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Postharvest Responses of Tropic Snow Peach Fruits to Preharvest Field Heat Removal

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Abstract: The aim of this work was to study the effect of floppy sprinkler irrigation method as a Field Heat Removing (FHR) treatment on postharvest fruit quality of Tropic Snow peach cultivar. The flesh temperature of the fruits at harvest was measured to assess the effect of field temperature history and followed the postharvest response of these fruits. The FHR fruits were stored at two different temperatures; either cold storage (1 ± 0.1°C) or ambient temperature (25±2°C) as a shelf life. The response of FHR or check fruits to reach the temperature of cold storage (1± 0.1 °C) was differed significantly. Fruit physical and chemical characteristics were assessed. At harvest time there was no significant effect of FHR treatment on fruit weight, vitamin C content and total phenols percentage. However, total soluble solids (TSS %), total sugars percentage and titratable acidity were significantly affected. FHR treatment markedly reduced weight loss percentage, increased firmness and acidity of Tropic Snow peach fruits which held at ambient temperature (25±2°C). A slight reduction in fruit weight loss and firmness occurred due to FHR treatment under cold storage temperature. The field heat removal of Tropic Snow peach fruit before harvest can help to maintain fruit quality and prolonged storage life.

Key words: Peach fruit · Field heat · Postharvest · Fruit quality · Shelf life · Cold storage

INTRODUCTION

Temperature is considered the single most important factor in maintaining fruits freshness and their quality after harvest. Each product has "field heat", which resulted from the sun and ambient temperature, depending on the time when it is being harvested. Consequently the field heat should be removed as soon as possible after the harvest to keep the quality. Furthermore, removing field heat from freshly harvested fruits reduces respiration rates and microbial activity. Preharvest field temperature can influence composition and quality of fruits at harvest as well as their postharvest response. Fruits flesh temperatures well above 35 - 40°C have been recorded in direct sunlight in a wide range of crops in both hot and temperate climates [1]. These high temperatures, both in terms of diurnal fluctuations and long-term exposure, may cause injure or weaken the tissues prior to harvest, reduce storage life, increase susceptibility to decay and also resulted in differences in internal quality properties such as sugar contents and tissue firmness. There are several methods for water cooling as a cooling method sprinkler, trickle and subsurface irrigation methods are relatively modern techniques especially in the new lands due to its high control of water distribution and suitability to most of soil and crop types [2]. Factors that affect moisture loss include initial temperature, transpiration co-efficient, humidity and exposure to airflow after cooling. High initial temperature resulted in high moisture loss can be minimized by harvest at cooler times of the day (i.e. early morning or at evening) and cooling or at least shading produces immediately after harvest. The primary advantage of high humidity during cooling is that packaging can absorb moisture, which reduces its capacity to absorb moisture from the product itself. On the tree, fruit flesh and skin of exposed fruit frequently reached temperatures 10-15°C above air temperature. These high fruit temperatures were associated with direct sunlight exposure suggesting that radiance has the largest impact on fruit temperature. Skin and flesh temperatures of fruits above 35°C on the exposed side of sun light could be maintained for as long as 2-4 h. The flesh temperatures of the fruits on the unexposed side of sun reached about 5°C above air; this could be due to heat transfer across the fruit and diffuse or reflected radiation. High field temperature may result in physiological disorders and increased deterioration. Also, it can induce visible injury at harvest, such as sunburn or

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sunscald; however, serious problems occur during fruit storage and handling following injury which was not visible at harvest.

The aim of this study is to prolong shelf life of Tropic Snow peach fruit and maintain fruit quality through field heat removal.

MATERIALS AND METHODS

The present study was carried out during the two successive seasons of 2009 and 2010 in a private orchard at El-Qssassene region, Ismailia Governorate, Egypt to study the effect of field heat removing treatment on shelf life and fruit quality of peach *Prunus persica* (Tropic Snow cultivar), by using floppy sprinkler irrigation method, two weeks before harvest. Field heat removal (FHR) of peach fruits was carried out by using the high performance of floppy sprinkler which can be achieved by operating pressure of 200 kPa and riser height of 2.0 m. as shown in Fig. 2 [3].

Mature and sound fruits were picked at 24th of May 2009 and 7th of June 2010. Flesh temperature was measured, soon after harvest, by using thermometer inserted 5mm into the flesh as described by Ferguson *et al.* [4]. The initial physic-chemical properties of the fruit were determined in both treated and untreated fruits. The changes in such properties were followed up after 5 days (shelf life) in ambient temperature (at 25°C ± 2 and 80-85 % RH). About 20 fruits from each treatment were stored at 1°C ± 0.1 and 90-95% RH to find out the time it takes to reach the required temperature. Another group of FHR and control fruits stored (at 1 ± 0.1 °C and 90-95 % RH) for 15 days. Fruit physical and chemical characteristics were assessed through the experimental working period as follows: the percentage of fruit weight loss was calculated for 20 labeled fruits in control and treated fruits in relation to its original weight and the average weight percentage was calculated for each treatment. Skin and flesh colour evaluation was done at two opposite sides of each fruit skin and flesh (after peeling fruits) using a Minolta CR 10

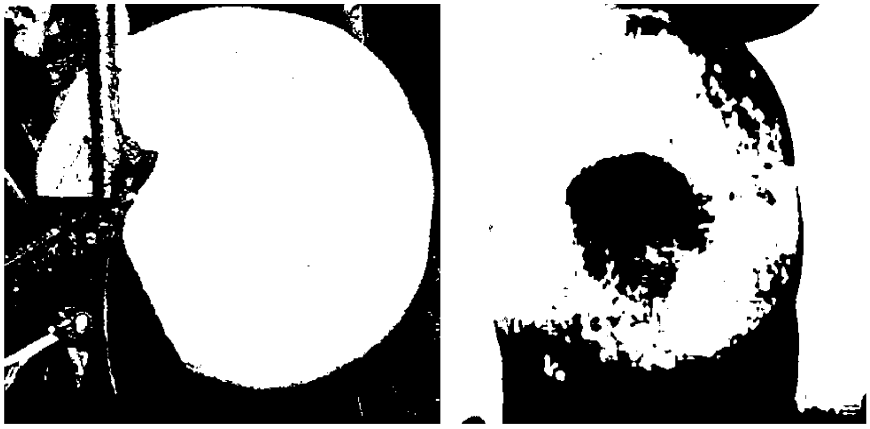

Fig. 1: Peach fruit cv. (Tropic snow)

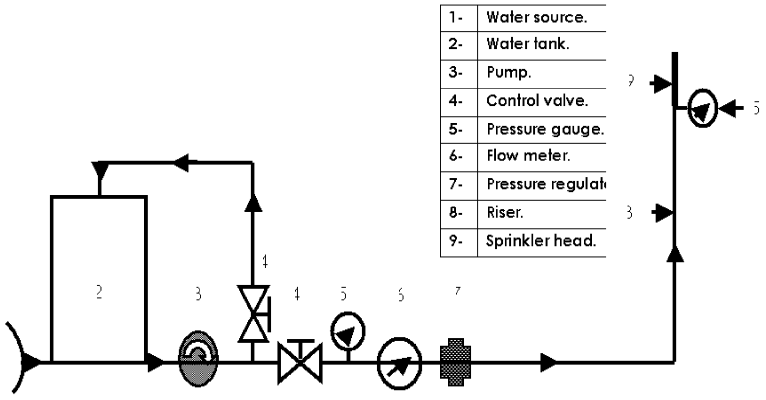

Fig. 2: Schematic diagram of the unit used

Fig. 3: Flesh colour of control (a) and Flesh colour of FHR (b) of Tropic Snow peach fruit at harvest

Fig. 4: Tropic Snow peach fruits after cold storage for 15 days at 1 °C and 90 - 95 % RH

chromameter given fruit in the sample by using a hand Magness Taylor pressure tester (lb/in^2). Total soluble solids (TSS %) was determined by using ATTAGO hand refractometer at 20°C and expressed as percentage. Total soluble sugars were calorimetrically determined by using phenol sulphoric acid method at 490 mμ wave length and the concentration was calculated as glucose [5]. Titratable acidity was determined in fruit juice by using 0.1 NaOH in the presence of phenolphthalein indicator until pH 8.0 and expressed as citric acid percent. Total soluble phenols were determined by using Folin and Ciocalateu colorimetric method at 700 mμ wave length and the concentration was calculated from a standard curve of pyrogallol [6].The termination of the experiment was done when fruit firmness reached the average of 2 lb/in^2.

All obtained data were statistically analyzed according to Sendecor and Cochran [7]. Means were compared by "Multiple Range Test" at 5% level of probability according to Duncan [8].

RESULTS AND DISCUSSION

It is clear from Table 1 that, in the hot dry climate of Ismailia at June, flesh temperature of peach fruit cv. Tropic Snow exposed to sunlight and air temperatures above 30 - 35°C reached about 45 °C in control fruits and about 22°C in FHR fruits. It is obvious from the obtained data in Table 2 that, half - cooling time for FHR fruits was 45 min. These fruits reached to required temperature (1°C) after 180 min. however, the half - cooling time for controlled

Table 1: Initial temperature of peach fruit core in both treated or untreated fruit with reference to air in 2009 and 2010 seasons

	Temperature °C	
Treatments	2009	2010
Air	35	33
Control	45.5	44.9
FHR	22.6	21.4

Table 2: The difference in the time needed to reach the fruit temperature required

	Coolant Temperature	
Time minutes	FHR	Control
0.0	22.0	45.2
15	18.0	40.0
30	14.5	33.5
45	11.4	28.6
60	8.6	26.5
75	6.5	24.5
90	5.4	22.6
105	5.0	20.1
120	4.2	18.5
135	3.0	16.7
150	2.0	15.0
165	1.6	13.8
180	1.0	11.6
195	--	10.7
210	--	9.5
225	--	8.8
240	--	7.2
255	--	6.5
270	--	5.3
285	--	4.8
300	--	4.0
315	--	3.1
330	--	2.8
345	--	2.0
360	--	1.8
375	--	1.2
390	--	1.0

fruits was 90 min. and it was reached to the required temperature after 390 min. At the beginning of the cold storage process, the cooling rate was relatively higher than that towards the end of the cooling period. This finding can be explained by the fact that the bigger the difference between the commodity temperature and the coolant the faster cooling rate is expected. It is evident that, when cooling is delayed after peach fruits were harvested the fruits are expected to suffer shortened storage period and deterioration during storage [9, 10].

At the beginning of the experiment (at harvest), field heat removal fruits had lower flesh (a/b) colour values than control fruits which means that the red colour was disappeared in FHR fruit flesh (Fig. 2). The highest (a/b) colour values were obtained by control fruits which means that the red colour was displayed. Seymour *et al.* [11] reported that, anthocyanines the primary red pigment in the vacuoles of peach cells may occur throughout the flesh in some cultivars with a concentration near the pit. FHR treatment reduced significantly TSS % and total sugars when compared with control fruits. There was a highly significant effect of FHR treatment on reducing weight loss of Tropic Snow peach fruits which held at ambient temperature 25°C in both the experimental seasons (Table 4). Fruit weight loss of FHR slightly increased, while, in control fruits, weight loss was increased significantly at the end of shelf life (5 days). However, it had a significant higher firmness and total acidity than the control fruits (at harvest) in both seasons (Table 3).

The changes in weight loss in control fruits were more rapid. Whereas, in FHR fruits, it slightly increased the advancing cold storage period at 1°C in both seasons (Table 5). The weight loss is mainly a result of water loss from the fruit tissues and partially of the respiration process. FHR reduced the fruits weight loss because its effect on reducing physiological changes rate, mainly respiration process rate. The higher temperature of the fruit, the greater is its tendency to lose moisture [10, 12, 13]. Fruit weight loss was increased with extending storage period. However, the highest significant values of weight loss was obtained by control fruits after 15 days storage followed in descending order by FHR fruits in both seasons. There was no significant difference between FHR and the control treatments in skin or flesh colour of Tropic Snow peach fruits after shelf life. Kurnaze and Kazka [14] and Verstreken and Baerdemaeker [15] found that, fruit weight loss was increased as storage time increased. Similar results have been reported by Akbudak and Eris [16] and Serrano *et al.* [17] who found that, weight loss in normal condition was high in all analytical periods compared to peaches and nectarines stored in control atmosphere.

Firmness of FHR fruits was significantly higher than control fruits after the shelf life period in both seasons (Table 4). Fruit firmness showed a significant decrease as the storage time increase. Since, it decreased from 7.2 and 7.7 in FHR fruits and 10.3 and 9.8 in control fruits lb/in^2 at harvest to about 1.7 and 1.6 in FHR fruits and 4.2 and 3.8 in control fruits (lb/in^2) after 15 days of storage at 1°C at

Table 3: Initial quality at harvest of both treated and untreated Tropic snow peach fruits in 2009 and 2010 seasons

			Flesh colour								
Treatments	Fruit weight (g)	Fruit size (cm^3)	a	b	a/b	Fruit Firmness (lb/in^2)	TSS (%)	Total sugars (%)	Acidity (%)	V.C (%)	Total phenols (mg /100 g f. w.)
						2005					
Control	90.1 a	91.5 a	8.2	25.1	0.33 a	7.0 b	11.4 a	7.7 a	0.3 b	31.2 a	66.8 a
FHR	91.0 a	88.3 a	7.2	25.8	0.28b	9.6 a	10.5 b	6.2 b	0.4 a	28.8 a	69.6 a
						2010					
Control	88.8 a	90.2 a	8.0	25.0	0.32 a	6.8 b	11.8 a	7.8 a	0.3 b	28.2 a	68.3 a
FHR	90.5 a	98.1 a	6.9	26.2	0.26 b	10.1 a	10.7 b	6.6 b	0.4 a	30.6 a	71.4 a

Values followed by the same letter (s) in each column are not significantly different at 5% level.

Table 4: Quality parameters of Tropic Snow peach fruit after 5 days at ambient temperature (25°C ± 2) in 2009 and 2010 seasons

		Skin colour			Flesh colour								
Treatments	Weight loss (%)	a	b	a/b	a	B	a/b	Fruit Firmness (lb/in^2)	TSS (%)	Total sugars (%)	Acidity (%)	V.C (%)	Total phenols (mg / 100 g f. w.)
							2009						
Control	5.5 a	13.8	32.5	0.42 a	8.2	25.1	0.33 a	2.1 b	12.8 a	8.6 a	0.1 b	33.5 a	63.5 a
FHR	3.3 b	15.1	33.5	0.45 a	8.0	0.25	0.32 a	4.6 a	11.4 b	7.4 b	0.3 a	32.4 a	62.5 a
							2010						
Control	4.8 a	12.8	32.5	0.39 a	8.0	25.0	0.32 a	1.8 b	12.6 a	8.3 a	0.1 b	33.2 a	64.3 a
FHR	2.4 b	14.5	34.2	0.42 a	7.7	24.6	0.31 a	4.2 a	11.2 b	7.1 b	0.3 a	34.3 a	66.4 a

Values followed by the same letter (s) in each column are not significantly different at 5% level.

Table 5: Effect of FHR treatment and following storage temperature (1°C + 90-95% RH) on weight loss % of Tropic Snow peach fruits in 2009 and 2010 seasons

	Storage period in days					
Treatments	0	3	6	9	12	15
			2009			
Control	0.00	2.5 a	5.6 a	8.8 a	10.6 a	12.2 a
FHR	0.00	1.1 b	2.4 b	4.6 b	6.5 b	8.2 b
			2010			
Control	0.00	3.07 a	6.6 a	9.2 a	11.1 a	13.4 a
FHR	0.00	0.9 b	2.1 b	3.6 b	5.8 b	9.2 b

Values followed by the same letter (s) in each column are not significantly different at 5% level.

Table 6: Effect of FHR treatment and following storage temperature (1°C + 90-95% RH) on flesh firmness lb/in^2 of Tropic Snow peach fruits in 2009 and 2010 seasons

	Storage period in days					
Treatments	0	3	6	9	12	15
			2009			
Control	7.2 b	6.5 b	4.8 b	3.6 b	2.8 b	1.7 b
FHR	10.3 a	9.0 a	7.8 a	6.6 a	5.4 a	4.2 a
			2010			
Control	7.7 b	6.2 b	5.0 b	3.8 b	2.4 b	1.6 b
FHR	9.8 a	8.6 a	7.4 a	6.2 a	4.5 a	3.8 a

Values followed by the same letter (s) in each column are not significantly different at 5% level.

Table 7: Effect of FHR treatment and following storage temperature (1°C + 90-95% RH) on soluble solids content of Tropic Snow peach fruits in 2009 and 2010 seasons

	Storage period in days					
Treatments	0	3	6	9	12	15
			2009			
Control	11.4	12.8	13.5	14.5	15.4	15.2
FHR	10.4	10.8	11.4	12.6	13.2	14.1
			2010			
Control	11.8	12.6	13.5	14.2	15.6	15.3
FHR	10.6	11.2	12.4	13.0	13.8	14.2

Values followed by the same letter (s) in each column are not significantly different at 5% level.

Table 8: Effect of FHR treatment and following storage temperature (1°C + 90-95% RH)on titratable acidity percentage of Tropic Snow peach fruits in 2009 and 2010 seasons

	Storage period in days					
Treatments	0	3	6	9	12	15
			2009			
Control	0.30 b	0.26 b	0.22 a	0.20 a	0.20 a	0.19 a
FHR	0.40 a	0.30 a	0.23 a	0.20 a	0.20 a	0.20 a
			2010			
Control	0.30 b	0.25 b	0.22 a	0.20 a	0.20 a	0.20 a
FHR	0.45 a	0.35 a	0.22 a	0.20 a	0.20 a	0.20 a

Values followed by the same letter (s) in each column are not significantly different at 5% level.

the two seasons, respectively. The reduction in fruit firmness mainly due to decomposition enzymatic degradation of insoluble protopectins to more simple soluble pectins, solubilization of cell and cell wall content as a result of increasing in pectin esterase activity and subsequent development of juiciness and the loss in peel and flesh hardness. These changes may be slowed down because of the removing of field heat and fast cooling (Table 6). These findings are in agreement with those obtained by El- Saedy and El-Naggar [10], Kurnaze and Kazka [14], Ravaglia *et al.* [18] and El-Etreby [19], Dundar [20].There was a significant effect for FHR treatment on TSS % (Table 4) where, FHR fruits maintained its TSS % low after shelf life compared with control fruits. Also, there was a significant effect of FHR treatment on the changes of TSS % (Table 7). The increasing rate in TSS % was lower for the FHR fruits during the cold storage period. The gradual increase in the values of TSS % with increasing of storage temperature and storage period could be due to the degradation of complex insoluble compounds (pectins) to simple soluble ones (sugars) which considered the major component of TSS % in the fruits and this changes increase with increasing storage temperature as a catalytic factor. In addition, the changes were increased with the progress of storage time, where it allows the accumulation of TSS % in the fruits. FHR treatment slows down such changes in the treated fruits. These results are in harmony with those obtained by Hussein [12] on Florda Prince, Almog and Tropic Snow peaches, Mohamed [21] on Florda Prince, Almog and Tropic Snow peaches and El- Saedy and El-Naggar [10] on Swilling peach.

In all treatments the total sugars percentage showed the same trend of TSS % (Table 4). These results are in agreement with those obtained by Chapman and Harvat [22].There was a significant effect for FHR treatment on titratable acidity percentage of peach fruit after shelf life (25°C for 5 days) where the FHR fruits had high percentage of acidity compared with the control fruits (Table 4). However, there was no significant effect for FHR treatment on acidity percentage of Tropic Snow peach fruit during storage period (Table 8) except for the higher significant content of acidity for the FHR fruits after 3 days of cold storage at 1°C in both seasons. Generally, acidity percentage was decreased during the storage period for both treatments. FHR treatment retarded the metabolic process respiration and as a result treated fruits contained more acidity percentage as a

respiratory substance. The consumption of organic acids in respiration was increased with increasing storage temperature and with the progress of storage time [10, 12, 21, 23].There was no significant difference between FHR and the control treatments in total soluble phenols content of Tropic Snow peach fruits at harvest (Table 3) or after shelf life (Table 4).

CONCLUSION

The obtained data suggested that, field heat removal of Tropic Snow peach fruit before harvest may impact an eventual fruit quality and can help to maintain fruit quality during cold storage and prolonged shelf life.

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