0% $CaCl_2$	37.93	0.42	2.49	83.50
T_{12} : 300 mg/l PBZ + 1.5% $CaCl_2$	39.18	0.42	2.50	82.13
SEm±	0.32	0.002	0.01	0.73
CD at 5%	0.96	NS	NS	2.15
CV%	1.50	1.18	0.36	1.55

Table 3: Effect of different pre-harvest treatments on sensory attributes of mango cv. Amrapali

Treatments	Apperance	Texture	Flavour	Overall acceptability
T_1 : Control	6.13	6.33	6.93	6.47
T_2 : 1.0% $CaCl_2$	7.27	7.07	7.27	7.20
T_3 : 1.5% $CaCl_2$	7.20	7.27	7.27	7.25
T_4 : 100 mg/l PBZ	7.27	7.27	7.20	7.24
T_5 : 200 mg/l PBZ	7.07	7.07	7.27	7.13
T_6 : 300 mg/l PBZ	7.13	7.27	7.40	7.27
T_7 : 100 mg/l PBZ + 1.0% $CaCl_2$	7.47	7.47	7.40	7.44
T_8 : 100 mg/l PBZ + 1.5% $CaCl_2$	7.93	7.97	8.10	8.00

T_9 : 200 mg/l PBZ + 1.0% $CaCl_2$	7.53	7.53	7.47	7.51
T_{10} : 200 mg/l PBZ + 1.5% $CaCl_2$	8.07	8.10	7.90	8.02
T_{11} : 300 mg/l PBZ + 1.0% $CaCl_2$	7.67	7.73	7.73	7.71
T_{12} : 300 mg/l PBZ + 1.5% $CaCl_2$	7.80	7.49	7.73	7.68

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