Effect of Pre-harvest Nutrients Application and Bagging on Quality and Shelf Life of Mango (*Mangifera indica* L.) Fruits *cv.* Amrapali

M. S. Jakhar\(^1\)*, and S. Pathak\(^1\)

**ABSTRACT**

The present experiment was conducted to study the effect of pre-harvest bagging and spray of CaCl\(_2\) and K\(_2\)SO\(_4\) on quality and shelf life of mango fruits *cv.* Amrapali during two succeeding years. Trees of Amrapali mango were sprayed three times at 30, 20, and 10 days before harvesting and bagging with brown paper bag 20 days before harvesting of fruits. Harvested fruits were stored under the ambient temperature (storage at room temperature) and observations were taken at three days intervals up to 18 days. The results indicated that the pre-harvest treatment of 2% CaCl\(_2\)+1% K\(_2\)SO\(_4\)+bagging was found superior to improve the quality of fruits in respect of highest fruits weight, firmness, TSS, ascorbic acid, total sugars, and β-carotene content with minimum black spotted fruits per cent and maintained it throughout the storage period up to 18 days. Fruits treated with 2% CaCl\(_2\)+1% K\(_2\)SO\(_4\)+bagging showed shelf life up to 12 days with lowest weight loss and highest organoleptic quality as against 6 days of untreated fruits (control).

**Keywords:** Black spotting, CaCl\(_2\), K\(_2\)SO\(_4\), Pre-harvest treatments, Storage.

**INTRODUCTION**

Mango (*Mangifera indica* L.) is one of the most important fruits of India and acknowledged as the “king of fruits”. It belongs to the family Anacardiaceae and genus Mangifera. Mango is recognized as one of the choicest and well accepted fruits all over the world due to its luscious taste, captivating flavor, attractive color and exemplary nutritive value. It plays an important role in balancing the human diet by providing about 64-86 calories per 100 grams of ripe fruits (Rathore *et al.*, 2007). It is a good source of vital protective nutrients like vitamins A, B, and C, niacin, and also rich in minerals including calcium, potassium and iron (Amin and Hanif, 2002). Mango fruit is utilized at both immature and mature stages. Raw fruits are used for making chutney, amchur, pickles, and juices. The ripe fruits are also utilized for processing of several products like ready-to-serve, nectar, squash, panna, syrup, mango leather, mango powder, flakes, toffee, jams, and jelly.

India has a rich wealth of mango germplasm with more than 1,000 varieties grown throughout the country (Yadav, 1997). Only a few varieties *viz.* Alphanso and Kesar are available with better storage life, and hence better suited for export. But, production of these cultivars is very limited. Among the promising mango hybrids, Amrapali is a well known late maturing and regular bearer dwarf hybrid variety. It was evolved as a result of a cross between ‘Dasheheri (alternate bearer) and Neelum (regular bearer)’ varieties of mango species *Indica* at IARI, New Delhi, in 1978.

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Amrapali possesses quality par excellence with very high pulp percentage and TSS with deep orange red flesh color and excellent in taste. Amrapali is one of the best suitable varieties for inter as well as overseas markets and processing industries.

Being a climacteric fruits, it is perishable in nature and possesses a shorter shelf life about one week at ambient temperature. After harvest, various physiological and biochemical changes occur in fruits which cause decline in quality and limit its shelf life. Amrapali is also susceptible to post harvest diseases due to its harvesting in rainy season, resulting in excess post harvest losses. Anthracnose (Coletotrichum gloeosporioides) and stem-end rot (Diplododia netalensis) are the major post harvest diseases of mango fruits, which cause black spots on fruits skin during ripening and storage. Many scientists estimated that 20-30 per cent losses in fruits and vegetables are due to post harvest diseases (Yadav et al., 2013). The main bottlenecks associated with this variety are its shorter shelf life and post harvest losses mainly due to post harvest diseases. In mango, post harvest losses lie in the range of 25-40% from harvesting to consumption stage (Tahir et al., 2002) and reduction in these losses is essential for increase the availability of fruits. However, loss of this very perishable commodity is a big worth annually. It is not only a serious problem of Amrapali growers and traders in India, but present time improvement in the shelf life and reduction in the post harvest losses of mango fruit is an international issue. Hence, this investigation was formulated with pre-harvest nutrient application and fruits bagging.

Pre-harvest paper bagging is a physical protection method which not only improves the visual quality of fruit by promoting skin coloration and reducing blemishes, but can also change the micro-environment for fruit development, which can have several beneficial effects on internal fruit quality. Pre-harvest bagging of fruit can also reduce the incidence of disease, insect pest and/or mechanical damage, sunburn of the skin, fruit cracking, agrochemical residues on the fruit, and bird damage (Sharma et al., 2014). The 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). Madani et al. (2014) reported that the pre harvest preharvest application of 2% calcium chloride improves the quality and decreases the enzymatic activity in papaya fruits during the storage. Treatment with calcium nitrate and calcium chloride (0.6-2.0%) delayed ripening after harvest, lowered weight loss, and reduced respiration rates (Bender, 1998). It enhances the mango quality by increasing the fruit firmness and by maintaining the middle lamella cells. Fruits storability was also improved by CaCl$_2$ under cold storage (Wahdan et al., 2011). The potassium treatments improve the productivity of several mango cultivars in terms of fruit size and weight. Pre-harvest treatment of 1% potassium sulfate have resulted in improving the fruit quality parameters i.e. juice content, total soluble solids, ascorbic acid, total sugars, and reducing the weight loss during the storage. Sulfate compound can also reduce the infection of diseases (Burondkar et al., 2009). The aim of the present study was to determine the effect of pre-harvest nutrient application and fruits bagging on post harvest quality and shelf life of mango fruits cv. Amrapali.

**MATERIALS AND METHODS**

**Plant Material and Treatment**

The experiment was conducted at Main Experimental Station, Horticulture and Post Harvest Technology Laboratory of ND University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh (India) during the two successive seasons of 2010-2011 and 2011-2012. Fourteen-year old bearing trees of mango cv. Amrapali, having
uniform vigor and health were selected in high density mango orchard. Trees were spaced 2.5x2.5 m and received uniform pruning and cultural operations. Twenty-four selected trees were subjected to eight pre-harvest treatments viz. bagging (T<sub>1</sub>), 2% CaCl<sub>2</sub> (T<sub>2</sub>), 1% K<sub>2</sub>SO<sub>4</sub> (T<sub>3</sub>), 2% CaCl<sub>2</sub>+bagging (T<sub>4</sub>), 1% K<sub>2</sub>SO<sub>4</sub>+bagging (T<sub>5</sub>), 2% CaCl<sub>2</sub>+1% K<sub>2</sub>SO<sub>4</sub> (T<sub>6</sub>), 2% CaCl<sub>2</sub>+1% K<sub>2</sub>SO<sub>4</sub>+bagging (T<sub>7</sub>), and Control (T<sub>8</sub>) with three replications. One tree was taken as a unit for a replication of treatment.

**Treatments Methodology**

Fruits were bagged at 20 days before harvesting of fruits using single layer brown paper (pulp paper) bags. Twenty five uniform sized fruits were marked at all directions of the canopy of the trees. Individual fruit was covered with brown paper bag and tied with thread on the stalk of fruits. Treatment with 2% CaCl<sub>2</sub> and 1% K<sub>2</sub>SO<sub>4</sub> alone and their combination were sprayed three times at 30, 20, and 10 days before harvesting, whereas treatments along with bagging were sprayed only at 30 and 20 days before harvesting and just after second spray, treated fruits were bagged. Twin-20 was used as spreader in spray solution.

**Fruit Harvest and Storage**

Fruits of all trees were separately harvested at optimum maturity stage by hand with 1.0 cm stalk to escape any damage of fruit. Harvesting was done in the morning hours dated 14<sup>th</sup> July during both years. The field heat of harvested fruits was removed by dipping in fresh water and then carefully sorted and graded as fresh and uniform sized fruits. These fruits were transported from orchard to the laboratory without any type of physical damage including bruising. In the laboratory, fruits were washed in running tap water and cleaned with muslin cloth. Fruits were packed in corrugated fiber board boxes with the use of newspaper as liner. All boxes were tagged as per treatments and stored under ventilated room (at ambient temperature) for 18 days. Weather data during the trial from 14<sup>th</sup> June to 1<sup>st</sup> August (2010 and 2011) are given in Table 1.

**Fruit Quality Analysis**

Three fruits per treatment were evaluated for quality analysis just after harvesting and at 6 days intervals during storage until 18 days by the following methods.

- **Fruit Weight (g):** Fruits were taken randomly and their weight was recorded with the help of physical balance. Average weight was calculated and expressed in gram.
- **Weight Loss (%):** Weight of fruits was recorded with the help of physical balance and weight loss per cent was calculated by using the following standard procedure mentioned in AOAC (2000).
- **Fruit Firmness (kg cm<sup>-2</sup>):** Fruit firmness

<table>
<thead>
<tr>
<th>Month</th>
<th>Date</th>
<th>Temperature (°C)</th>
<th>Relative humidity (%)</th>
<th>Rainfall (mm)</th>
</tr>
</thead>
<tbody>
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<td>July</td>
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<td>27.0</td>
<td>33.0</td>
<td>28.0</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>25.2</td>
<td>35.0</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
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<td>27.5</td>
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<tr>
<td></td>
<td>26</td>
<td>27.0</td>
<td>30.0</td>
<td>27.0</td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>27.5</td>
<td>33.0</td>
<td>26.5</td>
</tr>
<tr>
<td>August</td>
<td>1</td>
<td>26.0</td>
<td>32.0</td>
<td>26.0</td>
</tr>
</tbody>
</table>
Weight loss % = \frac{\text{Initial fruit weight} - \text{Weight of fruit on observation day}}{\text{Initial fruit weight}} \times 100

was determined as reported by Magness and Taylor (1925), with the help of pressure tester by using a 5/16 plunger. Two readings were taken at two opposite sides on the fruit and mean was expressed in kg cm\(^{-2}\).

Black Spotted Fruits (%): Black spotted fruits were collected and their weight was recorded with the help of physical balance. The per cent of black spotted fruits was calculated by using the following formulae:

\text{Black spotted fruits} \% = \frac{\text{Weight of Black spotted fruits on observation day} + \text{Weight of previous Black spotted fruits}}{\text{Initial fruits weight}} \times 100

Total Soluble Solids (TSS%): TSS were determined with the help of hand refractometer of 0-32 per cent range. The reading was corrected to 20° C with the help of reference table (Ranganna, 1986) and the mean value was expressed as per cent total soluble solids in fruit pulp.

Acidity (%), Ascorbic Acid (mg 100 g\(^{-1}\)) and \(\beta\)-carotene (µg 100 g\(^{-1}\)): Acidity (%), ascorbic acid (mg 100 g\(^{-1}\)) and \(\beta\)-carotene (µg 100 g\(^{-1}\)) were determined by the procedures of Ranganna (1986).

Total Sugars (%): Total sugars content was determined by Fehling’s solution method given by (Lane and Eynon, 1923).

Organoleptic Evaluation:

The organoleptic evaluation for assessing sensory attributes such as peel color, flesh color, texture, taste and flavor of the stored fruits were made by using 9 point Hedonic Rating Scale by a panel of eight judges as described by Larmond (1977).

Shelf Life

The shelf life (days) was determined up to the time when weight loss of fruits reached 10 percent during the storage. The shelf life of fruits was accounted from the date of harvesting to the shelf life expiration date.

Statistical Analysis

The data obtained in this study was subjected to Analysis Of Variance (ANOVA) for a Randomized Block Design (RBD) with three replications and the means were compared using OPSTAT of CCS HAU, Hisar, Haryana, India with \(P < 0.05\) being accepted as significant.

RESULTS AND DISCUSSION

Fruits Weight (%)

The pre-harvest treatment of 2% CaCl\(_2\)+1% K\(_2\)SO\(_4\)+bagging was found superior to produced mango fruit of maximum weight (173.73 and 200.70g) which was statistically at par with the treatment of 2% CaCl\(_2\)+1% K\(_2\)SO\(_4\) in both years, respectively (Table 2). However, minimum fruit weight was recorded in the control (120.35 and 143.39g) in both years, respectively. The appreciable improvement in fruit weight has also been earlier reported with the pre-harvest application of 1.5% CaCl\(_2\) by Karemera and Habimana (2014) and 1% K\(_2\)SO\(_4\) by Burondkar et al. (2009) in mango fruits. Chonhenchob et al. (2011) studied the effects of pre-harvest bagging on mango in Taiwan and reported that bagging increased fruit weight, size, and sphericity over un-bagged fruit.

The fruits weight gradual decrease with the advancement of storage period in both years might be due to evapo-transpiration of water, respiration, and degradation processes.
Table 2. Effect of pre-harvest nutrient application and bagging on average fruit weight (g) of mango cv. Amrapali during the storage.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2010-2011 Storage days</th>
<th>2011-2012 Storage days</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0  6  12  18</td>
<td>0  6  12  18</td>
<td></td>
</tr>
<tr>
<td>Bagging</td>
<td></td>
<td></td>
<td>131.89</td>
</tr>
<tr>
<td>2% CaCl(_2)</td>
<td>144.78 137.74 127.41 117.61</td>
<td>164.48 152.20 140.43</td>
<td>157.32</td>
</tr>
<tr>
<td>1% K(_2)SO(_4)</td>
<td>158.76 153.57 145.47 134.27</td>
<td>182.64 173.36 160.01</td>
<td>176.06</td>
</tr>
<tr>
<td>2% CaCl(_2)+Bagging</td>
<td>173.07 164.14 151.86 140.28</td>
<td>187.62 179.83 166.25</td>
<td>184.25</td>
</tr>
<tr>
<td>1% K(_2)SO(_4)+Bagging</td>
<td>183.16 166.54 153.72 134.27</td>
<td>193.71 185.98 172.30</td>
<td>197.35</td>
</tr>
<tr>
<td>2% CaCl(_2)+1% K(_2)SO(_4)</td>
<td>184.53 179.89 172.30 158.20</td>
<td>207.69 199.30 182.60</td>
<td>200.70</td>
</tr>
<tr>
<td>Control</td>
<td>132.56 125.47 116.04 107.32</td>
<td>157.54 150.33 138.47</td>
<td>143.39</td>
</tr>
<tr>
<td>Mean</td>
<td>164.22 157.84 148.09 136.62</td>
<td>185.98 174.75 161.11</td>
<td>178.34</td>
</tr>
<tr>
<td><strong>Treatments (t)</strong></td>
<td><strong>Storage days (d)</strong></td>
<td><strong>t×d</strong></td>
<td><strong>Storage days (d)</strong></td>
</tr>
<tr>
<td>4.53</td>
<td>1.51</td>
<td>2.07</td>
<td>1.15</td>
</tr>
<tr>
<td><strong>P&lt;0.05</strong></td>
<td><strong>SEm</strong>±</td>
<td><strong>P&lt;0.05</strong></td>
<td><strong>SEm</strong>±</td>
</tr>
</tbody>
</table>

Quality and Shelf Life of Mango Fruits

The weight loss per cent in mango fruits significantly increased with the advancement of storage period in both years of experiment. The lowest weight loss (7.94% and 7.57%) of fruits was recorded in the treatment of 2% CaCl\(_2\)+1% K\(_2\)SO\(_4\)+bagging, while maximum weight loss (12.88% and 12.55%) occurred in the control (Table 3). Whereas, treatment of 2% CaCl\(_2\)+bagging appeared to be the second best for minimizing the weight loss per cent in fruits during storage period. The decrease in weight loss by the application of calcium chloride may be due to its role in the maintenance of fruits firmness, reduction of respiration, and delay in the senescence (Cheor et al., 1990). Karemera and Habimana (2014) also reported that the mango fruits cv. Alphonso treated with 1.5% CaCl\(_2\) spray showed the minimum weight loss during storage. The results are also in accordance with earlier reports of Burondkar et al. (2009) and Mathooko et al. (2011).

Weight Loss (%)

The maximum firmness (7.15 and 7.07 kg cm\(^{-2}\)) was recorded in treatment of 2% CaCl\(_2\)+1% K\(_2\)SO\(_4\)+bagging, while the lowest firmness (5.59 and 5.52 kg cm\(^{-2}\)) was noticed in the control in both years, respectively (Table 4). The fruit firmness of mango gradually decreased during the entire period of storage mainly due to the softening of cell wall during the ripening and senescence. Softening of fruits is caused either by breakdown of insoluble protopectin into soluble pectin or cellular disintegration leading to membrane permeability (Mootto et al., 1975). Whereas, fruits treated with the treatment 2% CaCl\(_2\)+1% K\(_2\)SO\(_4\)+bagging showed slow reduction in firmness during the storage (Table 4). Similarly, Karemera and Habimana (2014) reported that the effect of pre-harvest spray of CaCl\(_2\) on increasing the firmness of Totapuri mango fruits was due to its effect on maintaining the middle lamella cells. Sharma et al. (2013) have also
Table 3. Effect of pre-harvest nutrient application and bagging on weight loss (%) in mango fruits cv. Amrapali during the storage.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2010-2011 Storage days</th>
<th>2011-2012 Storage days</th>
<th>t×d</th>
<th>Mean</th>
<th>2010-2011 Storage days</th>
<th>2011-2012 Storage days</th>
<th>t×d</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bagging</td>
<td>4.86</td>
<td>12.73</td>
<td>18.95</td>
<td>12.18</td>
<td>6.08</td>
<td>8.21</td>
<td>7.41</td>
<td>5.58</td>
</tr>
<tr>
<td>2% CaCl₂</td>
<td>3.26</td>
<td>8.96</td>
<td>15.12</td>
<td>9.11</td>
<td>6.75</td>
<td>8.58</td>
<td>8.07</td>
<td>6.38</td>
</tr>
<tr>
<td>1% K₂SO₄</td>
<td>5.16</td>
<td>12.91</td>
<td>18.56</td>
<td>12.21</td>
<td>4.84</td>
<td>4.37</td>
<td>11.95</td>
<td>17.95</td>
</tr>
<tr>
<td>2%CaCl₂+Bagging</td>
<td>2.73</td>
<td>8.55</td>
<td>15.04</td>
<td>8.77</td>
<td>2.59</td>
<td>2.46</td>
<td>7.81</td>
<td>14.47</td>
</tr>
<tr>
<td>1%K₂SO₄+Bagging</td>
<td>4.75</td>
<td>12.58</td>
<td>18.23</td>
<td>11.85</td>
<td>4.37</td>
<td>4.17</td>
<td>11.95</td>
<td>17.95</td>
</tr>
<tr>
<td>2%CaCl₂+1% K₂SO₄</td>
<td>2.93</td>
<td>8.56</td>
<td>15.09</td>
<td>8.86</td>
<td>2.72</td>
<td>2.72</td>
<td>7.95</td>
<td>14.25</td>
</tr>
<tr>
<td>2%CaCl₂+1%K₂SO₄+Bagging</td>
<td>2.51</td>
<td>7.23</td>
<td>14.07</td>
<td>7.94</td>
<td>2.13</td>
<td>2.13</td>
<td>6.85</td>
<td>13.73</td>
</tr>
<tr>
<td>Control</td>
<td>5.34</td>
<td>13.06</td>
<td>20.24</td>
<td>12.88</td>
<td>4.99</td>
<td>4.99</td>
<td>12.63</td>
<td>20.02</td>
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<tr>
<td>Mean</td>
<td>3.94</td>
<td>10.57</td>
<td>16.91</td>
<td>10.47</td>
<td>3.62</td>
<td>3.62</td>
<td>10.05</td>
<td>16.47</td>
</tr>
</tbody>
</table>

Table 4. Effect of pre-harvest nutrient application and bagging on firmness (kg cm⁻²) of mango fruits cv. Amrapali during the storage.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2010-2011 Storage days</th>
<th>2011-2012 Storage days</th>
<th>t×d</th>
<th>Mean</th>
<th>2010-2011 Storage days</th>
<th>2011-2012 Storage days</th>
<th>t×d</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bagging</td>
<td>8.31</td>
<td>7.49</td>
<td>5.64</td>
<td>2.88</td>
<td>6.08</td>
<td>8.21</td>
<td>7.41</td>
<td>5.58</td>
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<tr>
<td>2% CaCl₂</td>
<td>8.76</td>
<td>8.24</td>
<td>6.45</td>
<td>3.57</td>
<td>6.75</td>
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<tr>
<td>1% K₂SO₄</td>
<td>7.98</td>
<td>7.23</td>
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<td>2.55</td>
<td>5.77</td>
<td>7.90</td>
<td>7.16</td>
<td>5.25</td>
</tr>
<tr>
<td>2%CaCl₂+Bagging</td>
<td>8.93</td>
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<td>6.62</td>
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<td>6.93</td>
<td>8.87</td>
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<td>1%K₂SO₄+Bagging</td>
<td>8.41</td>
<td>7.58</td>
<td>5.75</td>
<td>2.95</td>
<td>6.17</td>
<td>8.30</td>
<td>7.51</td>
<td>5.68</td>
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<tr>
<td>2%CaCl₂+1% K₂SO₄</td>
<td>8.84</td>
<td>8.36</td>
<td>6.60</td>
<td>3.65</td>
<td>6.86</td>
<td>8.77</td>
<td>8.30</td>
<td>6.53</td>
</tr>
<tr>
<td>2%CaCl₂+1%K₂SO₄+Bagging</td>
<td>9.12</td>
<td>8.58</td>
<td>6.86</td>
<td>4.02</td>
<td>7.15</td>
<td>9.03</td>
<td>8.51</td>
<td>6.80</td>
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<tr>
<td>Control</td>
<td>7.71</td>
<td>6.99</td>
<td>5.22</td>
<td>2.44</td>
<td>5.59</td>
<td>7.62</td>
<td>6.91</td>
<td>5.16</td>
</tr>
<tr>
<td>Mean</td>
<td>8.51</td>
<td>7.86</td>
<td>6.06</td>
<td>3.23</td>
<td>6.41</td>
<td>8.41</td>
<td>7.77</td>
<td>5.99</td>
</tr>
</tbody>
</table>

reported that the bagged ‘Royal Delicious’ apple fruit were firmer at harvest than un-bagged fruit, and that bagged fruit retained higher firmness values during storage.

Black Spotted Fruits (%) 

The minimum black spotted fruit (4.46 and 7.35%) was recorded in treatment of 2% CaCl₂+1% K₂SO₄+bagging, whereas maximum (96.61 and 100%) was noted in the control in both years, respectively (Table 5). Also, treatment of 1% K₂SO₄+bagging, 2% CaCl₂+bagging, and bagging alone, respectively, were also found effective in minimizing the black spotted fruit per cent over the control. Black spotted fruit per cent significantly increased during the storage period in both years. Black spotting in stored mango is mainly due to the infection of anthracnose caused by Coletotrichum gloeosporioides and stem-end rot caused by Diplododia netalensis (Yadav et al., 2013). Similarly, pre-harvest fruit bagging has been reported to reduce the incidence of anthracnose and stem-end rot in mango. It also improves the physical quality i.e., the
Table 5. Effect of pre-harvest nutrient application and bagging on black spotted fruit (%) in mango cv. Amrapali during the storage.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2010-2011 Storage days</th>
<th>2011-2012 Storage days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0  6  12  18 Mean</td>
<td>0  6  12  18 Mean</td>
</tr>
<tr>
<td>Bagging</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.65 2.65 15.55 26.40</td>
<td>11.81 3.23 3.23 18.76</td>
</tr>
<tr>
<td>2% CaCl₂</td>
<td>30.67 53.42 83.24 100</td>
<td>66.83 37.78 65.56 96.19</td>
</tr>
<tr>
<td>1% K₂SO₄</td>
<td>24.36 44.78 71.25 100</td>
<td>60.10 30.46 53.61 88.97</td>
</tr>
<tr>
<td>2%CaCl₂+Bagging</td>
<td>1.96 1.96 10.27 19.06</td>
<td>8.31 2.08 2.08 13.40</td>
</tr>
<tr>
<td>1%K₂SO₄+Bagging</td>
<td>1.25 1.25 8.50 18.26</td>
<td>7.32 1.82 1.82 10.06</td>
</tr>
<tr>
<td>2%CaCl₂+1% K₂SO₄</td>
<td>18.46 36.53 64.44 100</td>
<td>54.86 27.17 48.80 79.29</td>
</tr>
<tr>
<td>2%CaCl₂+1%K₂SO₄+Bagging</td>
<td>0.45 0.45 5.33 11.61</td>
<td>4.46 1.12 1.12 8.80</td>
</tr>
<tr>
<td>Control</td>
<td>86.43 100 100 100</td>
<td>96.61 100 100 100</td>
</tr>
<tr>
<td>Mean</td>
<td>20.78 30.13 44.82 59.41</td>
<td>38.79 25.46 34.53 51.93</td>
</tr>
</tbody>
</table>

| SEM±                       | 2.15 0.84 2.45 2.18      | 1.02 2.87                |
| P< 0.05                    | 6.38 2.43 7.34 6.40      | 3.04 8.21                |

The incidence of black spots, which increased their market appeal (Sarker et al., 2009; Chonhenchob et al., 2011). The above results are close confirmatory to earlier findings of Singh et al. (1987) and Burondkar et al. (2009).

Total Soluble Solids (TSS %)

The significantly maximum TSS content was recorded in fruits treated with 2% CaCl₂+1% K₂SO₄+bagging (18.20 and 18.40%), while the minimum was recorded in the control (15.41% and 15.60%) in both years, respectively (Table 6). The TSS content of mango fruits significantly increased with storage period, reached its peak, and then declined during the storage at ambient temperature in both years. The initial increase in TSS content might be due to the breakdown of starch and polysaccharides into simple sugars and organic acid during the subsequent storage, but later on, the decline in TSS content might be due their utilization in evapo-transpiration, respiratory process, and other biochemical activities (Koksal et al., 1994).

Table 6. Effect of pre-harvest nutrient application and bagging on Total Soluble Solids (TSS %) in mango fruits cv. Amrapali during the storage.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2010-2011 Storage days</th>
<th>2011-2012 Storage days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0  6  12  18 Mean</td>
<td>0  6  12  18 Mean</td>
</tr>
<tr>
<td>Bagging</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8.97 15.50 19.77 19.07</td>
<td>15.83 9.17 15.62 19.88</td>
</tr>
<tr>
<td>1%K₂SO₄+Bagging</td>
<td>9.55 17.60 20.95 21.22</td>
<td>17.33 9.82 17.72 21.15</td>
</tr>
<tr>
<td>2%CaCl₂+1% K₂SO₄</td>
<td>10.00 17.97 21.10 21.49</td>
<td>17.64 10.20 18.10 21.26</td>
</tr>
<tr>
<td>2%CaCl₂+1%K₂SO₄+Bagging</td>
<td>10.20 18.27 21.92 22.39</td>
<td>18.20 10.37 18.43 22.12</td>
</tr>
<tr>
<td>Control</td>
<td>8.75 15.17 19.22 18.50</td>
<td>15.41 9.05 15.30 19.37</td>
</tr>
<tr>
<td>Mean</td>
<td>9.42 16.81 20.52 20.59</td>
<td>16.84 9.63 16.95 20.70</td>
</tr>
</tbody>
</table>

| SEM±                       | 0.15 0.09 0.32 0.14      | 0.09 0.32                |
| P< 0.05                    | 0.45 0.24 0.91 0.43      | 0.25 0.91                |

723
The TSS content in the control and bagging increased up to 12th days of storage, whereas other treatments showed increasing trend up to 15th days and then declined during the storage period. Similarly, earlier reports have revealed that the pre-harvest spray of CaCl₂ and K₂SO₄ improve the TSS content of mango fruits (Karemera and Habimana, 2014; Burondkar et al., 2009). Watanawan et al. (2008) have also reported that the pre-harvest bagging improved the TSS content of in mango fruits.

**Acidity (%)**

The significantly maximum acidity content was recorded in the control (0.29 and 0.28%), while the minimum was recorded in the treatment of 2% CaCl₂+1% K₂SO₄+bagging (0.21 and 0.19%) in both years, respectively. Other treatments also showed lower acidity content in comparison to the control in both years (Table 7). The acidity content of mango fruits continuously decreased during the entire period of storage, probably due to the general catabolization of organic acids and their conversion into sugars (Mottoo et al., 1975). The above results fall in line with the earlier reports of Dhahiya et al. (2001) and Karemera and Habimana (2014).

**Table 7.** Effect of pre-harvest nutrient application and bagging on total acidity (%) in mango fruits cv. Amrapali during the storage.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2010-2011 Storage days</th>
<th>2011-2012 Storage days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 6 12 18 Mean</td>
<td>0 6 12 18 Mean</td>
</tr>
<tr>
<td>Bagging</td>
<td>0.40 0.31 0.23 0.15 0.27</td>
<td>0.40 0.29 0.22 0.14 0.14</td>
</tr>
<tr>
<td>2% CaCl₂</td>
<td>0.39 0.29 0.21 0.14 0.26</td>
<td>0.38 0.28 0.20 0.13 0.12</td>
</tr>
<tr>
<td>1% K₂SO₄</td>
<td>0.37 0.28 0.20 0.12 0.24</td>
<td>0.37 0.25 0.17 0.10 0.09</td>
</tr>
<tr>
<td>2%CaCl₂+Bagging</td>
<td>0.37 0.27 0.21 0.12 0.24</td>
<td>0.38 0.27 0.19 0.12 0.24</td>
</tr>
<tr>
<td>1%K₂SO₄+Bagging</td>
<td>0.36 0.27 0.19 0.11 0.23</td>
<td>0.36 0.24 0.16 0.09 0.21</td>
</tr>
<tr>
<td>2%CaCl₂+1% K₂SO₄+Bagging</td>
<td>0.35 0.26 0.18 0.10 0.22</td>
<td>0.34 0.24 0.15 0.08 0.20</td>
</tr>
<tr>
<td>2%CaCl₂+1%K₂SO₄+Bagging</td>
<td>0.34 0.25 0.17 0.09 0.21</td>
<td>0.33 0.23 0.15 0.06 0.19</td>
</tr>
<tr>
<td>Control</td>
<td>0.42 0.33 0.25 0.16 0.29</td>
<td>0.41 0.32 0.23 0.15 0.28</td>
</tr>
<tr>
<td>Mean</td>
<td>0.37 0.28 0.21 0.12 0.25</td>
<td>0.37 0.26 0.18 0.11 0.23</td>
</tr>
</tbody>
</table>

| SEm±;雕像days (d); Treatments (t) Storage days (d) Treatments (t) | txd | 0.007 0.002 0.007 0.002 0.007 0.32 |
| -0.05 0.012 0.007 0.019 0.007 0.91 |

Ascorbic Acid (mg 100 g⁻¹)

The highest ascorbic acid content was recorded in the treatment of 2% CaCl₂+1% K₂SO₄+bagging (57.00 and 56.70 mg 100 g⁻¹, respectively) which was found statistically at par with 2% CaCl₂+1% K₂SO₄ during storage in both years. The minimum ascorbic acid content was recorded in the control (42.60 and 42.23 mg 100 g⁻¹) in both years, respectively (Table 8). The ascorbic acid content of mango fruits significantly decreased with the advancement of storage period, probably due to the rapid conversion of L-ascorbic acid into dehydro-ascorbic acid in the presence of ascorbinase enzyme (Mapson, 1970). The above results are very close to the findings of Sharma et al. (1990) and Watanawan et al. (2008) in mango.

**β-carotene (µg 100 g⁻¹)**

The highest β-carotene content was recorded in treatment of 2% CaCl₂+1% K₂SO₄+bagging (3566 and 3611 µg 100 g⁻¹) which was statistically at par with treatments 2% CaCl₂+1% K₂SO₄ (3534 and 3569 µg 100 g⁻¹) during storage in both years, respectively (Table 9). The lowest β-carotene content was noted in the control (2433 and 2450 µg 100 g⁻¹) in both the years,
Table 8. Effect of pre-harvest nutrient application and bagging on ascorbic acid (mg 100 g⁻¹) in mango fruits cv. Amrapali during the storage.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2010-2011 Storage days</th>
<th></th>
<th>Mean</th>
<th></th>
<th>2011-2012 Storage days</th>
<th></th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0  6  12  18</td>
<td>Mean</td>
<td>0</td>
<td>6  12  18</td>
<td>Mean</td>
<td>0  6  12  18</td>
<td>Mean</td>
</tr>
<tr>
<td>Bagging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>51.26 44.68 42.79 40.18</td>
<td>44.73</td>
<td>50.91</td>
<td>44.31</td>
<td>42.43 39.81 44.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2% CaCl₂</td>
<td>55.38 50.72 48.32 44.98</td>
<td>49.85</td>
<td>54.98</td>
<td>50.33 47.93</td>
<td>44.63 49.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1% K₂SO₄</td>
<td>58.73 53.37 50.95 47.11</td>
<td>52.54</td>
<td>58.36</td>
<td>53.02 50.62</td>
<td>47.79 52.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2%CaCl₂+Bagging</td>
<td>57.99 52.73 49.81 46.08</td>
<td>51.65</td>
<td>57.56</td>
<td>52.73 49.81</td>
<td>46.08 51.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1%K₂SO₄+Bagging</td>
<td>60.61 55.44 52.79 49.88</td>
<td>54.68</td>
<td>60.25</td>
<td>55.16 52.83</td>
<td>49.58 54.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2%CaCl₂+1% K₂SO₄+Bagging</td>
<td>61.72 56.54 54.71 51.72</td>
<td>56.17</td>
<td>61.30</td>
<td>56.16 54.31</td>
<td>51.34 55.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2%CaCl₂+1%K₂SO₄+Bagging</td>
<td>62.17 57.34 55.58 52.91</td>
<td>57.00</td>
<td>61.97</td>
<td>57.08 55.19</td>
<td>52.56 56.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>49.22 43.54 40.81 36.82</td>
<td>42.60</td>
<td>48.80</td>
<td>43.18 40.48</td>
<td>36.45 42.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>57.14 51.79 49.47 46.21</td>
<td>51.15</td>
<td>56.77</td>
<td>51.49 49.20</td>
<td>46.03 50.87</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Treatments (t) Storage days (d) t×d
SEm ± 0.34 0.17 0.47 0.36 0.26 0.53
P < 0.05 1.03 0.49 1.36 1.08 0.73 1.50

Table 9. Effect of pre-harvest nutrient application and bagging on β-carotene (µg 100 g⁻¹) in mango fruits cv. Amrapali during the storage.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2010-2011 Storage days</th>
<th></th>
<th>Mean</th>
<th>2011-2012 Storage days</th>
<th></th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0  6  12  18</td>
<td>Mean</td>
<td>0</td>
<td>6  12  18</td>
<td>Mean</td>
<td>0</td>
</tr>
<tr>
<td>Bagging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1110 3011 4211 5263</td>
<td>3399</td>
<td>1116</td>
<td>3023 4220</td>
<td>5277</td>
<td>3409</td>
</tr>
<tr>
<td>2% CaCl₂</td>
<td>1204 3032 4279 5297</td>
<td>3453</td>
<td>1219</td>
<td>3088 4289</td>
<td>5313</td>
<td>3477</td>
</tr>
<tr>
<td>1% K₂SO₄</td>
<td>1192 3029 4271 5275</td>
<td>3442</td>
<td>1201</td>
<td>3046 4282</td>
<td>5288</td>
<td>3454</td>
</tr>
<tr>
<td>2%CaCl₂+Bagging</td>
<td>1255 3077 4313 5341</td>
<td>3497</td>
<td>1267</td>
<td>3114 4335</td>
<td>5373</td>
<td>3522</td>
</tr>
<tr>
<td>1%K₂SO₄+Bagging</td>
<td>1233 3065 4293 5316</td>
<td>3477</td>
<td>1241</td>
<td>3099 4305</td>
<td>5345</td>
<td>3498</td>
</tr>
<tr>
<td>2%CaCl₂+1% K₂SO₄+Bagging</td>
<td>1310 3084 4358 5385</td>
<td>3534</td>
<td>1324</td>
<td>3134 4392</td>
<td>5426</td>
<td>3569</td>
</tr>
<tr>
<td>2%CaCl₂+1%K₂SO₄+Bagging</td>
<td>1333 3104 4411 5416</td>
<td>3566</td>
<td>1352</td>
<td>3185 4427</td>
<td>5481</td>
<td>3611</td>
</tr>
<tr>
<td>Control</td>
<td>992 2389 3101 3248</td>
<td>2433</td>
<td>1011</td>
<td>2407 3118</td>
<td>3265</td>
<td>2450</td>
</tr>
<tr>
<td>Mean</td>
<td>1204 2974 4155 5067</td>
<td>3350</td>
<td>1217</td>
<td>3012 4171</td>
<td>5096</td>
<td>3374</td>
</tr>
</tbody>
</table>

Treatments (t) Storage days (d) t×d
SEm ± 22.78 15.79 32.51 21.92 16.14 27.89
P < 0.05 63.27 15.79 32.51 21.92 16.14 27.89

respectively. The β-carotene content of mango fruits significantly increased with the advancement of storage period, likely due to the breakdown of chlorophyll and increase in carotenoids content by chlorophyllase enzyme during the storage. Analogous observations to these findings have also been earlier reported in mango (Singh et al., 1998; Babu and Krishnamurthy, 1993).

Total Sugars (%)
The significantly highest total sugars content was recorded in treatment of 2% CaCl₂+1% K₂SO₄+bagging (14.71 and 15.16%), while the minimum was noted in the control (11.44 and 11.73%) in both years, respectively (Table 10). The sugars content in the control and bagging increased up to 12th days of storage, whereas other treatments showed increasing trend up to the 15th day and then declined during the storage period in both years. The initial increase in sugars content of fruits during storage might be because of an increase in reducing sugars and non-reducing sugars resulting from conversion of starch into simple sugars and, later on, reduction in sugar content mainly due to its utilization in respiration process.
Table 10. Effect of pre-harvest nutrient application and bagging on total sugars (%) in mango fruits cv. Amrapali during the storage.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2010-2011 Storage days</th>
<th>2011-2012 Storage days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 6 12 18 Mean</td>
<td>0 6 12 18 Mean</td>
</tr>
<tr>
<td>Bagging</td>
<td>5.92 12.22 15.62 14.05 11.95 6.27</td>
<td>12.58 15.94 14.40 12.30</td>
</tr>
<tr>
<td>2% CaCl₂</td>
<td>6.29 12.65 15.78 15.40 12.53 6.61</td>
<td>12.99 16.12 15.75 12.87</td>
</tr>
<tr>
<td>1% K₂SO₄</td>
<td>7.23 13.77 17.08 16.89 13.74 7.58</td>
<td>14.08 17.47 17.16 14.07</td>
</tr>
<tr>
<td>2%CaCl₂+Bagging</td>
<td>6.85 13.03 16.16 15.68 12.93 7.18</td>
<td>13.14 16.53 16.05 13.23</td>
</tr>
<tr>
<td>1%K₂SO₄+Bagging</td>
<td>7.35 13.95 17.26 17.04 13.9 7.74</td>
<td>14.14 17.64 17.22 14.19</td>
</tr>
<tr>
<td>2%CaCl₂+1% K₂SO₄</td>
<td>7.66 14.55 17.90 17.54 14.41 7.99</td>
<td>14.83 18.32 18.12 14.82</td>
</tr>
<tr>
<td>2%CaCl₂+1%K₂SO₄+Bagging</td>
<td>7.93 14.82 18.24 17.83 14.71 8.36</td>
<td>15.19 18.65 18.42 15.16</td>
</tr>
<tr>
<td>Control</td>
<td>5.28 11.71 15.09 13.67 11.44 5.63</td>
<td>12.04 15.39 13.84 11.73</td>
</tr>
<tr>
<td>Mean</td>
<td>6.81 13.34 16.64 16.01 13.20 7.17</td>
<td>13.62 17.00 16.37 13.54</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatments (t)</th>
<th>Storage days (d)</th>
<th>t×d</th>
<th>Treatments (t)</th>
<th>Storage days (d)</th>
<th>t×d</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEm±</td>
<td>0.06</td>
<td>0.04</td>
<td>0.11</td>
<td>0.07</td>
<td>0.06</td>
</tr>
<tr>
<td>P&lt;0.05</td>
<td>0.19</td>
<td>0.11</td>
<td>0.32</td>
<td>0.22</td>
<td>0.16</td>
</tr>
</tbody>
</table>

(Banday, 1996). The above results corroborate the findings of Karemera and Habimana (2014) and Burondkar et al. (2009) in mango.

Organoleptic Evaluation

Fruits treated with 2% CaCl₂+1% K₂SO₄+bagging were found significantly superior in organoleptic quality with highest score (7.71 and 7.79, respectively) and rated as moderate, while the control obtained the lowest score (6.65 and 6.75, respectively) and rated as “nor like nor dislike” in both years (Table 11). However, all the pre-harvest treatments were found acceptable up to 12th day of storage against 6th day of the control, in both years. The above results fall in line with the findings of Hayat et al. (2003) who reported that the pre-harvest treatment of 2% CaCl₂ on apple cv. Banky retained the best general appearance, organoleptic quality, and consumer acceptability during storage. Similarly, Sharma et al. (2014) reported that the pre-harvest bagging improved the visual quality

Table 11. Effect of pre-harvest nutrient application and bagging on organoleptic quality of mango fruits cv. Amrapali during the storage.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2010-2011 Storage days</th>
<th>2011-2012 Storage days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 6 12 18 Mean</td>
<td>0 6 12 18 Mean</td>
</tr>
<tr>
<td>Bagging</td>
<td>7.42 8.45 8.21 5.42 7.38 7.51 8.57 8.29 5.46 7.46</td>
<td></td>
</tr>
<tr>
<td>2% CaCl₂</td>
<td>7.32 8.14 7.92 5.05 7.11 7.46 8.26 8.00 5.09 7.20</td>
<td></td>
</tr>
<tr>
<td>1% K₂SO₄</td>
<td>7.32 8.25 8.07 5.15 7.20 7.46 8.37 8.15 5.19 7.29</td>
<td></td>
</tr>
<tr>
<td>2%CaCl₂+Bagging</td>
<td>7.42 8.51 8.29 5.63 7.46 7.46 8.63 8.37 5.67 7.53</td>
<td></td>
</tr>
<tr>
<td>1%K₂SO₄+Bagging</td>
<td>7.42 8.62 8.38 5.77 7.55 7.51 8.74 8.46 5.81 7.63</td>
<td></td>
</tr>
<tr>
<td>2%CaCl₂+1% K₂SO₄</td>
<td>7.32 8.32 8.14 5.35 7.28 7.46 8.44 8.22 5.39 7.38</td>
<td></td>
</tr>
<tr>
<td>2%CaCl₂+1%K₂SO₄+Bagging</td>
<td>7.42 8.81 8.56 6.03 7.71 7.51 8.93 8.64 6.07 7.79</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>7.24 7.94 7.77 4.83 6.95 7.46 8.06 7.85 4.87 7.06</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>7.36 8.38 8.17 5.40 7.33 7.48 8.50 8.25 5.44 7.418</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatments (t)</th>
<th>Storage days (d)</th>
<th>t×d</th>
<th>Treatments (t)</th>
<th>Storage days (d)</th>
<th>t×d</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEm±</td>
<td>0.02</td>
<td>0.05</td>
<td>0.13</td>
<td>0.04</td>
<td>0.06</td>
</tr>
<tr>
<td>P&lt;0.05</td>
<td>0.07</td>
<td>0.13</td>
<td>0.36</td>
<td>0.12</td>
<td>0.16</td>
</tr>
</tbody>
</table>
of fruit by promoting skin coloration and reducing blemishes, it also changed the micro-environment for fruit development, which can have several beneficial effects on internal fruit quality. Sarker et al. (2009) also reported that the bagging also improved the physical quality i.e., the incidence of black spots, of mango fruits, which increased their market appeal.

Shelf Life

Fruits treated with 2% CaCl₂+1% K₂SO₄+bagging showed the maximum shelf life up to 12th day with minimum weight loss (7.94% and 7.57%, respectively) in both years. Although, other treatments viz. 2% CaCl₂+bagging, 2% CaCl₂+ 1% K₂SO₄ and 2% CaCl₂, also showed the shelf life up to 12 days and appeared to be the second, third and fourth, respectively, in minimizing weight loss of mango fruits in both years. Other treatments, including the control, showed the shelf life up to only 6th day, while the maximum weight loss (12.88 and 12.55%) was recorded in untreated fruits (control) in both years, respectively (Table 3). Similarly, Karemera and Habimana (2014) have also reported that the trees sprayed with 1.50% CaCl₂ at 30 days before harvest extended the shelf life of mango cv. Totapuri up to 25.89 days and physical-chemical proprieties were also improved compared to fruits from non-sprayed trees. Burondkar et al. (2009) also reported the effect of 1% K₂SO₄ on shelf life of mango fruits by reducing the weight loss. Signes et al. (2007) reported that pre-harvest bagging delayed ripening resulting in extended shelf life of ‘Perla’, a black table-grape.

CONCLUSIONS

Thus, it is concluded that the pre-harvest treatment of 2% CaCl₂+1% K₂SO₄+bagging was found to be the best to increase the fruits quality in respect of fruits weight, firmness, TSS, ascorbic acid, total sugars and β-carotene, with minimum weight loss and black spotting in mango fruits cv. Amrapali and maintained it throughout the entire period of storage. Treated fruit can be stored up to 12 days with minimum weight loss, highest organoleptic quality, and acceptability during the storage. Therefore, the pre-harvest treatment of 2% CaCl₂+1% K₂SO₄+bagging is suggested to the mango traders and grower of India for taking a quality production with prolonged shelf life to obtain a profitable price of mangoes in domestic and export markets.

REFERENCES


اثر کاربرد عناصر غذایی و کیسه بندی پیش از برداشت روی کیفیت و انبارداری میوه Amrapali (Mangifera indica L.)

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چکیده

هدف پژوهش حاضر مطالعه اثر کیسه بندی و پاشیدن CaCl۲ و K۲SO۴ پیش از برداشت محصول Amrapali روی کیفیت و انبارداری میوه اینه کولتیوار میوه در طی دو سال پی در پی بود. محلول های مزبور در سه نوبت شامل ۱۰ و ۲۰ روز قبل از برداشت روی درختان این رقم اپانیا پاشیده شد و روی کل از چندان محصول، میوه داخل یا کاغذ هفته آی قرار داده شدند. میوه های جیده شده در انباری با حرارت محیط قرار داده شد و تا ۱۸ روز به طور سیستم در داخل انها بازدارند. مشاهدات ثبت می شد. داده ها حاکی از آن بود که بهترین نتیجه برای بهبود کیفیت میوه‌ها از نظر بیشترین وزن میوه، β-carotene، TSS، استاد اسکورپیک، ترکیب کل، و محصولات K۲SO۴ و CaCl۲ داشتند کمترین مقدار K۲SO۴ و CaCl۲/۱۰۰۰۰ کیسه بندی پیش از برداشت به دست می آید. میوه هایی که با ۸۲ CaCl۲/۱۰۰۰۰ و K۲SO۴/۱۰۰۰۰ کیسه بندی تیمار شده بودند کمترین کاهش وزن و بیشترین خواص کیفیت های حاصلی (طعم، رنگ) داشتند. تیمار ابراری دارای حفظ کرده بودند در حالی که برای میوه های تیمار نشده (شاهد) این دوره روز روز بود.