Pak. J. Bot., 39(5): 1565-1574, 2007.

SAP DYNAMICS AND ITS MANAGEMENT IN COMMERCIAL MANGO CULTIVARS OF PAKISTAN

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Abstract

To supply the superior quality mango at international markets require many problems to be surmounted. Different experiments have been conducted to devise a strategy for sapburn management in commercial mango cultivars of Pakistan. In the first experiment, the effect of harvest time of a day and total sap quantity in different cvs of mango was studied. Sap collected from cv Chaunsa was 11.89 times more as compared to cv Sindhri and the quantity of sap exuded early in the morning was greater than later during the day. In the second experiment, it was observed that there is a little effect of delayed de-stemming (after harvest) on sap quantity. However, the total sap quantity was maximum in cv Chaunsa (spurt, 0.77ml & ooze, 0.54ml) and minimum in cv Sindhri (spurt, 0.15ml & ooze, 0.08ml). In the third experiment, three commercial mango cvs were tested against spurt and ooze sap to observe the sapburn susceptibility after 24hrs, 48hrs and 72hrs at two different storage conditions (ambient: 25 ± 1°C; 14°C & 85%RH). Chaunsa cv was the most susceptible followed by cv Sindhri and cv Dusehri. Sapburn incidence in cv Chaunsa were more at ambient temperature (25 ± 1°C) than in cold storage (14°C, RH 85%). However in cvs Sindhri and Dusehri sapburn incidence were almost similar at both the temperatures. In the fourth experiment, level of sapburn severity was studied with reference to harvest time of the day. Sapburn severity increased as daytime proceeded. After 7 days of storage at ambient temperature as well as in cold storage (13 ± 1°C & 80-85% RH) average sapburn severity score was maximum in fruits which were harvested at 3:00 pm (1.08) while minimum in fruits harvested at 8:00 am (0.06). In another experiment fruits were placed on de-sapping trays for different time periods to determine the optimum time of de-sapping to reduce the incidence of sapburn injury. After 15 days of storage (13 ± 1°C & 80-85% RH) minimum sapburn injury occurred in fruits which were placed for 20 minutes (0.65) on de-sapping tray followed by 10 minutes (0.73) as compared with control (2.54) or fruit harvested by traditional method. The results will be used to work out a practical sapburn management approach in commercial mango cvs of Pakistan.

Introduction

The mango (*Mangifera indica* L.) is an ancient but nonetheless most attractive tropical fruit. Mango has become popular throughout world due to its delicious taste, attractive flavour, diuretic and therapeutic values. Mango fruit besides local consumption has an important role in foreign exchange earnings. Pakistan is the 4th largest mango exporter in the world. Pakistan exported about 105,210 tonnes of mango, worth US$ 32.4 million during 2005 (Anon., 2006).

Our mango industry is currently facing many challenges including tree decline (Fateh *et al.,* 2006; Khanzada *et al.,* 2006), limited shelf life of fruit and quality issues (Malik *et al.,* 2006). One of the quality concerns for our mango producers and exporters is sapburn injuries resulting in poor cosmetic quality fruits which lower the price of fruit especially in international markets. In common with other members of the Anacardiaceae, mango plants have an extensive system of ducts in both the fruit and stem (Joel, 1980). During harvesting the fruit, sap or heavy sugary waxy material locally called "Doodh" gets exuded on the fruit skin. This sap is very sticky due to which it attracts soils which adheres on the fruit making dirty and it is high in sugars and other nutrients, attracting microorganisms which grow rapidly on the sap and cause quick decay of the fruit. When the sap is contacted with the fruit surface, it caused brownish-black to black streaks or blotches on the mango skin due to its acidic nature (Campbell, 1992; Loveys *et al*., 1992). The skin injury symptoms may appear after few hours as the ripening progresses. Damage caused to the skin of mango fruit by contact with sap exuded from the cut or broken pedicel reduces cosmetic quality and storage life of the fruit. The mango sap removed from fruit can be separated into two distinct fractions on standing: oil and a protein-polysaccharide fraction, the former being responsible for skin injury (O'Hare & Prasad, 1991). Injury occurs as the oil fraction makes contact with and enters the mango skin, which is normally *via*., the lenticels. A major component of this oil fraction is terpinolene which gave symptoms indistinguishable from sapburn injury when applied to the fruit surface. Sap exuded from the mango leaf petioles also contained terpinolene, but its concentration is less than 1% of the concentration in pedicel sap and this sap is not damaging to the fruit skin (Loveys *et al*., 1992). The intensity of sapburn injury depends on many factors including the cultivars, tree age, fruit maturity and conditions under which harvesting takes place etc., (Lim & Kuppelweiser, 1993).

Various approaches have been reported to avoid the problem of sapburn including: de-sapping on the ground in the field, on special de-sapping racks and trays, or on conveyor belts or machines (Ledger, 1991; Meurant, 1991). These methods have been used singularly or in various combinations, all with inconclusive results. In the past, no work has been done on sapburn management in commercial mango cultivars of Pakistan. Therefore, the need for a comprehensive study on sapburn management in commercial mango cvs of Pakistan was felt by the industry so as to improve the cosmetic fruit quality of mango. The main objectives of these studies were to assess different commercial mango cvs for their total sap quantity in relation to harvest time and de-stemming time, to evaluate the mango cvs for their sapburn susceptibility under ambient and cold storage conditions and to check the effects of field de-sapping techniques on sapburn incidence.

Materials and Methods

Plant material: Uniform mango fruits of different cvs were harvested at physiological maturity with a 4-5 cm fruit stalk attached, from commercial orchards located in Districts Multan and Faisalabad, Punjab province, Pakistan.

Experiment 1: Effect of harvest time (of a day) on total sap quantity: Fifteen fruits of each cvs Sindhri and Chaunsa were harvested at different times of a day; cv Sindhri (T_1 = 9:30 am; T_2 = 11:30 am; T_3 = 3:30 pm and T_4 = 6:30 pm); cv Chaunsa (T_1 = 7:00 am; T_2 = 11:00 am; T_3 = 3:00 pm). Immediately after harvest fruit pedicels were cut back and fruit were placed on a glass beaker in inverted position. Sap collected within first 15 seconds was measured with a disposable plastic syringe (TERUMO® : Terumo Medical Corporation, Elkton, USA). Then fruits were again placed on a glass beaker in inverted position till the ooze sap completely exuded out. Sap quantity was again measured. Similar procedure was repeated for cv Chaunsa.

Experiment 2: Effect of delayed de-stemming on total sap quantity: Thirty-six fruits per variety (Anwar Ratoul, Chaunsa, Sindhri, and Dusehri) were harvested at the same time in the morning. Out of these 40 fruits, 9 fruits were de-stemmed immediately after harvest and their sap quantity was measured. After one hour again 9 fruits were de-stemmed and their sap quantity was measured. Similar procedure was repeated after two hours and four hours of harvest and sap quantity was measured.

Experiment 3: Sapburn severity of different mango cultivars at two different storage conditions: Sixty fruits were harvested per variety (Sindhri, Chaunsa and Dusehri) from a commercial mango orchard. Out of these, 30 fruits were treated with spurt sap, while remaining with ooze sap at four spots (2 cm^2) using a camel hair brush. Fruits were placed at two different storage conditions (ambient: 25 ± 1°C; cold storage: 14°C, RH 85%). Incidence of sapburn injury was observed after 24 hrs, 48 hrs and 72 hrs. Damage was scored from nil to dark brown depending on the level of injury (no change to severe) (Brown *et al*., 1986).

Experiment 4: Sapburn severity level in relation to fruit harvesting at different times of a day: Thirty fruits per each treatment were harvested at different times of a day; cv Chaunsa (T_1 = 8:00 am; T_2 = 11:00 am; T_3 = 3:00 pm). Immediately after harvest fruit pedicels were cut back and fruits were placed on a glass beaker in an inverted position to collect sap. Sap was applied to the skin of the fruit at four spots with the help of a camel hair brush. Then fruits were placed carefully for sometime to settle the sap onto the skin of the fruit. The fruits were air dried and packed in cardboard boxes and transported to the laboratory. Half of the fruits per each treatment were kept at ambient temperature while the remaining half was placed in cold storage (13 ± 1°C, 80-85% RH). The sapburn severity data was recorded after 24, 48, 72 hrs and 7 days interval for fruits stored at both the temperatures ambient (25 ± 1°C) and cold storage (13 ± 1°C, 80-85% RH). The sapburn severity score was rated by examining the four spots, categorized as (Nil-no change, Light-light change in colour, Moderate-brown colour and Severe-dark brown colour) (Holmes *et al*., 1993).

Experiment 5: Optimizing de-sapping time to control the incidence of mango sapburn injury by using de-sapping tray: Thirty fruits per treatment were harvested along with their pedicels and immediately after removing the pedicels fruits were placed on de-sapping tray in an inverted position for 20 minutes (T_1) and 10 minutes (T_2), while 30 fruits were also taken from the lot harvested by traditional method (T_3). After sap exudation fruits were packed in cardboard boxes and stored (13 ± 1°C & 80-85% RH) for 15 days. Sapburn injury score was recorded after 24, 48 and 72 hrs and 7 and 15 days interval during storage and damage was scored from 0 to 4 depending on the injury level [0= no injury, 1= very mild (injury area <1 cm^2), 2= mild (injury area >1<2 cm^2), 3= moderate (injury area >2< 4 cm^2), 4= severe (injury area >4 cm^2)] (Brown *et al*., 1986).

Statistical design and data analysis: All experiments were laid out according to Completely Randomized Design (CRD) with three replications. The data were analyzed by ANOVA using GenStat®, UK software, and Least Significant Difference (LSD) test was used to compare differences among treatment means for each variable.

Results

Experiment 1: Effect of harvest time (of a day) on sap quantity: Two types of sap were observed, spurt sap: (exuded within first 15 seconds after removing the pedicel of fruit and it was the most injurious to the skin of fruit, and ooze sap released more slowly after de-stemming and was not much injurious to the skin. It was observed that the total sap contents of cv Chaunsa was 11.89 times higher as compared to cv Sindhri. Statistically significant difference ($P \leq 0.05$) was found between harvest time (of a day) and total sap quantity in both cultivars (Table 1a, 1b). It was also observed that there is a greater sap flow early in the morning than latter as the daytime proceeded.

Experiment 2: Effect of delayed de-stemming on sap quantity: It was observed that as the de-stemming time was extended, the sap quantity decreased, but not statistically significant as compared to time zero hour. The total sap quantity was maximum in cv Chaunsa (Spurt, 0.77ml & Ooze, 0.54ml) and the minimum sap quantity was measured in cv Sindhri (Spurt, 0.15ml & Ooze, 0.08ml) followed by cv Dusehri (Spurt, 0.17ml & Ooze, 0.11ml) (Table 2).

Experiment 3: Sapburn severity of different mango cultivars at two different storage conditions: In this experiment incidence of sapburn injury were observed after 24 hrs, 48 hrs and 72 hrs. The results showed that spurt sap was more injurious to the fruit skin of mango as compared with ooze sap and it was observed that cv Chaunsa (1.20) was more prone to sapburn injury as compared with others cvs Sindhri (0.98) and Dusehri (0.38). The ooze sap caused minimal injury in cv Sindhri, while no injury in case of cvs Dusehri and Chaunsa (Fig. 1). The interaction of treatment with different time intervals showed significant results only in cvs Sindhri and Chaunsa, while non-significant in case of cv Dusehri (Table 3a). In case of cv Chaunsa the statistical analysis of data regarding different storage conditions showed significant results ($P \leq 0.05$) and it was observed that the fruits placed at room temperature had more sapburn injury (1.01) as compared to cold storage (0.18), while cvs Sindhri and Dusehri showed non-significant results (Table 3b). In case of cv Sindhri there was significant result ($P \leq 0.05$) regarding different storage times and it was also observed that incidence of sapburn injury continued even after 72 hrs during storage (Table 3c). The results regarding interaction of treatments with different storage condition and interaction of different time intervals with storage conditions showed significant results ($P \leq 0.05$) only for cv Chaunsa and non-significant in cvs Sindhri and Dusehri (Table 3d).

Experiment 4: Sapburn severity level in relation to fruit harvesting at different times of a day: Statistical analysis of the data regarding sapburn severity level in relation to fruit harvesting at different times of a day showed significant results ($P \leq 0.05$). It was clear from the results that the fruits harvested in afternoon (3:00 pm) were severely affected with sap as compared to the fruits harvested in the morning time (8:00 am) (Fig. 2). Similarly, the results regarding different time intervals were also significant. It was observed that the maximum sapburn injury took place within 24 hrs of sap contact, however, it might continue even after 7 days of storage (Fig. 3). While the different storage conditions showed non-significant effect on sapburn severity level (Table 4a). The interactions, treatment with different storage conditions, different storage conditions with time and treatments with time and different conditions showed significant results except interaction of treatment with time intervals (Table 4b, 4c, 4d).

Table 1. Effect of harvest time (of a day) on sap quantity.

1a. Sap quantity in mango cv Sindhri

Treatments	Spurt sap (ml)	Ooze sap (ml)
T_1 (9:30 am)	0.04a	0.02^{NS}
T_2 (11:30 am)	0.04a	0.12^{NS}
T_3 (3:30 pm)	0.01b	0.01^{NS}
T_4 (6:30 pm)	0.01b	0.00^{NS}

Any two means not sharing a common letter are significantly different (P≤0.05)
NS = Non-Significant

1b. Sap quantity in mango cv Chaunsa

Treatments	Spurt sap (ml)	Ooze sap (ml)
T_1 (7:00 am)	0.35a	0.14a
T_2 (11:30 am)	0.34a	0.11a
T_3 (3:00 am)	0.22b	0.04b

Any two means not sharing a common letter are significantly different (P≤0.05)

Table 2. Effect of delayed de-stemming on sap quantity (ml).

Treatment	Anwar Ratoul		Chaunsa		Sindhri		Dusehri	
	Spurt	Ooze	Spurt	Ooze	Spurt	Ooze	Spurt	Ooze
T_1 (0hr)	0.09a	0.02a	0.23ab	0.12a	0.04a	0.01b	0.30a	0.16a
T_2 (1hr)	0.02b	0.02a	0.25a	0.14a	0.03a	0.02ab	0.15b	0.15a
T_3 (2hrs)	0.03b	0.03a	0.15b	0.14a	0.06a	0.04a	0.11b	0.08a
T_4 (4hrs)	0.03b	0.04a	0.14b	0.14a	0.03a	0.01b	0.09b	0.07b

Any two means not sharing a common letter are significantly different (P≤0.05)

Experiment 5: Optimizing de-sapping time to control the incidence of mango sapburn injury by using de-sapping tray: Statistical analysis of the data showed that sapburn injury level decreased with the extended time of placement over de-sapping tray. After 15 days of storage (13°C, 85±5% RH), the minimum sapburn injury was observed in fruits placed for 20 minutes (0.65) followed by 10 minutes (0.73) as compared with fruits harvested by traditional method (2.54) (Fig. 4). Similarly, the results regarding different time intervals were also significant (P≤0.05), and it was observed that the sapburn injury might continue even after 15 days of storage. The interaction between treatments x time intervals also showed significant results (Table 5).

Discussion

An understanding of sap dynamics in mango cvs is very important in devising a strategy for reducing the sapburn injuries. The greater sap flow early in the morning than latter during the day might be due to the high water content or turgor pressure which was decreased as the temperature increased. Because with the increase in temperature ultimately transpiration increased and loss of water from the fruit took place which decreased the sap quantity later during the day (Bagshaw, 1989).

Sap quantity was also affected by delayed de-stemming time but not significantly. It might be due to the high water pressure inside the fruit which became lower as the time goes on and gradually less amount of sap exuded from the fruit.

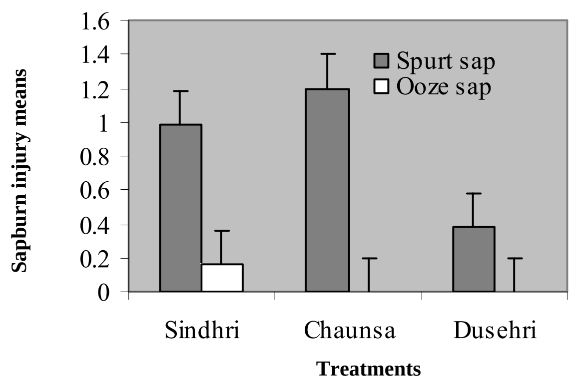

Fig. 1. Sapburn severity in mango cvs Sindhri, Chaunsa and Dusehri. Vertical bars represents ± SE of means for three replicates.

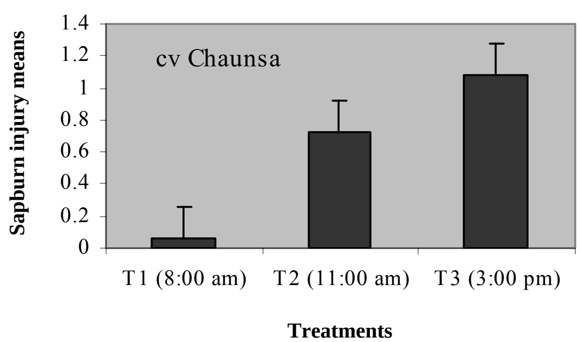

Fig. 2. Sapburn severity level in relation to fruit harvesting at different times of a day in mango cv Chaunsa. Vertical bars represents ± SE of means for three replicates.

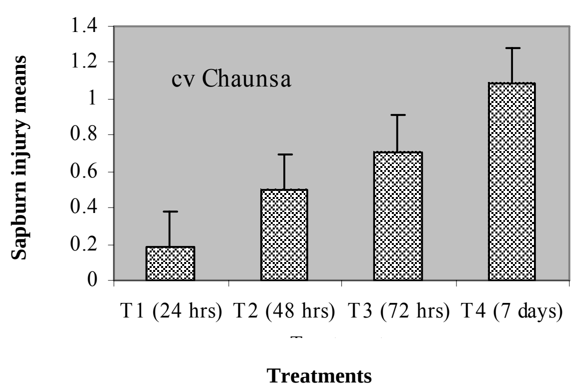

Fig. 3. Sapburn severity level at different storage intervals in mango cv Chaunsa. Vertical bars represents ± SE of means for three replicates.

Table 3. Sapburn severity in mango cvs Sindhri, Chaunsa and Dusehri at two different storage conditions.

3a. Effect of treatment and different time intervals on sapburn severity

Treatment	Sapburn injury means								
	Sindhri			Chaunsa			Dusehri		
	T_1 (24)	T_2 (48)	T_3 (72)	T_1 (24)	T_2 (48)	T_3 (72)	T_1 (24)	T_2 (48)	T_3 (72)
T_1 (Spurt sap)	0.13b	0.63b	2.16a	0.00c	1.30b	2.30a	0.06^{NS}	0.50^{NS}	0.60^{NS}
T_2 (Ooze sap)	0.03b	0.10b	0.33b	0.00c	0.00c	0.00c	0.00^{NS}	0.00^{NS}	0.00^{NS}
Means	**0.08c**	**0.36b**	**1.25a**	**0.00c**	**0.65b**	**1.15a**	**0.03^{NS}**	**0.25^{NS}**	**0.30^{NS}**

Any two means not sharing a common letter are significantly different (P≤0.05)
NS = Non-Significant

3b. Effect of treatment x storage conditions interaction on sapburn severity

Treatment	Sapburn injury means					
	Sindhri		Chaunsa		Dusehri	
	Temp 1	Temp 2	Temp 1	Temp 2	Temp 1	Temp 2
T_1 (Spurt sap)	0.91^{NS}	1.04^{NS}	2.02a	0.37b	0.42^{NS}	0.36^{NS}
T_2 (Ooze sap)	0.22^{NS}	0.08^{NS}	0.00c	0.00c	0.00^{NS}	0.00^{NS}
Means	**0.56^{NS}**	**0.56^{NS}**	**1.01a**	**0.18b**	**0.21^{NS}**	**0.17^{NS}**

Any two means not sharing a common letter are significantly different (P≤0.05)
NS = Non-Significant

3c. Effect of time x storage conditions interaction on sapburn severity

Treatment	Sapburn injury means					
	Sindhri		Chaunsa		Dusehri	
	Temp 1	Temp 2	Temp 1	Temp 2	Temp 1	Temp 2
T_1 (24hrs)	0.10^{NS}	0.06^{NS}	0.00c	0.00c	0.06^{NS}	0.00^{NS}
T_2 (48hrs)	0.30^{NS}	0.43^{NS}	1.30a	0.00c	0.26^{NS}	0.23^{NS}
T_3 (72hrs)	1.30^{NS}	1.20^{NS}	1.73a	0.56b	0.30^{NS}	0.30^{NS}

Any two means not sharing a common letter are significantly different (P≤0.05)
NS = Non-Significant

3d. Effect of treatment x time x storage conditions interaction on sapburn severity

	Treatment	T_1 (24hrs)		T_2 (48hrs)		T_3 (72 hrs)	
		Temp 1	Temp 2	Temp 1	Temp 2	Temp 1	Temp 2
Sindhri	T_1 (Spurt sap)	0.13	0.13	0.40	0.86	2.20	2.13
	T_2 (Ooze sap)	0.06	0.00	0.20	0.00	0.40	0.26
	($P \leq 0.05$)	NS		NS		NS	
Chaunsa	T_1 (Spurt sap)	0.00d	0.00d	2.60b	0.00d	3.46a	1.13c
	T_2 (Ooze sap)	0.00d	0.00d	0.00d	0.00d	0.00d	0.00d
Dusehri	T_1 (Spurt sap)	0.13	0.00	0.53	0.46	0.60	0.60
	T_2 (Ooze sap)	0.00	0.00	0.00	0.00	0.00	0.00
	($P \leq 0.05$)	NS		NS		NS	

Any two means not sharing a common letter are significantly different (P≤0.05)
NS = Non-Significant

Table 4. Sapburn severity level in relation to fruit harvesting at different times of a day in mango cv Chaunsa.

4a. Effect of treatment x storage conditions interaction on sapburn severity level

Treatment	**T_1 (Room Temp.)**	**T_2 (Cold storage)**
T_1 (8:00 am)	0.00^{NS}	0.12^{NS}
T_2 (11:00 am)	0.66^{NS}	0.79^{NS}
T_3 (3:00 pm)	1.01^{NS}	1.14^{NS}

NS = Non-Significant (P≤0.05)

4b. Effect of storage conditions x time interaction on sapburn severity level

Treatment	**T_1 (24hrs)**	**T_2 (48hrs)**	**T_3 (72hrs)**	**T_4 (7days)**	**Means**
Temp 1	0.18^{NS}	0.46^{NS}	0.66^{NS}	0.92^{NS}	0.56^{NS}
Temp 2	0.18^{NS}	0.56^{NS}	0.76^{NS}	1.24^{NS}	0.68^{NS}

NS = Non-Significant (P≤0.05)

4c. Effect of treatment x time interaction on sapburn severity level

Treatment	**T_1 (24hrs)**	**T_2 (48hrs)**	**T_3 (72hrs)**	**T_4 (7days)**
T_1 (8:00 am)	0.00f	0.06ef	0.06ef	0.14ef
T_2 (11:00 am)	0.00f	0.47def	0.97bcd	1.47ab
T_3 (3:00 pm)	0.56cde	1.00bc	1.11b	1.64a

Any two means not sharing a common letter are significantly different (P≤0.05)

4d. Effect of treatment x time x storage conditions interaction on sapburn severity level

Treatment		**T_1 (24hrs)**	**T_2 (48hrs)**	**T_3 (72hrs)**	**T_4 (7days)**	
T_1 (8:00 am)	Temp 1	0.00	0.00	0.00	0.00	NS
	Temp 2	0.00	0.11	0.11	0.28	NS
T_2 (11:00 am)	Temp 1	0.00	0.44	0.83	1.38	NS
	Temp 2	0.00	0.50	1.11	1.56	NS
T_3 (3:00 pm)	Temp 1	0.56	0.94	1.16	1.38	NS
	Temp 2	0.56	1.06	1.06	1.88	NS

NS = Non-Significant (P≤0.05)

Table 5. Optimizing de-sapping time to control the incidence of sapburn injury in mango cv Chaunsa.

Treatment	**T_1 (24hrs)**	**T_2 (48hrs)**	**T_3 (72hrs)**	**T_4 (7days)**	**T_5 (15days)**
T_1 (20 min)	0.33hi	0.46ghi	0.68fghi	0.85efg	0.93ef
T_2 (10 min)	0.30i	0.43ghi	0.76efgh	0.98ef	1.18e
T_3 (Control)	1.80d	2.30c	2.55bc	2.83ab	3.20a
Means	0.81D	1.06CD	1.33BC	1.56AB	1.77A

Any two means not sharing a common letter are significantly different (P≤0.05)

Mango sapburn susceptibility varied among cultivars, although the problem was considerably more severe in cv Chaunsa, moderate damage was observed in cv Sindhri and slight damage in cv Dusehri. The degree of sap injury observed has been related to at least three factors: total sap flow, oil content and lenticels density (O'Hare *et al*., 1992). In the present study, mango cvs having a lower sap flow and oil content than cv Chaunsa had much lower incidence of injury. In case of cv Chaunsa greatest oil content was consistent with the amount of injury observed. Lenticels density also appeared to have a modifying effect on injury, as damage only occurred where sap flowed over lenticels. This was consistent with previous observations (Robinson *et al*., 1993; O' Hare & Prasad, 1991).

It is uncertain whether the chemical consistency of the oil fraction may have influenced the degree of sap injury in this trial. Previous study (Loveys *et al*., 1993) has provided evidence that different terpenoids may cause varying amounts of damage to mango skin and that the chemical consistency of sap can vary between cultivars. In the present study, the oil fraction was separately applied to fruit, and consequently its potency was assessed. It was found that almost 99% injury took place by applying spurt sap and 1% injury was observed by ooze sap (Lim & Kuppelweiser, 1993).

More sapburn severity of the fruits harvested at afternoon time might be due to the fact that the daytime temperature affected sap quantity and severity. As the day temperature increased it also increased the rate of transpiration from the fruit surface which ultimately results in reduction of water concentration in mango fruit sap and when the concentration of water was reduced, the terpinolene oil concentration was more which could be the real cause of sapburn severity.

De-sapping fruits by placing over de-sapping tray for 20 minutes reduced the chances of sapburn injury because during this time maximum sap including spurt sap was exuded within first few seconds which normally cause almost 100% damage, did not touch the fruit skin. But in fruits which were de-sapped for 10 minutes on de-sapping tray, since the sap was not exuded completely that later continued to exude on surface and caused some injury. While in case of fruits harvested by traditional method, since no de-sapping was done and sap was continuously releasing during handling and transportation, so it increased the chances of sapburn injuries on fruits.

The results indicate that harvest time (of a day) has a significant relationship with sap quantity and sapburn injuries. Total sap quantity also varied with cultivar. Chaunsa cv had more than 11 times of the sap quantity of cv Sindhri, so extra care must be taken during harvesting to packing of cv Chaunsa. Postharvest de-stemming time had little effect on total sap contents. Regarding susceptibility of mango cvs to sapburn, cv Dusehri was least susceptible while cv Chaunsa was the most. For better control of sapburn injury in mango, it is suggested that fruit should be harvested early in the morning because at that time less injury was observed. De-sapping fruit over tray for 20 minutes, gave best results in controlling sapburn injuries in comparison with traditional method of harvesting and handling of mango fruits.

Acknowledgements

We are thankful to Pakistan Horticulture Development and Export Board for providing financial assistance to conduct this study under "*Mango Quality Improvement Programme*" and Ayub Agriculture Research Institute (AARI), Faisalabad for providing cold storage facility.

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(Received for publication 23 May 2007)