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# Sap burn damage of Mango (*Mangifera indica* L.) and its management in Telangana

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**Abstract**
One of the main problems in the marketing of mango in Telangana is sap burn damage. It is characterized by causing dark brown spots or blackish streaks on mango fruits. The symptoms of contact with sap may not be apparent initially, but can be perfectly distinguished in a few days or as the ripening process occurs. Sap burn damage reduces the quality and shelf life of mango fruits as it promotes a higher incidence of anthracnose and can vary according to the region, season, age of the tree, maturity stage at harvest, and variety. The management practices to reduce sap burn damage are sodium chloride (5.0%) and calcium hydroxide (0.5 and 1.0%) for 5 min; alum (0.5 and 1.0%); use of Agral®, Cold Power®, Mango Wash® detergents; sodium hydroxide (2.0%); cut with peduncle > 5 cm and remove peduncle after 24 h; desapping for 20 min up to 4 h; Lemon (0.5%); Sodium bicarbonate (1.0%): Tween 80; Sodium lauryl sulfonate or sodium hypochlorite (0.1%) or dry-decolorized; Commercial or enzymatic detergent (0.1%); Sodium carboxymethyl cellulose and sodium lauryl sulfate; wax coating based on polyethylene; DC Tron (100-1000 µL / L).

**Keywords:** Mango, sap burn injury, varieties, desapping, anthracnose, sodium hydroxide

## Introduction
India is the largest producer of mango in the world, but at the same time, globally, Mexico is the largest exporter of the fruit, accounting for 20 percent of world mango exports. It is important to note that the demand for mangoes is growing across the world, especially in markets such as the United States, Canada, the European Union, and China, and India can play a great role in fulfilling the demand. The area under mango in India is about 2.25 million ha with a production of about 21.8 million t. registering an average productivity of 9.7 t ha-1. The area under mango in Telangana is about 1.15 lakh ha with a production of about 10.8 lakh t. registering an average productivity of 9.31 t ha-1(Srinivasa Reddy, I.V. 2022) [46].

The mango, being perishable, suffers with many postharvest problems including different diseases and disorders, which again reduce the value of fruits during storage. Among different postharvest problems, sap-burn or sap-injury in mango fruit is a major industry concern, as it results in poor fruit quality, lower prices and promotes microbial infection, due to the presence of nutrient materials like carbohydrates, protein etc. supporting the growth of such organisms. Because of harvest, when the stem (pedicel) of a mango fruit is broken, the broken end exudes out sap, which adheres on the fruit peel causing serious skin damages within a few hours thereby, results an ugly look. The Sap is highly acidic in nature with pH value of about 4.3. The sap contained in the fruit ducts remains under considerable pressure and when the pedicel is broken, the sap squirts out and spreads over the fruit peel, which causes serious skin damages. Sap Burn/ Injury is characterized by brownish-black to black streaks or blotches on the skin of mango due to its acidic nature, which results in poor cosmetic quality fruits thus lowers the price of fruit both in domestic and international markets. One of major quality concerns for mango producers and exporters is the Sap Burn or Sap Injury. Today India loses about 30% of its total production because of Sap Burn/ Sap Injury. Further to manage sap burn injury, in depth knowledge of the components of mango sap in the different local varieties is essential. There are no reports so for of the exact composition of mango sap in general and in particular from Indian as well as Telangana varieties. Hence we conducted this study and suggested different management practices for management of sap burn damage in Telangana.

Mango is one of the favorite fruits in the USA market, where consumption has doubled in the past 10 years. During the 2014-2016 on average, 120 million 10-pound boxes have been imported; mainly from Mexico (67.0%), Peru (10.0%), Ecuador (9.0%), Brazil (7.1%), Guatemala (4.6%), and Haiti (2.3%).

Mexico is one of the top mango exporters to the USA providing 67% of the total exported by producing countries, which represents around 63.6 million boxes per year with a value of 366 million dollars. The main exported varieties for the USA market are Tommy Atkins, Ataulfo, Kent and Keitt compromising 35, 30, 15 and 10% respectively of the exported volume (EMEX, A.C., 2016) [12]. One of the main problems in terminal market is the sapburn damage, which causes dark brown spots or black stripes in mango fruit. Symptoms may be not apparent at the beginning, but they are perfectly distinguished in a few days along to the ripening process. The sapburn damage decreases the quality and shelf life of mango fruit since it promotes higher anthracnose incidence and it may vary according to region, season, tree age, maturity stage at harvest, and variety (Lim and Kuppelweiser, 1993) [26]. Previous results indicated that sap chemical composition consists of two different fractions: one oil fraction and another one derivate from proteins and polysaccharides. The first one causes the more severe sapburn damage. Besides that, it has been demonstrated that this oil fraction constitutes around 50% of the exudate sap flushed after peduncle removal and it decreases to only 3% after 90 min (O Hare and Prasad, 1991) [37]. In addition, it is stated that sap flushed from mango fruit contains laccase, terpens, and mucilage (Joel *et al.*, 1978; Joel and Fahn, 1980) [21]. In addition, it is specified that the sap exuded in the afternoon (2:00 p.m.) is less than that exudate from fruit harvest at morning (7:00 a.m.). However, sapburn damage is higher for fruit harvested in the afternoon and conclude that the higher damage caused by sap from fruit harvest in the afternoon may be due to a less sap dilution because of less turgor pressure. Several studies have shown that sapburn damage may be alleviate by using calcium hydroxide solutions (1.0%), detergent (0.1%), DC Tron (100-1000 μl/l), or hot water treatment at 51-55 °C for 10 min (O Hare and Prasad, 1991; Lim and Kuppelweiser, 1993) [37, 26].

**Laticifers**

Mango tree is characterized by having through its leaves, flowers, stems and fruits, a vast system of ducts called laticifers, which contain resin or sap (Mauseth, 1988; Joel, 1981)[31,20]. There are different opinions about the role of laticifers; however, the most successful is they are a system of plant protection against the attack of herbivores and microorganisms (Fahn, 1990) [13]. There are two types of laticifers: the non-articulated ones that develop from a cell that lengthens with the growth of the plant; and articulated laticifers, which consist of linear or branched series of cells that are joined one after the other (Mauseth, 1988; Joel, 1981) [31, 20]. The laticifers are heterogeneously distributed throughout the plant and the sap it contains does not have the same chemical composition in all species and even varies among cultivars (Rojas-Jimenez, 2000) [40]. At the base of the fruit, the laticifers have many branches and can be narrow (between 20 and 30 μm) or very wide (1 mm). The basal part of the stem contains narrow laticifers that widen toward the abscission zone. In the abscission zone (region of the stem where the mature fruit is naturally detached from the tree), laticifers are found both in the system of fruit duct and that of the stem, systems that are parallel to each other but do not interconnect. The narrow fruit ducts occupy the peripheral zone of the base of the fruit and end before the abscission zone; and the wider ones end up closed at a short distance after the abscission zone; Stem ducts also cross the abscission zone (Joel, 1981)[20].

**Sap Chemical Composition**

When a fruit is harvested before reaching the consumption ripening stage, the sap, which is found in the ducts of the base of the fruit under considerable pressure, is released by draining through the exocarp causing the damage. Sap is a colloidal suspension of small particles that can be white-milky, yellow-brown, yellow-orange or colorless, which flows, mainly after the detachment of the peduncle, causing spots on the mango skin due to its nature acid (pH 4.3) (John *et al*., 2003; Rojas-Jimenez, 2000; Campbell, 1992) [23, 40, 8]. Sapburn injury is characterized by browning and necrosis around the lenticels, causing deterioration in the appearance of the fruit, decreasing its commercial value and storage (Holmes *et al*., 1993) [18]. Sap turns pale yellow when dried and contains resinous acid, mangiferous acid, resinol, mangiferol and mangiferin (Morton, 1987) [34]; Sap has a characteristic aroma to that of a ripe fruit, which suggests the spectrum of volatile aromas may be similar in mango pulp and sap (Loveys *et al.*,1992; Mac Leod *et al.*, 1988) [27, 28]. In general, sap contains a wide variety of chemical compounds, which differ depending on the species and variety (Fahn, 1990) [13].

The sap is made up of two phases, an aqueous and an oily phase. The oil phase is yellow-brown. This fraction constitutes approximately 50% of the latex immediately after cutting and its proportion decreases to 3 to 10% within 90 seconds of the harvest (Barman *et al*., 2015) [3]. It is the main responsible for quickly staining the mango peel due to the high content of terpenes (3-carene, terpinolene) and 5-resorcinol (Loveys *et al.*, 1992) [27]. Terpenes make contact with the skin of the fruit and enter it through lenticels (O Hare and Prasad, 1991) [37], causing a direct activation of the polyphenol oxidase or indirectly providing contact between the enzyme and its substrate (Robinson *et al.*, 1993) [39]. On the other hand, the aqueous phase is essentially composed of proteins and polysaccharides, as well as proteases, peroxidases and polyphenols (Saby *et al.*, 2003) [42], which can also cause spots on the skin, although its effect is much less (Loveys *et al.*, 1992) [27] and they found that Kensington mango volatiles, in addition to containing terpinolene, carbohydrates and proteins, contain also phenols and catechols. Likewise, Joel and Fahn, 1980 [21] found the sap secreted by the mango fruit contains laccase and mucilaginous substances.

Sandoval *et al.*, 1998 [44] evaluated the content of terpinolene and 3-carene in sap of the varieties Ataulfo, Haden, Tommy Atkins, Kent and Keitt harvested in the states of Michoacan, Nayarit and Sinaloa. They found that in the sap of all varieties there is greater proportion of terpinolene, with Tommy Atkins and Ataulfo having the highest number of terpenes with respect to the varieties Kent, Haden and Keitt, and therefore those most susceptible to sapburn damage. Whereas (Diaz de Leon-Ssnchez *et al.*, 2000) [10] differ from Sandoval *et al.*, 1998[44], since they quantified the terpinolene and 3-carene levels of the sap in Haden and Tommy Atkins varieties of Michoacan, Mexico. They found the levels of 3-carene were higher than the terpinolene, in the two varieties studied. Likewise, Rojas-Jimenez, 2000 [40] quantified the terpinolene and 3-carene levels of the sap in Ataulfo, Tommy Atkins, Haden, Keitt and Kent, harvested in Michoacán, Nayarit and

Sinaloa. It was found that all cultivars contain a higher proportion of 3-carene than of terpinolene, 3-carene being the main compound responsible for sapburn damage, and Haden the most sensitive cultivar to damage. However, previous studies carried out with the cultivars Kensington and Irwin, harvested in Australia, showed that terpinolene is the main component of the oil phase of the sap contained in the fruits of the Kensington cultivar, which is very susceptible to damage. Meanwhile in the cultivar Irwin, which is a variety less susceptible to sapburn damage, the main component was 3-carene. Subsequently, it was shown that the direct application of synthetic terpinolene to the surface of the mangoes produced symptoms similar to those of sapburn damage. These results suggest that terpinolene is the main component of the sap responsible for the damage (Holmes *et al*., 1993, Loveys *et al.*, 1992) [18, 27]. On the other hand, Osuna *et al.,* 2000 [38], analyzed the latex oil phase of four mango varieties Ataulfo, Haden, Tommy Atkins and Kent, finding the main components causing the damage are terpinolene or car-3. ene depending on the cultivar.

**Factors influencing the Sapburn**

Sapburn damage is a major problem affecting the mango quality. It initially consists in the darkening of the skin around the lenticels; these areas become progressively larger and darker in the 48 hours after cutting, causing deterioration in the appearance of the fruits, changes in their metabolism (respiration and ethylene production) and an increase in the susceptibility to attack by pathogens. This susceptibility to pathogen attacks is probably due to its high carbohydrate content, increasing the possibilities of mechanical damage to the fruit (Negi *et al.,* 2002) [35], which significantly reduces the acceptability and shelf life of these fruits (Holmes *et al.,* 1993) [18]. In the Mexican Pacific region, losses caused by sapburn damage affect approximately 9.9% of export mango production (EMEX, A.C., 1996) [11].

The sap composition is complex and the amount that emanates from the fruit varies depending on factors, such as the weather, the time of day in which the harvest is made, the variety, the time of harvest (beginning, middle or end of the harvest season), age of the trees, fruit maturity, lenticel density, among others (Montero and Molina, 2005, O Hare *et al.,* 1994, Lim and Kuppelweiser, 1993) [33, 36, 26]. Sapburn damage in mango fruits ranges from 5% to 50%, varying in magnitude according to the factors mentioned above (Barman *et al.*, 2015) [3]. Some results suggest sapburn damage depends mainly on both the chemical composition of the sap and the sensitivity of the different cultivars to this substance (Diaz de Leon-Sanchez *et al.,* 2005) [9].

Loveys *et al.,* 1992 [27], indicate that the content of the oil phase of the sap (phase responsible for causing stains in the mango) composed of terpenes and 5-resorcinol, varies with the cultivar. Also, Montero and Molina, 2005 [33] mention that this phase varies with the time of desapping. Rojas *et al.,* 1999 [41] and they indicate that the fruits of Tommy Atkins and Ataulfo have more terpenes than the cultivars Kent, Haden and Keitt.

Hassan *et al.*, 2009 [17], point out that geographic location and crop management are factors that also play an important role in the sap production in fruits. In addition, they indicate the differences of maturity (indicated by the % of dry matter), can contribute to the differences in the characteristics of the sap between the same variety of different growing regions. This effect was very visible in his investigation when observing the varieties "Kensington" and "Nam Doc Mai" of the locality of Ayr of Queensland, Australia had higher percentage of dry matter (more mature). They also showed greater percentage of the oil phase of latex and higher concentrations of 5-n-heptadecenilresorcinol and 5-n-pentadecilresorcinol compared to the fruits of the localities of Nambour or Gin Gin.

Another factor considered important is the time it takes for the sap to emanate. Lim and Kuppelweiser,1993[26] evaluated the effect of the damage caused by the sap at different emission times; they also observed that the sap collected from 15 seconds to 15 minutes caused a damage of only 2.5%. While Osuna *et al.,* 2000 [38], point out the sap emitted during the first 30 seconds of the varieties Ataulfo, Haden, Tommy Atkins, and Kent caused the highest damage in the appearance of the fruit. Loveys *et al.,* 1992 [27] obtained similar results in the Kensington variety, where the damage caused by sap emitted during the first seconds was 100%.

The time of the day in which the harvest is carried out is one of the most important factors to consider in sapburn injuries. There is a greater flow of sap during the first hours of the morning than in the afternoon, due to the high-water content or the turgor pressure, which decreases as the temperature of the day increases (Amin *et al.,* 2008) [1]. With this increase, the transpiration rate of the fruit surface increases, which ultimately results in the reduction of the water concentration in the latex, and when said reduction occurs, the concentration of the oil phase is higher, which is the main cause of sapburn damage in the fruit (Barman *et al.*, 2011) [4].

On the other hand, Amin *et al.,* 2008 [1] evaluated the harvesting and desapping of the cultivar cv. Samar Bahisht Chaunsa from Pakistan in relation to 3 times (morning 7 a.m., noon 12 p.m., and afternoon 5 p.m.) to observe in which of them there was less damage by sap. They found that harvesting and desapping at 7 a.m. in combination with a subsequent immersion of the fruits in lime (0.5%) was the best treatment to avoid sapburn injuries. Maqbool *et al.*, 2007 [30], agree that the highest sap content occurs in the morning that in the afternoon and found the Chaunsa cultivar of Pakistan had a higher concentration of sap than the Sindhri variety.

With respect to the ripening factor, the onset and severity of the lesion in the fruit increases as it ripens, during storage at room temperature (Barman *et al.,* 2015) [3]. In the same way, Maqbool and Ullah (2008) [29] also reported the symptoms of the lesion in the fruit increased as the ripening increased. This is because the activity of the polyphenol oxidase enzyme increases with the onset of ripening (Menezes *et al.,* 1995) [32].

Other factors that may affect sapburn damage are temperature and storage time, Maqbool *et al.,* 2007 [30] analyzed three cultivars of commercial mango Chaunsa, Sindhri and Dusehri to observe the susceptibility of these to sap after 24, 48 and 72 hours in two different storage conditions (environment: 25 °C and cold storage: 14 °C, with an RH of 85%), the cultivar Chaunsa was the most susceptible, followed by cv Sindhri and cv Dusehri. The incidence of sapburn damage in cv Chaunsa was more at room temperature (25 ± 1 °C) than in cold storage (14 °C, 85% RH). However, in cv Sindhri and Dusehri the damage was almost similar in both temperatures. Maqbool *et al.,* 2007 [30] also analyzed the severity level by sap with reference to the harvest time of the day. Sapburn damage increased as the day progressed. After 7 days of storage at room temperature, as well as in cold storage (14°C), the damage caused was medium, the maximum damage occurred when the fruits were harvested at 3 pm, while the minimum damage in fruits harvested at 6 am. In the same way, they analyzed the desapping of the fruits, in trays, for different periods of time, in order to determine the optimal time of desapping to reduce the sapburn damage. The minimum lesion occurred after 15 days of storage (14 °C) in fruits that were desapped for 20 minutes.

A prominent factor is the presence of enzymes polyphenol oxidases and peroxidases, which are present in the skin of the fruit, as well as in the same sap; Several investigations have shown that the blackening due to contact with sap is related to the presence of these enzymes (Saby *et al.*, 2002, Thygensen *et al.*, 1995, Loveys *et al.*, 1992, Joel *et al.*, 1978) [43, 47, 27, 22]. The amount and activity of the enzymes vary depending on the mango cultivar. Robinson *et al.*, 1993 [39] suggested when the latex is in contact with the exocarp or skin of the fruit, a breakdown of the superficial tissues is caused, allowing the interaction between these enzymes and their substrates. So, there is a correlation between sapburn damage and the activity of enzymes from the group of polyphenol oxidases, such as catecholase, and laccase. Catecholase catalyzes the oxidation of o-dihydroxyphenols to o-quinones; this enzyme is usually found in the chloroplasts and mitochondria of the exocarp of the fruit. Both enzymes use molecular oxygen and their phenolic substrates are found in vacuoles (Robinson *et al.*, 1993) [39]. Regarding the laccase, it catalyzes the hydroxylation of monophenols to o-diphenols present in the sap (Robinson *et al.*, 1993) [39]. Diaz de Leon-Sanchez *et al.*, 2005 [9] mention that several mango studies suggest that terpenes favor sapburn damage through the activation of polyphenol oxidases (PFO's); however, in their research they determined the correlation between sapburn damage and total PFO's activity of the exocarp and sap in Haden and Tommy Atkins mangoes harvested in April, May and June in Lazaro Cardenas, Michoacan. They found the activity of the total PFO's of the exocarp was similar in Tommy Atkins and Haden during the first two harvest seasons, increasing in the last season in Tommy Atkins, while the activity of the total PFO's of the sap was greater in Tommy Atkins that in Haden in all seasons of harvest. The authors concluded the susceptibility to sapburn damage showed a contrasting behavior in both cultivars. In Tommy Atkins, it increased throughout the three seasons while in Haden it decreased, so that the total activities of the PFO's in exocarp and latex do not explain the susceptibility to sapburn damage in Mexican mango of Haden and Tommy Atkins varieties.

On the other hand, Saby *et al.*, 2002 [43] point out that the polyphenol oxidase and peroxidase enzymes present in the mango skin are responsible for sapburn damage, and not the polyphenol oxidase and peroxidase present in the sap. That is, when the organic compounds present in the sap come in contact with the mango peel, they can dissolve the waxy layer on the surface and disorganize the susceptible part of the cellular structure. During this process, the polyphenol oxidase and peroxidase present in the peel come into contact with their polyphenol substrates and react in the presence of atmospheric oxygen resulting in the typical brown color, which is characteristic of sapburn damage. The variations in the degree of color observed in the different varieties may be due to variations in the enzymatic activities and the polyphenol content present in the skin.

**Management of Sapburn damage in Telangana**

The effect of sap in contact with the surface of the fruit is very variable, sometimes the spot occurs immediately and it is completely irreversible; while other times the sap remains transparent and colorless during storage and transport of fruit and it can be removed, at least partially, without causing permanent damage (Montero and Molina, 2005) [33]. These factors make it difficult to search for a consistently effective treatment. However, some of the most effective alternatives are listed below.

**1. Physical methods**

Care should be taken, when the Mangoes are packed with stem removed, since initial spurt of sap would burn fruit, leaving a blemish that will develop during storage and transport. Sap burns must be avoided. Therefore, stems should be clipped in short, holding fruit with the stem end down. Fruits can be placed on the desapping bench and allow them to drain for 20-30 minutes until sap flow has stopped.

**2. Natural methods**

To reduce sapburn damage, the fruit should be washed in water at room temperature, in one or more disinfectants or soaps such as Agral®, Cold Power® or Mango Wash® (Guoqin Li. (2015) [15].

**3. Chemical methods**

Remove peduncles and immerse the fruits in 1% and 5% sodium chloride solutions, as well as in a 0.5% and 1% calcium hydroxide solution, separately for 5 minutes. The detachment and immersion of fruits in 5% sodium chloride and 1% calcium hydroxide were effective in reducing sapburn damage in the "Karuthakolumban" variety. While immersion in 1% sodium chloride and 0.5% calcium hydroxide successfully reduced sapburn damage in the varieties "Willard", "Chembaddan" and "Ambalavi" (Krishnapillai and Wilson, 2016) [19]. The fruits harvested with a peduncle of 4-5 cm long, and later blended in a lime solution at 0.5% prevent sapburn damage. (Hafeez *et al.*, 2016) [16]. Application of sodium hydroxide (1%) and alum (0.5 and 1%) (Double sulphate of alumina and potassium) showed the best results compared to the use of calcium hydroxide (1%) and control (Barman *et al*. 2015) [3].

Harvest the mango fruits with a certain length of peduncle (5 cm or more) and accumulate the fruits in the field in boxes. The sap will not drip from fruits that have a long length of attached peduncle. In Brazil, it is a common practice to harvest the mangos with the long peduncle (length> 5 cm), and carefully transport the fruits from the field to the packinghouse where the peduncle of the fruits is trimmed. Approximately 24 hours after harvesting, the sap of the fruits will stop dripping and they will not leak if the peduncles are trimmed later. Cut the peduncles at the abscission zone (approximately 1 cm), and immediately afterwards place the fruits with the peduncle trimmed downwards in such a way as to allow the sap to drip without touching the peel of the mango. The duration of the removal varies from 20 minutes to 4 hours depending on the time it takes for the fruit to stop dripping the latex. Desap the fruit and wash it with one of the following solutions: lemon (0.5%), sodium bicarbonate (1%), aluminum potassium sulphate - alum (1%), and detergents (Brecht *et al.*, 2009) [6].

Harvest of the mango fruits (cv. Samar Bahisht Chaunsa) and desapped in the morning (7 a.m.) for its subsequent immersion in lime at 0.5% to control sapburn lesions. The result was to eliminate 100% of the lesions (Amin *et al.*, 2008) [1]. Immediately after the harvest of Sindhri and Chaunsa cultivars from Pakistan, the following solutions were used separately: calcium hydroxide, Tween-80, sodium carboxymethyl cellulose, sodium lauryl sulfate, detergents and vegetable oil. The fruits after the treatments were dried in the air and packed in cardboard boxes, transported to the laboratory and stored (14 ° C and 85% RH, 25 ° C and 56% RH) for 7 and 14 days in the case of Sindhri cv. and cv. Chaunsa, respectively. The fruits treated with calcium hydroxide presented the best results against sapburn injuries (in addition to improving the total quality of the fruit) followed by Tween-80 in both cultivars. (Maqbool and Ullah, 2008)[29]. Desapping in solution (1% in water) of sodium lauryl sulfonate ether; and / or in sodium hypochlorite solution (100 mg L-1); and / or dry desapped (Montero M. and Molina M. E., 2005) [33]. Wash the fruit with commercial detergent (0.1%) or enzymatic (0.1%) to reduce the damage in Haden, Kent and Tommy Atkins, during the first 6 hours of harvesting; For Ataulfo variety during the first 2 hours of harvest and washing with a calcium hydroxide solution (1%) at 2 hours can still reverse the sapburn damage (Osuna *et al.*, 2000) [38]. Bosquez *et al.*, 2000 [5] suggested that solutions of sodium carboxy methyl cellulose and sodium lauryl sulphate are efficient to control sap injuries in mango fruits of the Haden and Tommy Atkins varieties. In Australia, release machines are used to remove the sap; later a thin layer of water is sprinkled on the surface of the fruit to remove the sap from the peel (Brown, B. and J. Bagshaw, 1997) [7]. Application of polyethylene based wax coatings on the mango surface before drying the sap surface; this will help to reduce sapburn damage, without negatively affecting the development of color (Shorter, A.J. and D.C. Joyce, 1994)[45]. Desap of the fruit in a 0.5% solution of sodium carbonate in water (pH 11). From 77 to 87% of the fruit without damage or with very slight damage (Fonseca, J. M. (1993) [14]. Desap under a lime solution; use of dips and / or detergent sprays; packing with short stems; pack without stems during the harvest, immersing or spraying detergent on the fruit immediately (Holmes *et al.*, 1993) [18]. Immersion for 1 min of the fruits in a DC Tron solution (100-1000 μL / L) gave better results against sapburn damage compared to Ethokem, Agral 60, CropLife, Codacide, 1% Chlorsan, and / or calcium hydroxide (Lim and Kuppelweiser, 1993) [26]. Desap the fruit and then submerge it in a 1% calcium hydroxide solution (O Hare, T. and Prasad, A., 1991) [37]. Desap the fruit and immerse it in a detergent solution (Ledger, S. N. 1991) [25]. Landrigan *et al.*, 1991 and Baker, 1991 [24, 2] suggested that to reduce sapburn damage it is necessary to use solutions such as: sodium carbohydrate, sodium lauryl sulfate, calcium hydroxide solutions, varnish with vegetable oil, waxes and dehydration in commercial detergent.

## Conclusions

This study recommends proper low cost sap management practices for reducing postharvest loss in terms of sap burn in local varieties of Telangana. Local popular mango cultivars should be harvested with 4-5cm stalk to minimize sap burn and collection of latex carefully after stalk removal and washing fruits thoroughly in water. However it needs high labour cost and time. De-stemming and dipping fruits in different chemicals was observed to be effective in reducing sap burn injury without affecting quality in all mango varieties of Telangana. Thus the mango growers obtain better income from their crop and consumers will benefit from the availability of good quality mangoes in markets. The role of mango sap in defense of the fruit against various pest infestations and infections has been long suspected.

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