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Influence of ethrel on ripening and quality of persimmon *(Diospyros kaki)*

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ABSTRACT

The present investigation was conducted to study the effect of post-harvest ethrel treatment on ripening and quality of persimmon (*Diospyros kaki* Thunb.) under ambient (24 ± 2°C) as well as refrigerated (3-6°C) conditions. Fully matured persimmon cv. Hachiya fruits were dipped in ethrel solution of varying concentrations (50, 100, 150 and 200 ppm) or with control (water dip). The observations on per cent physiological loss in weight (PLW), per cent ripening and spoilage, fruit length (cm) and breadth (cm), and quality parameters, viz. total soluble solids (°B), titratable acidity (%), total sugars (%), reducing sugars (%) and TSS: acid content were recorded at regular interval till the fruits were acceptable. Results of the study revealed that PLW (%) increased with the increase in storage period under both the storage conditions. All the quality parameters, like TSS, total sugars, reducing sugars and TSS: acid ratio were influenced by ethrel treatment but the acidity remains unaffected. The fruits treated with higher concentration of ethrel (150 or 200 ppm) showed more ethylene injury (spots on fruits), while those treated with lower concentration (50 or 100 ppm) or untreated did not show any such injury when stored under refrigerated condition. A dip in 100 ppm ethrel for 1 minute was found to be the best for persimmon cv. Hachiya under both the storage conditions.

Key words: Ambient, Ethrel, Persimmon, Quality, Refrigerated storage

Persimmon (*Diospyros kaki* Thunb.) is a promising fruit that contains a higher quantity of vitamin C, vitamin A, citric acid, proteins, lipids, carbohydrates, inorganic salts like phosphorus, potassium and iron (Shin 1996). This fruit is consumed fresh after losing in astringency and also used for making sweetened juice, pickles, vinegars, wines etc. At present, persimmon is being grown on a limited scale in Jammu and Kashmir, Himachal Pradesh, Uttarakhand and parts of eastern India. This fruit has a climacteric nature and thus it is harvested at full maturity. The colour of persimmon slowly evolves during storage and sometimes it can become brownish, a sign of cold damage (Gorini and Testoni 1988). This damage is related to the too early ripening stage when they have not reached the turning stage of colour. The respiration process takes place after its harvesting which thus resulted in its ripening but its astringent taste should be avoided which is overcome only when it is fully matured. The ripening of persimmon is normally not uniform which creates problem in steady marketing of fruits. Ethrel (2-Chloroethyl phosphonic acid), a natural ripening agent has been found effective in causing ripening of fruits (Warner and Leopold 1969). For this, different ethrel treatments have been given to the fruit for varying time period which resulted in proper ripening of fruit and thus increased its consumer acceptability. On dipping mature fruits in ethrel, it enters fruit cells, releases ethylene and hastens the ripening process. The fruits of persimmon cultivar Hachiya be picked when firm and ripened at room temperature until soft. Its astringency is eliminated during the ripening process. A very limited work has been conducted on this. Thus, keeping in view the above points, the present study was undertaken to find out the optimum concentration of ethrel for uniform ripening of persimmon cv. Hachiya.

MATERIALS AND METHODS

The hand picked mature and healthy fruits of uniform size, shape, free from pest and diseases, injuries, bruises and blemishes were harvested at maturity stage from the 16 years old persimmon trees at Regional Horticulture Research Sub-Station, Bhaderwah of SKUAST-Jammu during 2008 and 2009. These fruits were washed and drained prior to ethrel treatment: a dip treatment of 1 minute was given to all the fruits. Four different concentrations of ethrel, i.e. T_1: 50 ppm, T_2: 100 ppm, T_3: 150 ppm and T_4: 200 ppm were used, while control fruits T_5: water dip or not and then placed at both ambient (24 + 2°C) as well as refrigerated temperature (3-6°C). Thirty fruits in two sets were kept in each replication, one set was used for recording physiological loss in weight, ripening, spoilage and the other set was used for chemical analysis. As the experiment was triplicated, the physiological loss in weight (PLW) was

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determined by periodical weighing of fruits and differential weight loss was expressed in per cent with respect to storage time and post-harvest treatments. Similarly, the per cent ripening and per cent spoilage was also calculated periodically by dividing the number of ripened/spoiled fruits from the total number of fruits placed in set. The axial and radial diameter (cm) was recorded by digital vernier callipers (Mitsuyo). Total soluble solids (TSS) content of stored fruits were recorded with the help Erma-hand refractometer (0-32^{o}Brix) and necessary temperature corrections were made. Total sugars, reducing sugar and acidity were recorded by AOAC (1994). The data were subjected to statistical analysis by factorial completely randomized design outlined by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

In the present investigation, the percentage of physiological loss in weight, ripening and spoilage increased significantly under both ambient as well as refrigerated conditions with the increasing concentration of ethrel (Table 1 and 2). Ethrel treated persimmon fruits were more uniform in ripening than the fruits under control. These findings are in agreement with the findings of Suryanarayana and Goud (1984) for sapota who reported that higher the ethrel concentration, faster was the ripening.

Table 1 Effect of post-harvest ethrel treatment on physical characteristics of persimmon cv. Hachiya during storage at room temperature (pooled data of 2 years)

Treatment (ppm)	Storage period (days)		
	0	2	3
	PLW (%)		
T_1		3.42	4.72
T_2		3.56	5.08
T_3		3.74	5.16
T_4		3.86	5.42
T_5		2.99	4.64
CD (P=0.05)	Treatment (T)	Days (D)=0.23	T×D=0.31
	Length (cm)		
T_1	7.90	7.72	7.46
T_2	7.91	7.69	7.55
T_3	7.97	7.74	7.53
T_4	8.18	7.96	7.72
T_5	8.32	8.09	7.88
CD (P=0.05)	T=NS	D=NS	T×D=0.14
	Breadth (cm)		
T_1	7.59	7.44	7.29
T_2	7.22	7.13	7.07
T_3	7.41	7.33	7.25
T_4	7.61	7.54	7.43
T_5	7.30	7.22	7.14
CD (P=0.05)	T=0.03	D=0.02	T×D=0.04

NS, Non-significant

Table 2 Effect of post-harvest ethrel treatment on physical characteristics of persimmon cv. Hachiya during storage at refrigerated temperature (Pooled data of 2 years)

Treatment (ppm)	Storage period (days)					
	0	2	3	4	5	6
		PLW (%)				
T_1		2.08	2.58	3.62	4.12	4.76
T_2		2.14	2.76	3.56	4.24	4.92
T_3		2.81	3.02	3.85	4.66	5.34
T_4		2.92	3.26	4.02	4.92	5.81
T_5		1.26	2.37	3.14	3.86	4.62
CD (P=0.05)	Treatment(T)=0.25		Days (D)=0.25		T×D=0.51	
		Length (cm)				
T_1	8.08	8.01	7.90	7.84	7.78	7.73
T_2	8.20	8.12	8.05	7.98	7.94	7.89
T_3	8.30	8.30	8.24	8.18	8.10	8.03
T_4	8.61	8.61	8.56	8.51	8.45	8.34
T_5	7.90	7.76	7.57	7.64	7.56	7.47
CD (P=0.05)	T=0.24			D=NS	T×D=0.36	
		Breadth (cm)				
T_1	7.21	7.16	7.10	7.10	7.08	7.07
T_2	7.16	7.12	7.08	7.07	7.05	7.04
T_3	7.28	7.24	7.19	7.17	7.16	7.15
T_4	7.82	7.78	7.74	7.73	7.72	7.70
T_5	7.21	7.16	7.12	7.10	7.06	7.03
CD (P=0.05)	T=0.09			D=NS	T×D=0.12	

NS, non-significant

However, with the increasing concentration of ethrel, not only the percentage of ripening (Fig 1 and 2) but spoilage was also increased indicating shorter post-ripening period under both the storage conditions. Among the various ethrel concentrations, 100 ppm maintained comparatively higher percentage of marketable fruits on all days of observation. The fruits treated with 150 and 200 ppm ethrel for 1 minute were not acceptable after 3 days of storage at ambient temperature as they showed ethylene injury, i.e. spots on fruits, whereas fruits stored under refrigerated conditions were not acceptable after 6 days of storage. However, the control fruits as well as those treated with 50 and 100 ppm (lower concentration) did not show any injury. These fruits were better than those treated with higher concentration of ethrel.

The data presented in Table 3 and 4 indicated that as the storage period advanced, the total soluble solids, reducing sugars and total sugars increased significantly till they reached a peak and then declined gradually under both room as well as refrigerated temperature. The increase in TSS and sugars of fruits could be attributed to the conversion of starch and other insoluble carbohydrates into soluble sugars. The lower content of TSS and sugars

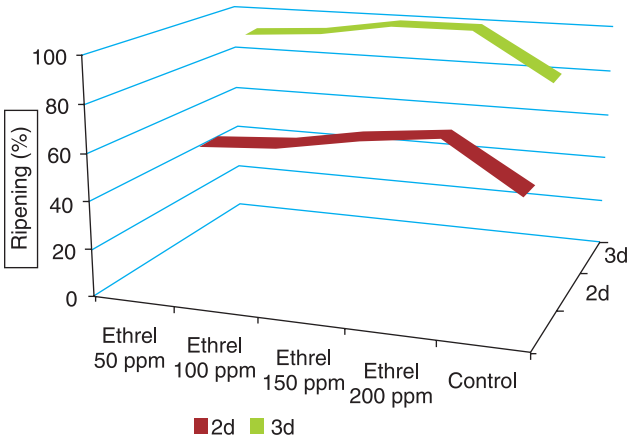

Fig 1 Effect of post-harvest ethrel treatment on ripening (%) of persimmon cv. Hachiya during storage at room temperature (pooled data of 2 years)

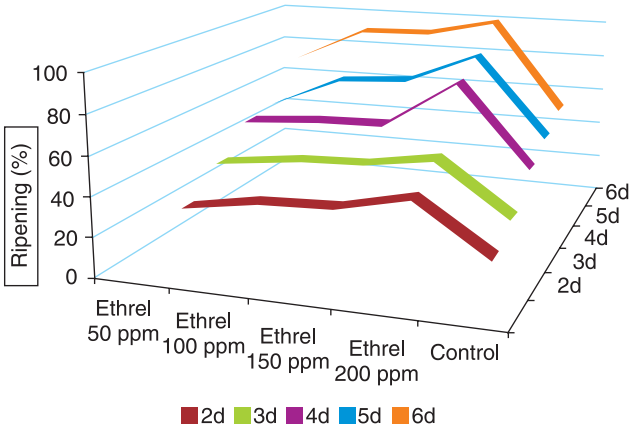

Fig 2 Effect of post-harvest ethrel treatment on ripening (%) of persimmon cv. Hachiya during storage at refrigerated temperature (pooled data of 2 years)

Table 3 Effect of post-harvest ethrel treatment on chemical characteristics of persimmon cv. Hachiya during storage at room temperature (Pooled data of 2 years)

Treatment (ppm)	Storage Period (days) 0	2	3
	TSS (°B)		
T_1	16.25	16.48	17.85
T_2	16.25	17.97	19.75
T_3	16.25	18.53	20.05
T_4	16.25	18.55	20.60
T_5	16.25	16.28	16.62
CD (P=0.05)	Treatment (T)=0.24	Days (D)=0.16	T×D=0.35
	Acidity (% citric acid)		
T_1	0.47	0.42	0.38
T_2	0.47	0.38	0.31
T_3	0.47	0.34	0.28
T_4	0.47	0.32	0.24
T_5	0.47	0.44	0.41
CD (P=0.05)	T=NS	D=NS	T×D=NS
	Reducing sugar (%)		
T_1	10.93	12.92	13.46
T_2	10.93	13.14	14.32
T_3	10.93	13.60	14.63
T_4	10.93	13.88	14.71
T_5	10.93	12.46	13.28
CD (P=0.05)	T=0.24	D=0.18	T×D=0.31
	Total sugars (%)		
T_1	14.66	15.18	15.48
T_2	14.66	15.63	16.24
T_3	14.66	15.92	16.45
T_4	14.66	15.96	16.72
T_5	14.66	14.86	15.06
CD (P=0.05)	T=0.27	D=NS	T×D=0.38
	TSS acid ratio		
T_1	34.58	39.23	58.72
T_2	34.58	47.67	67.72
T_3	34.58	55.75	75.96
T_4	34.58	58.34	85.83
T_5	34.58	37.00	42.70
CD (P=0.05)	T=12.05	D=NS	T×D=NS

NS, Non-significant

Table 4 Effect of post-harvest ethrel treatment on chemical characteristics of persimmon cv. Hachiya during storage at refrigerated temperature (Pooled data of 2 years)

Treatment (ppm)	Storage period (days) 0	2	3	4	5	6
	TSS (°B)					
T_1	16.25	16.02	16.86	17.96	18.25	18.02
T_2	16.25	17.54	18.62	20.10	20.40	20.15
T_3	16.25	18.35	19.40	20.30	20.75	20.40
T_4	16.25	18.24	19.60	21.15	21.32	21.02
T_5	16.25	15.86	16.32	16.80	16.95	17.06
CD (P=0.05)	Treatment (T)=0.28		Days (D)=0.28		T×D=0.42	
	Acidity (% citric acid)					
T_1	0.47	0.49	0.48	0.46	0.44	0.41
T_2	0.47	0.50	0.47	0.45	0.43	0.40
T_3	0.47	0.48	0.45	0.42	0.40	0.37
T_4	0.47	0.47	0.43	0.41	0.39	0.35
T_5	0.47	0.51	0.49	0.47	0.45	0.42
CD (P=0.05)	T=NS		D=NS		T×D=NS	
	Reducing sugar (%)					
T_1	10.93	12.40	12.78	13.42	13.72	13.35
T_2	10.93	12.66	13.46	14.38	14.84	14.13
T_3	10.93	12.73	13.88	14.66	14.96	14.26
T_4	10.93	13.05	14.02	14.34	14.99	14.32
T_5	10.93	12.24	13.03	13.22	13.60	13.14
CD (P=0.05)	T=0.23		D=0.23		T×D=0.34	

Table 4 (*Concluded*)

	0		2		3	
			Total sugars (%)			
T_1	14.66	15.03	15.25	15.49	16.23	16.03
T_2	14.66	15.26	15.70	15.96	16.92	16.24
T_3	14.66	15.46	15.85	15.82	17.14	16.46
T_4	14.66	15.58	16.22	16.64	17.36	16.80
T_5	14.66	14.77	15.04	15.28	15.86	15.26
CD (P=0.05)	T=0.28		D=0.28		T×D=0.42	
			TSS: acid ratio			
T_1	34.58	32.82	35.27	39.81	42.37	45.64
T_2	34.58	35.30	39.89	45.58	48.84	51.10
T_3	34.58	38.39	42.94	50.21	56.60	56.45
T_4	34.58	40.89	47.24	52.27	58.41	71.38
T_5	34.58	30.34	34.03	36.82	37.95	41.17
CD (P=0.05)	T=NS		D=NS		T×D=NS	

in fruit tissues was due to their utilization in respiration. The ethrel treated fruits recorded higher TSS and sugars compared to the fruits under control. These results are in consonance with the findings of Madhavi *et al*. (2005) in sapota. Singh *et al*. (2002) also reported an increase in TSS and sugar content in apple with the application of 300 ppm ethrel.

There was a continuous decrease in acidity content of persimmon with the progress of ripening period under both the storage conditions (Table 3 and 4). Further, acidity decreased with the increasing concentration of ethrel. The decrease in acidity might be attributed to the conversion of acids into sugars (Pool *et al*. 1975) and utilization of organic acids during respiration. The decreased acidity content of ethrel treated fruits may be due to acceleration of ripening under the influence of ethylene. Abd El-Fatah *et al*. (2008) also reported similar range of acidity in ethrel treated persimmon fruits, while Singh *et al*. (2002) revealed that an application of ethrel 300 ppm lowered the acidity of apple.

TSS: acid ratio of persimmon fruits increased continuously throughout the ripening period (Table 3 and 4) under both the storage conditions. Though, TSS had shown initial increase followed by decrease, the TSS: acid ratio increased. This might be due to that the magnitude of decrease in acidity is more compared to decrease in TSS in the later stages of storage. Persimmon fruits treated with ethrel exhibited higher TSS: acid ratio than the control under both the storage conditions.

It is thus concluded that among the various concentrations of ethrel tried, 100 ppm ethrel for 1 minute was found to be the best as it did not show any injury and also maintain the quality of fruit under both the storage conditions.

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