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## INTEGRATED APPROACH FOR EXTENDING SHELF LIFE OF ACID LIME (*CITRUS AURANTIFOLIA* SWINGLE)

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### ABSTRACT

The study was conducted at the University of Horticultural Sciences, Bagalkot during the year 20124-25. Nine treatment combinations involving preharvest sprays of CaCl<sub>2</sub> (1%) and KNO<sub>3</sub> (10 g/L) + GA<sub>3</sub> (20 ppm) with postharvest coatings of CaCl<sub>2</sub> (2%), CMC (1%) and Gum Arabica (10%) each with mancozeb (1500 ppm). Results showed that physiological loss in weight, TSS and decay percentage increased, while acidity, ascorbic acid and firmness decreased with storage. Among all, T<sub>4</sub> (CaCl<sub>2</sub> 1% spray with CaCl<sub>2</sub> 2% + mancozeb 1500 ppm coating) was most effective in minimizing PLW (15.25%), while retaining maximum acidity (6.31%), ascorbic acid (27.84 mg/100 ml), firmness (38.72 N), juice content (45.65%). The beneficial effect of calcium was due to its role in strengthening cell walls and maintaining membrane integrity, while mancozeb minimized microbial decay. Overall, combined preharvest CaCl<sub>2</sub> spray and postharvest CaCl<sub>2</sub> coating with mancozeb effectively extended shelf life upto 20 days and maintained fruit quality of Kagzi lime under ambient storage.

**Keywords:** Kagzi lime, preharvest spray, coating, shelf life, mancozeb.

### Introduction

Citrus belongs to the family *Rutaceae*, are among the most important fruit crops globally, valued for their refreshing flavor, nutritional richness and diverse uses. Among them, acid lime (*Citrus aurantifolia* Swingle) holds a prominent place in India for its high juice content, strong acidity and pleasant aroma. It is widely used in fresh and processed forms such as beverages, pickles and flavoring agents (Ladaniya, 2010). India ranks second in global fruit and vegetable production, with citrus occupying about 3.27 lakh ha area, producing 3.548 million tonnes (Anon., 2021). Acid lime contributes about 22.3% of the total citrus area, mainly grown in Andhra Pradesh, Maharashtra, Madhya Pradesh, Tamil Nadu, Gujarat and Karnataka.

Kagzi lime, known for its thin peel, high juice content and fewer seeds, is a non-climacteric fruit

harvested at the mature green stage and is highly perishable (Waghaye *et al.*, 2019). Postharvest losses in acid lime range from 25–40% (Bisen *et al.*, 2012) due to physiological weight loss, microbial infections and poor storage. Major pathogens include *Penicillium digitatum*, *Geotrichum candidum* and *Colletotrichum gloeosporioides*, which cause rapid decay under warm, humid conditions. The bahar system of cultivation (Ambe, Mrig, and Hasta bahar) leads to seasonal oversupply, particularly during Ambe bahar (June–August), causing price crashes and distress sales (Deshmukh *et al.*, 2015; Ladaniya, 2008). Limited cold storage and processing facilities worsen farmers losses.

To minimize such losses, integrated pre and postharvest strategies are vital. Preharvest calcium sprays improve cell wall strength and firmness, while postharvest edible coatings form semi-permeable films that reduce moisture loss, respiration and microbial

attack. Coatings like Gum Arabica, CMC and calcium chloride are effective, safe and affordable (Perez-Vazquez *et al.*, 2023). Hence, the present study was undertaken to evaluate the effect of preharvest sprays and postharvest coatings on the shelf life and quality of Kagzi lime under ambient conditions, aiming to develop simple, low-cost and farmer-friendly technologies for reducing postharvest losses.

### Material and Methods

#### Plant Material and Preharvest Treatments

The uniform, healthy and disease-free *Kagzi lime* trees of similar age were selected from the orchard located at Sector No. 70, University of Horticultural Sciences, Bagalkot. Preharvest sprays were applied to study their influence on fruit quality and storability. The treatments included calcium chloride ( $\text{CaCl}_2$ ) at 1% and potassium nitrate ( $\text{KNO}_3$ ) at 10 g/L combined with gibberellic acid ( $\text{GA}_3$ ) at 20 ppm, applied 30 days before harvest using a power sprayer during early morning hours to ensure uniform coverage and effective absorption. Fruits were harvested manually at the physiologically mature green stage, free from defects and carefully transported to the laboratory for postharvest studies.

#### Postharvest Coating Treatments

Postharvest coatings consisted of  $\text{CaCl}_2$  at 2%, carboxymethyl cellulose (CMC) at 1%, and Gum Arabica at 10%, each combined with the fungicide mancozeb at 1500 ppm. The experiment comprised nine treatment combinations laid out in a Randomized Complete Block Design (RCBD) with three replications. The treatments included control ( $T_1$ ),  $\text{CaCl}_2$  1% spray ( $T_2$ ),  $\text{KNO}_3 + \text{GA}_3$  spray ( $T_3$ ) and combinations of preharvest sprays with respective postharvest coatings and fungicide from  $T_4$  to  $T_9$ .

#### Preparation of Solutions

The 1%  $\text{CaCl}_2$  spray was prepared by dissolving 100 g in 10 L of water, while 100 g  $\text{KNO}_3$  and 0.2 g  $\text{GA}_3$  were dissolved in 10 L of water for the combined spray. Coating solutions were prepared as follows: 2%  $\text{CaCl}_2$  (20 g  $\text{L}^{-1}$ ), 1% CMC (10 g  $\text{L}^{-1}$ ), and 10% gum arabic (100 g  $\text{L}^{-1}$ ), the latter prepared with mild heating (~40 °C), addition of 0.1% Tween-20 as a plasticizer, and pH adjustment to neutral (Ali *et al.*, 2010).

Fruits from each treatment were dipped in the respective coating solution for about one minute, air-dried at room temperature, labeled and packed in clean gunny bags. The fruits were stored under ambient

laboratory conditions and observations were recorded at 5-day intervals throughout the storage period.

#### Methods for Quality Parameter Evaluation in Acid Lime

**Physiological loss in weight (PLW):** The 30 marked fruits per treatment were weighed initially and reweighed at 5-day intervals using an electronic balance. The cumulative weight reduction during storage was calculated as (El-Gioushy *et al.*, 2022):

$$\text{PLW (\%)} = \frac{[(\text{Initial weight} - \text{Final weight}) / \text{Initial weight}] \times 100$$

**Total Soluble Solids (°B):** It was measured using a hand refractometer (0–32 °Brix). Clear juice drops were placed on the prism and readings were recorded in °Brix.

**Juice Content (%):** Juice content was determined by weighing the extracted juice and whole fruit using an electronic balance. It was expressed as (Srivastava and Sanjeev kumar, 2002):

$$\text{Juice content (\%)} = \frac{(\text{Weight of extracted juice} / \text{Weight of whole fruit}) \times 100$$

**Titrateable Acidity (%):** Acidity was determined by titrating juice with 0.1 N NaOH using phenolphthalein as indicator and expressed as % citric acid (Ranganna, 1986):

$$\text{Acidity (\%)} = \frac{\text{Titre value} \times \text{N of NaOH} \times \text{Vol. made up} \times \text{Eq. weight of acid}}{\text{Vol. of aliquot taken} \times \text{Vol. of sample taken} \times 1000} \times 1000$$

**Ascorbic Acid (mg/100 ml):** Ascorbic acid was estimated by titration with 2,6-dichlorophenol indophenol dye and expressed as mg/100 ml juice:

$$\text{Ascorbic acid (mg/100ml)} = \frac{\text{Ascorbic acid content in standard (mg)} \times \text{Total sample volume} \times \text{TV}_2}{\text{mL of aliquot} \times \text{Wt. of sample taken} \times \text{TV}_1} \times 100$$

**Firmness (N):** Firmness was measured using a Texture Analyzer (TAXT Plus, Stable Micro System, Model: Texture Export v1.22) by penetration test with a 2 mm stainless steel probe at the equatorial region. The force required to penetrate the peel was recorded in Newtons (N). Mean values of three fruits per replication were taken.

**Treatment details**

Treatment combination	Preharvest spray	Postharvest coating
T <sub>1</sub>		Control
T <sub>2</sub>	CaCl <sub>2</sub> 1 %	-
T <sub>3</sub>	KNO <sub>3</sub> 10g/L + GA <sub>3</sub> 20 ppm	-
T <sub>4</sub>	CaCl <sub>2</sub> 1 %	CaCl <sub>2</sub> 2 % + mancozeb 1500 ppm
T <sub>5</sub>	CaCl <sub>2</sub> 1 %	CMC 1 % + mancozeb 1500 ppm
T <sub>6</sub>	CaCl <sub>2</sub> 1 %	Gum Arabica 10 % + mancozeb 1500 ppm
T <sub>7</sub>	KNO <sub>3</sub> 10g/L + GA <sub>3</sub> 20 ppm	CaCl <sub>2</sub> 2 % + mancozeb 1500 ppm
T <sub>8</sub>	KNO <sub>3</sub> 10g/L + GA <sub>3</sub> 20 ppm	CMC 1 % + mancozeb 1500 ppm
T <sub>9</sub>	KNO <sub>3</sub> 10g/L + GA <sub>3</sub> 20 ppm	Gum Arabica 10 % + mancozeb 1500 ppm

**Result and discussion****Effect on physiological loss in weight**

The data presented in **Table 1** showed a steady increase in physiological loss in weight (PLW) of fruits during ambient storage. The highest PLW (24.61%) was recorded in untreated fruits, while the lowest (15.25%) was observed in fruits treated with preharvest CaCl<sub>2</sub> at 1% and postharvest CaCl<sub>2</sub> coating at 2% + mancozeb 1500 ppm (T<sub>4</sub>), followed by T<sub>7</sub> (KNO<sub>3</sub> 10g/L + GA<sub>3</sub> 20 ppm and postharvest CaCl<sub>2</sub> coating at 2% + mancozeb 1500 ppm, 15.35%). The reduction in PLW in treated fruits could be attributed to the role of calcium in strengthening cell wall structure through calcium pectate cross-linking and maintaining membrane integrity, which minimized water loss and leakage of cellular fluids (Picchioni *et al.*, 1998; Lester and Grusak, 1999). GA<sub>3</sub> treatment might have delayed senescence by reducing respiration and slowing down cell wall degradation (Sakhale and Kapse, 2012), while KNO<sub>3</sub> improved osmotic regulation and maintained turgor pressure. In postharvest coatings CaCl<sub>2</sub> were more effective in reducing PLW by forming a semi-permeable barrier that limited moisture loss and slowed respiration (Banks *et al.*, 1993; Garcia *et al.*, 1996). Gum Arabica and CMC coatings also helped reduce water loss due to their film-forming properties, similar to findings reported by Ali *et al.* (2010) and Mahajan and Dhatt (2004). Overall, integrated CaCl<sub>2</sub> treatments were most effective in minimizing PLW of Kagzi lime fruits during storage.

**Effect on Total soluble solids (TSS °B)**

The data in Table 2 showed a gradual increase in total soluble solids of acid lime during storage, with the highest value (9.52 °Brix) in untreated fruits and the lowest (8.54 °Brix) in fruits treated with preharvest CaCl<sub>2</sub> (1%) spray and postharvest CaCl<sub>2</sub> coating (2%) with mancozeb. The increase in TSS was due to the breakdown of complex carbohydrates and the concentration effect resulting from moisture loss, while the slower rise in CaCl<sub>2</sub>-treated fruits resulted from

calcium role in maintaining cell wall integrity and reducing respiration. Similar results were reported by Rohani *et al.* (1997), Shahid and Abbasi (2011), and Madani *et al.* (2014), confirming that calcium-based coatings effectively delay sugar accumulation and moisture loss.

**Effect on titratable acidity**

From the Table 3, titratable acidity of acid lime fruits decreased gradually during storage due to the utilization of organic acids in respiration and their conversion into sugars. The control (T<sub>1</sub>) showed the fastest decline in acidity (7.09% to 5.01%), while the highest acidity was retained in T<sub>4</sub> (CaCl<sub>2</sub> 1% spray and CaCl<sub>2</sub> 2% + Mancozeb 1500 ppm coating, 6.31%), followed by T<sub>7</sub> (KNO<sub>3</sub> + GA<sub>3</sub> spray and CaCl<sub>2</sub> coating, 6.24%) and T<sub>6</sub> (CaCl<sub>2</sub> spray + Gum Arabica coating, 5.97%). The superior acidity retention in CaCl<sub>2</sub>-treated fruits is attributed to calcium role in maintaining cell wall integrity and reducing membrane permeability, thereby slowing respiration and organic acid degradation. Gum Arabica coating also delayed acidity loss by forming a semi-permeable film that restricted gas exchange and minimized metabolic activity. Similar findings were reported by Ishaq *et al.* (2009) in apricot, Shahid and Abbasi (2011) in orange and El-Anany *et al.* (2009) in apple.

**Effect on juice content**

The juice content of fruits gradually declined during storage due to increased physiological and moisture loss from transpiration and respiration (Table 4). The control (T<sub>1</sub>) showed the lowest juice content, decreasing sharply from 47.10% to 28.33% by 30 DAS, due to higher PLW and moisture loss. The highest juice retention was recorded in T<sub>4</sub> (CaCl<sub>2</sub> 1% spray and CaCl<sub>2</sub> 2% + Mancozeb coating) and T<sub>7</sub> (KNO<sub>3</sub> + GA<sub>3</sub> spray and CaCl<sub>2</sub> + Mancozeb coating), both maintained above 37% juice content due to calcium role in strengthening cell walls and reducing membrane permeability, which minimized respiration and moisture loss. This was followed by Gum Arabica

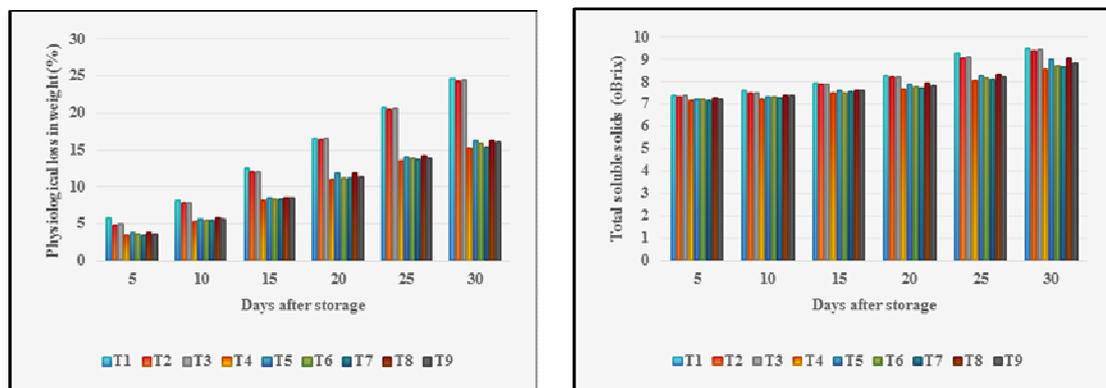
coating (T<sub>6</sub> and T<sub>9</sub>), which reduced respiration and water loss and modified the atmosphere around fruits by forming a semi-permeable film. Similar findings were reported by Mahajan *et al.* (2013) in Kinnow, Hassan *et al.* (2014) in tangerine and Daisy *et al.* (2020) in citrus fruits, confirming that calcium and Gum Arabica coatings effectively preserved juice content during storage.

### Effect on ascorbic acid

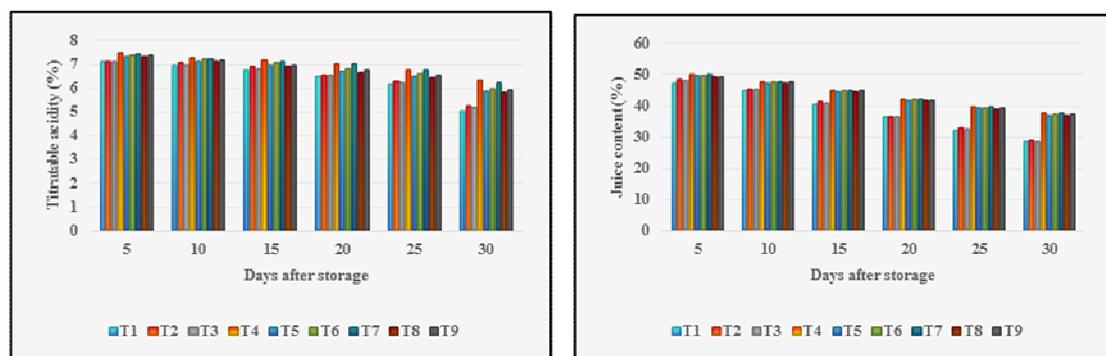
As shown in Table 5, ascorbic acid content of acid lime declined from 31.90 mg/100 ml at 5 DAS to 23.23 mg/100 ml at 30 DAS due to respiration and oxidative breakdown. The lowest retention was observed in the control (T<sub>1</sub>, 21.12 mg/100 ml), while the highest was recorded in T<sub>4</sub> (CaCl<sub>2</sub> 1% spray + CaCl<sub>2</sub> 2% coating + Mancozeb, 24.95 mg/100 ml) and T<sub>7</sub> (24.82 mg/100 ml), followed by Gum Arabica coated treatments (T<sub>6</sub> and T<sub>9</sub>). The better retention in CaCl<sub>2</sub> treated fruits is attributed to strengthened cell walls and reduced metabolic activity, while Gum Arabica coating slowed moisture loss and gas exchange, thereby retained ascorbic acid, consistent with earlier reports in, banana and tangerine (Ullah, 2009; Hassan *et al.*, 2014).

### Effect on firmness of fruits

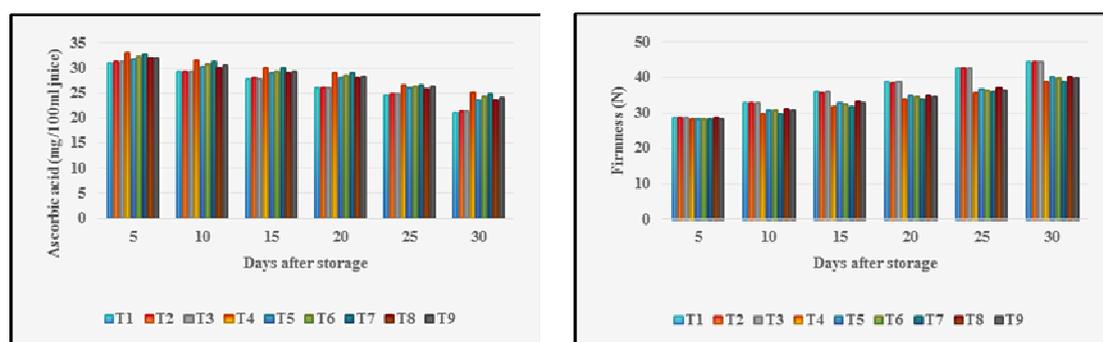
As shown in Table 6, firmness of acid lime declined progressively during storage due to metabolism and senescence, which cause solubilization of pectic substances, hemicellulose degradation and starch hydrolysis, weakening the middle lamella and leading to softening (Chaves *et al.*, 2007; Zewter *et al.*, 2012). The lowest firmness was recorded in T<sub>4</sub> (CaCl<sub>2</sub> 1% spray and CaCl<sub>2</sub> 2% + Mancozeb coating, 38.72 N), followed by T<sub>7</sub> (KNO<sub>3</sub> + GA<sub>3</sub> spray and CaCl<sub>2</sub> coating, 38.85 N), and Gum Arabica coated fruits T<sub>6</sub> and T<sub>9</sub> (39.76–39.85 N). The superior firmness in CaCl<sub>2</sub> treatments is attributed to Ca<sup>2+</sup> ions forming calcium pectate cross-links in the middle lamella, reducing enzymatic degradation by polygalacturonase and pectin methylesterase and delaying senescence (Lester and Grusak, 1999; Manganaris *et al.*, 2007). Mancozeb may have additionally minimized microbial induced softening. Gum Arabica coatings also helped retain firmness by forming semi-permeable films that reduced transpiration, modified gas exchange and slowed metabolic activity, consistent with earlier reports in guava and papaya (Ghasemnezhad *et al.*, 2013).



**Fig. 1:** Effect of different preharvest sprays and post-harvest coating treatments on physiological loss in weight and TSS of acid lime fruits stored at ambient condition



**Fig. 2:** Effect of different preharvest sprays and post-harvest coating treatments on titratable acidity and juice content of acid lime fruits stored at ambient condition



**Fig. 3:** Effect of different preharvest sprays and post-harvest coating treatments on ascorbic acid content and firmness of acid lime fruits stored at ambient condition

**Table 1 :** Effect of different preharvest sprays and postharvest coating treatments on physiological loss in weight of acid lime fruits stored at ambient condition (28.9 °C, 35.56 % RH)

Treatments	Physiological loss in weight (%)						
	Days after storage						
	5 DAS	10 DAS	15 DAS	20 DAS	25 DAS	30 DAS	Mean
T <sub>1</sub>	5.82	8.15	12.50	16.62	20.74	24.61	<b>14.74</b>
T <sub>2</sub>	4.72	7.75	11.98	16.44	20.41	24.34	<b>14.27</b>
T <sub>3</sub>	4.89	7.87	12.05	16.50	20.51	24.47	<b>14.38</b>
T <sub>4</sub>	3.45	5.35	8.18	11.04	13.51	15.25	<b>9.46</b>
T <sub>5</sub>	3.68	5.68	8.46	11.77	14.05	16.12	<b>9.96</b>
T <sub>6</sub>	3.55	5.52	8.31	11.23	13.83	15.86	<b>9.72</b>
T <sub>7</sub>	3.50	5.44	8.25	11.08	13.60	15.34	<b>9.54</b>
T <sub>8</sub>	3.79	5.78	8.55	11.86	14.16	16.22	<b>10.06</b>
T <sub>9</sub>	3.66	5.62	8.40	11.34	13.91	15.96	<b>9.82</b>
Mean	<b>4.12</b>	<b>6.35</b>	<b>9.63</b>	<b>13.10</b>	<b>16.08</b>	<b>18.69</b>	
S.Em±	<b>0.03</b>	<b>0.04</b>	<b>0.05</b>	<b>0.03</b>	<b>0.03</b>	<b>0.01</b>	
CD at 1%	<b>0.13</b>	<b>0.16</b>	<b>0.20</b>	<b>0.11</b>	<b>0.11</b>	<b>0.04</b>	

**Table 2 :** Effect of different preharvest sprays and postharvest coating treatments on total soluble solids of acid lime fruits stored at ambient condition (28.9 °C, 35.56 % RH)

Treatments	Total soluble solids (°Brix)						
	Days after storage						
	5 DAS	10 DAS	15 DAS	20 DAS	25 DAS	30 DAS	Mean
T <sub>1</sub>	7.40	7.57	7.95	8.28	9.26	9.52	<b>8.33</b>
T <sub>2</sub>	7.33	7.49	7.90	8.19	9.03	9.39	<b>8.22</b>
T <sub>3</sub>	7.37	7.51	7.88	8.23	9.13	9.42	<b>8.26</b>
T <sub>4</sub>	7.13	7.23	7.47	7.64	8.03	8.54	<b>7.67</b>
T <sub>5</sub>	7.23	7.33	7.57	7.86	8.24	8.97	<b>7.87</b>
T <sub>6</sub>	7.20	7.30	7.50	7.76	8.13	8.73	<b>7.77</b>
T <sub>7</sub>	7.17	7.27	7.53	7.69	8.08	8.63	<b>7.73</b>
T <sub>8</sub>	7.27	7.38	7.60	7.92	8.33	9.02	<b>7.92</b>
T <sub>9</sub>	7.23	7.37	7.58	7.81	8.20	8.80	<b>7.83</b>
Mean	<b>7.26</b>	<b>7.38</b>	<b>7.66</b>	<b>7.93</b>	<b>8.50</b>	<b>9.00</b>	
S.Em±	<b>0.04</b>	<b>0.04</b>	<b>0.05</b>	<b>0.03</b>	<b>0.02</b>	<b>0.01</b>	
CD at 1%	<b>0.18</b>	<b>0.15</b>	<b>0.19</b>	<b>0.11</b>	<b>0.06</b>	<b>0.04</b>	

**Initial value:** Control (7.32 °Brix), preharvest spray CaCl<sub>2</sub> 1 % (7.38 °Brix) and preharvest spray KNO<sub>3</sub> 10g/L + GA<sub>3</sub> 20 ppm (7.35 °Brix)

**Table 3 :** Effect of different preharvest sprays and postharvest coating treatments on titratable acidity of acid lime fruits stored at ambient condition (28.9 °C, 35.56 % RH)

Treatments	Titratable acidity (%)						
	Days after storage						
	5 DAS	10 DAS	15 DAS	20 DAS	25 DAS	30 DAS	Mean
T <sub>1</sub>	7.09	6.93	6.76	6.48	6.16	5.01	<b>6.40</b>
T <sub>2</sub>	7.10	7.04	6.89	6.53	6.29	5.23	<b>6.51</b>
T <sub>3</sub>	7.10	6.96	6.82	6.51	6.21	5.16	<b>6.46</b>
T <sub>4</sub>	7.47	7.26	7.14	7.01	6.76	6.31	<b>6.70</b>
T <sub>5</sub>	7.33	7.12	6.95	6.69	6.48	5.86	<b>6.74</b>
T <sub>6</sub>	7.36	7.19	7.08	6.78	6.61	5.97	<b>6.83</b>
T <sub>7</sub>	7.44	7.21	7.10	6.98	6.73	6.24	<b>6.95</b>
T <sub>8</sub>	7.31	7.10	6.91	6.63	6.42	5.78	<b>6.69</b>
T <sub>9</sub>	7.35	7.16	6.96	6.72	6.55	5.90	<b>6.77</b>
Mean	<b>7.28</b>	<b>7.11</b>	<b>6.96</b>	<b>6.70</b>	<b>6.47</b>	<b>5.72</b>	
S.Em±	<b>0.07</b>	<b>0.05</b>	<b>0.05</b>	<b>0.1</b>	<b>0.03</b>	<b>0.03</b>	
CD at 1%	<b>0.30</b>	<b>0.21</b>	<b>0.21</b>	<b>0.4</b>	<b>0.12</b>	<b>0.11</b>	

Initial value: Control (7.15 %), preharvest spray CaCl<sub>2</sub> 1 % (7.21 %) and preharvest spray KNO<sub>3</sub> 10g/L + GA<sub>3</sub> 20 ppm (7.18 %)

**Table 4 :** Effect of different preharvest sprays and postharvest coating treatments on juice content of acid lime fruits stored at ambient condition (28.9 °C, 35.56 % RH)

Treatments	Juice content (%)						
	Days after storage						
	5 DAS	10 DAS	15 DAS	20 DAS	25 DAS	30 DAS	Mean
T <sub>1</sub>	47.10	44.76	40.40	36.33	32.22	28.33	<b>38.19</b>
T <sub>2</sub>	48.30	45.27	41.08	36.59	32.66	28.70	<b>38.77</b>
T <sub>3</sub>	48.06	45.12	40.96	36.46	32.55	28.53	<b>38.61</b>
T <sub>4</sub>	49.84	47.68	44.95	42.14	39.57	37.76	<b>43.66</b>
T <sub>5</sub>	49.41	47.36	44.57	41.59	39.06	36.90	<b>43.15</b>
T <sub>6</sub>	49.54	47.47	44.70	41.86	39.26	37.22	<b>43.34</b>
T <sub>7</sub>	49.86	47.51	44.73	42.01	39.47	37.64	<b>43.54</b>
T <sub>8</sub>	49.21	47.20	44.41	41.50	38.83	36.79	<b>42.99</b>
T <sub>9</sub>	49.36	47.42	44.61	41.73	39.15	37.02	<b>43.22</b>
Mean	<b>48.96</b>	<b>41.64</b>	<b>43.38</b>	<b>40.02</b>	<b>36.97</b>	<b>34.32</b>	
S.Em±	<b>0.05</b>	<b>0.02</b>	<b>0.02</b>	<b>0.02</b>	<b>0.02</b>	<b>0.03</b>	
CD at 1%	<b>0.22</b>	<b>0.08</b>	<b>0.09</b>	<b>0.08</b>	<b>0.06</b>	<b>0.12</b>	

Initial value: Control (52.85 %), preharvest spray CaCl<sub>2</sub> 1 % (52.98 %) and preharvest spray KNO<sub>3</sub> 10g/L + GA<sub>3</sub> 20 ppm (52.92 %)

**Table 5 :** Effect of different preharvest sprays and postharvest coating treatments on ascorbic acid content of acid lime fruits stored at ambient condition (28.9 °C, 35.56 % RH)

Treatments	Ascorbic acid (mg/100ml juice)						
	Days after storage						
	5 DAS	10 DAS	15 DAS	20 DAS	25 DAS	30 DAS	Mean
T <sub>1</sub>	31.08	29.25	27.87	25.98	24.65	21.12	<b>26.66</b>
T <sub>2</sub>	31.17	29.31	27.93	26.06	24.78	21.33	<b>26.76</b>
T <sub>3</sub>	31.14	29.27	27.91	26.01	24.75	21.25	<b>26.72</b>
T <sub>4</sub>	32.91	31.45	30.05	28.96	26.65	24.95	<b>29.16</b>
T <sub>5</sub>	31.84	30.38	29.08	28.07	25.97	23.63	<b>28.16</b>
T <sub>6</sub>	32.23	30.76	29.32	28.43	26.32	24.26	<b>28.55</b>
T <sub>7</sub>	32.75	31.37	29.97	28.91	26.59	24.82	<b>29.07</b>
sT <sub>8</sub>	31.96	30.11	29.02	28.02	25.91	23.57	<b>28.10</b>
T <sub>9</sub>	32.02	30.54	29.28	28.38	26.28	24.14	<b>28.44</b>
Mean	<b>31.90</b>	<b>30.27</b>	<b>28.94</b>	<b>27.65</b>	<b>25.77</b>	<b>23.23</b>	
S.Em±	<b>0.34</b>	<b>0.42</b>	<b>0.34</b>	<b>0.31</b>	<b>0.40</b>	<b>0.04</b>	
CD at 1%	<b>1.40</b>	<b>1.75</b>	<b>1.40</b>	<b>1.27</b>	<b>1.65</b>	<b>0.16</b>	

Initial value: Control (33.24 mg/100ml), preharvest spray CaCl<sub>2</sub> 1 % (34.21 mg/100ml) and preharvest spray KNO<sub>3</sub> 10g/L + GA<sub>3</sub> 20 ppm (34.18 mg/100ml)

**Table 6 :** Effect of different preharvest sprays and postharvest coating treatments on firmness of acid lime fruits stored at ambient condition (28.9 °C, 35.56 % RH)

Treatments	Firmness (N)						
	Days after storage						
	5 DAS	10 DAS	15 DAS	20 DAS	25 DAS	30 DAS	Mean
T <sub>1</sub>	28.63	32.83	35.92	38.75	42.64	44.47	<b>37.21</b>
T <sub>2</sub>	28.53	32.68	35.71	38.52	42.45	44.29	<b>37.03</b>
T <sub>3</sub>	28.58	32.77	35.85	38.68	42.57	44.38	<b>37.14</b>
T <sub>4</sub>	28.21	29.78	31.74	33.70	35.71	38.72	<b>32.98</b>
T <sub>5</sub>	28.41	30.82	32.99	34.83	36.75	40.18	<b>34.00</b>
T <sub>6</sub>	28.33	30.57	32.56	34.57	36.27	39.76	<b>33.68</b>
T <sub>7</sub>	28.27	29.84	31.83	33.88	35.86	38.85	<b>33.09</b>
T <sub>8</sub>	28.48	30.94	33.06	34.96	36.87	40.27	<b>34.10</b>
T <sub>9</sub>	28.38	30.65	32.68	34.66	36.19	39.85	<b>33.74</b>
<b>Mean</b>	<b>28.42</b>	<b>31.21</b>	<b>33.59</b>	<b>35.84</b>	<b>38.37</b>	<b>41.20</b>	
<b>S.Em±</b>	<b>0.03</b>	<b>0.03</b>	<b>0.03</b>	<b>0.04</b>	<b>0.02</b>	<b>0.03</b>	
<b>CD at 1%</b>	<b>0.13</b>	<b>0.13</b>	<b>0.13</b>	<b>0.16</b>	<b>0.08</b>	<b>0.13</b>	

**Initial value:** Control (27.07 N), preharvest spray CaCl<sub>2</sub> 1 % (27.23 N) and preharvest spray KNO<sub>3</sub> 10g/L + GA<sub>3</sub> 20 ppm (27.18 N)

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