INDIAN JOURNAL OF ARID HORTICULTURE
2006, Vol. 1 (1) : 39-43

Effect of emulsions and carbendazim on storability of kinnow (*Citrus deliciosa* Tenore x *C. nobilis* Lour)

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Abstract

The individual effect of wax emulsion, oil emulsion and carbendazim were found significant in prolonging the post harvest life and standard quality of kinnow fruits.The treatment of wax emulsion and carbendazim under zero energy cool chamber gave better results. At the end of storage period (28th day), the minimum PLW (7.70 %), minimum TSS (11.07 %), and maximum acidity (0.83 %) were observed in the treatment of wax emulsion 12 % + carbendazim 500 ppm under zero energy cool chamber. At ambient conditions, the fruits were not much matching in quality to that of zero energy cool chamber stored fruits.

Key words: *Carbendazim, emulsion, kinnow, shelf life, ambient conditions.*

Introduction

Kinnow, a mandarin hybrid belongs to the family Rutaceae. In view of its heavy bearing character coupled with relative tolerance to diseases and pests, it has been popularized in irrigated areas of Rajasthan, Haryana, Punjab, Himachal Pradesh, Uttar Pradesh, Karnataka, Kerala and Tamil Nadu. However, the fruits on storage loose their quality. Therefore, an attempt was made for prolonging post harvest storage life and to study the effect of emulsions and fungicide under cool chamber and at ambient storage conditions on kinnow.

Materials and Methods

The experiment was conducted during the year 2001-02 under laboratory conditions, Depatment of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner. For conducting the study, uniform and healthy fresh fruits were picked up randomly and washed with tap water. The fruits were then treated with wax, oil emulsions and carbendazim and placed under zero energy cool chamber as well as at ambient storage condition. For the treatment oil emulsion at 0,1and 2 % and wax emulsion at 0, 4, 8 and 12 % concentrations were used. Two concentrations of carbendazim (0 and 500 ppm) were also taken for studying its effect on storability of kinnow fruits under zero energy cool chamber as well as at ambient storage conditions. Individual effect of these treatments and their combinations on storability of kinnow was studied. The temperature and relative humidity under storage conditions were recorded.

The observations were recorded on physiological loss in weight (PLW), TSS and acidity. The PLW in weight was determined by substracting final weight from initial weight followed by dividing by initial weight and expressed in percentage. The TSS content of the fruits was directly measured by the hand refractometer. Acidity was determined by titrating the juice against standard N/10 NaOH using phenolphthalein indicator and expressed on percentage basis. Five fruits were taken as an unit to record the observations under context. Each unit of fruits was replicated thrice to record the data. The data so recorded were subjected to statistical analysis using CRD and treatments effects were adjudged at 5% level of significance.

Results and Discussion

Data on PLW are presented in Table 1. The PLW increased continuously till the end of storage period irrespective of the treatments and storage conditions. The treatment showed highly significant effect on PLW throughout the storage period. However, mean maximum PLW was observed in control (20.95 %) followed by carbendazim 500 ppm (18.14 %) and mean minimum PLW was recorded in wax emulsion 12 % + carbendazim 500 ppm (13.19 %) preceded by wax emulsion 8 per cent + carbendazim 500 ppm (13.97 %) on 28th day of storage.

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The fruits stored in zero energy cool chamber exhibited minimum PLW of 4.00, 5.82, 7.95 and 10.42 % and that at ambient condition 5.39, 10.87, 16.59 and 22.17 % at 7th, 14th, 21th and 28th days of observations, respectively. Interactions between treatments and storage conditions were significant on all the days of storage. Maximum (27.52%) PLW was observed in control at ambient temperature and minimum (7.30%) in wax emulsion 12 per cent + carbendazim 500 ppm stored in zero energy cool chamber on 28th day of storage (Table 1).

It is evident from the study that the substantial increase in loss in weight increased with the advancement of storage period. Similar results have also been observed in different citrus spp. like lime (Garg and Ram,1972), and Coorg mandarin (Dalal, *et al.*,1962). The reduction in weight was possibly due to loss of moisture through transpiration and utilization of reserve food materials in process of respiration (Meyer *et al.*,1966).

The TSS content of the fruits affected by the treatments are presented in Table 2. As the storage period progressed, the TSS content of the fruits increased irrespective of the treatments. The mean maximum (12.70%) TSS content was found in control followed by 12.66 per cent in fruits treated with carbendazim 500 ppm on 28th day of storage. At the end of storage, mean minimum TSS (11.43%) was observed in the fruits treated with 12 % wax

Table 1. Effect of post harvest treatments and storage conditions on PLW of kinnow fruits *(%)*

S.No. Treatment /	Storage period (days) 7 days ZECC	AC	Mean	14 days ZECC	AC	Mean	21 days ZECC	AC	Mean	28 days ZECC	AC	Mean
1. Control	6.97	8.66	7.81	8.79	14.87	11.83	11.15	20.88	16.01	14.39	27.52	20.95
2.WE 4%	3.74	5.08	4.41	5.48	11.53	8.50	17.71	15.85	11.78	09.62	21.20	15.40
3. WE. 8%	3.39	4.73	4.06	4.15	10.66	07.90	01.26	15.19	11.22	09.03	20.52	14.77
4. WE 12%	3.04	4.28	3.66	4.72	09.42	07.07	16.80	14.31	10.55	08.39	19.88	14.13
5. Sesame Oil 1%	4.15	5.63	4.89	5.95	11.19	08.57	08.27	17.43	12.85	11.29	23.07	17.18
6. Sesame Oil 2%	3.86	5.30	4.58	5.63	10.72	08.17	07.86	16.99	12.42	10.80	22.57	16.69
7. Linseed Oil 1%	4.45	5.97	5.20	6.29	11.57	08.93	08.59	17.92	13.25	11.58	23.51	17.54
8. Linseed Oil 2%	4.29	5.81	5.05	6.10	11.28	08.69	08.38	17.66	13.02	11.30	23.23	17.26
9. Carbendazim 500 ppm	5.27	7.00	6.13	7.12	13.46	10.29	09.40	19.38	14.39	11.40	24.88	18.14
10. W E. 4 % + Carbendazim 500 ppm	3.36	4.58	3.97	6.09	09.88	07.98	07.23	15.00	11.11	08.94	20.32	14.63
I I. W E. 8 % + Carbendazim 500 ppm	3.04	4.18	3.61	4.72	09.03	06.87	06.67	14.10	10.38	08.33	19.60	13.97
12. W. E. 12 % + Carbendazim 500 ppm	2.66	3.75	3.20	4.33	08.25	06.29	06.03	13.35	09.69	07.70	18.67	13.19
13. Sesame Oil 1% + Carbendazim 500 ppm	3.92	5.25	4.58	5.60	10.42	08.01	07.91	16.77	12.34	10.90	22.36	16.63
14. Sesame Oil 2% + Carbendazim 500 rpm	3.59	4.91	4.25	5.30	10.03	07.66	07.56	16.19	11.87	10.44	21.66	16.05
15. Linseed Oil 1% + Carbendazim 500 ppm	4.28	5.67	4.97	6.01	11.02	08.52	08.31	17.50	12.90	11.35	23.00	17.17
16. Linseed Oil 2% + Carbendazitn 500 ppm	4.07	5.50	4.78	5.80	10.65	08.22	08.10	17.03	12.65	11.08	22.60	16.84
Storage condition mean	4.00	5 39		5.82	10.87		7.95	16.59		10.42	22.17	
	SED	CD 5%		SED	CD 5%		SED	CD 5%		SED	CD 5%	
Treatment (T)	0.02	0.04		0.06	0.12		0.02	0.04		0.02	0.05	
Storage condition (S)	0.00	0.01		0.02	0.04		0.00	0.01		0.00	0.01	
TXS Interaction	0.03	0.07		0.08	0.17		0.03	0.07		0.03	0.07	

W. E.= means Wax Emulsion, NS = Non Significant, ZECC= Zero Energy Cool Chamber, AC= Ambient Conditions

Table 2. Effect of post harvest treatments and storage conditions on TSS content of kinnow fruits (%)

S.No.	Treatment	Storage period: 7 days			14 days			21 days			28 days		
		ZECC	AC	Mean	ZECC	AC	Mean	ZECC	AC	Mean	ZECC	AC	Mean
1.	Control	11.0	11.50	10.25	11.47	12.13	11.80	11.93	12.57	12.25	12.30	13.10	12.70
2.	WE 4%	10.5	11.03	10.76	10.70	11.47	11.08	11.2	11.83	11.51	11.57	12.47	12.01
3.	WE. 8%	10.33	11.87	10.60	10.60	11.20	10.90	11.00	11.67	11.33	11.37	12.10	11.73
4.	WE 12%	10.17	11.70	10.43	10.43	11.03	10.73	10.80	11.47	11.13	11.17	11.87	11.52
5.	Sesame Oil 1 %	10.67	11.23	10.95	11.00	11.60	11.30	11.50	12.17	11.84	11.90	12.63	12.26
6.	Sesame Oil 2 %	10.50	11.10	10.80	10.80	11.50	11.15	11.37	12.03	11.70	11.73	12.50	12.11
7.	Linseed Oil 1%	10.83	11.40	11.11	11.17	11.90	11.53	11.77	12.50	12.13	12.20	13.00	12.60
8.	Linseed Oil 2 %	10.70	11.23	10.96	11.03	11.73	11.38	11.63	12.40	12.01	12.07	12.87	12.47
9.	Carbendazim 500 ppm	10.93	11.43	11.18	11.33	11.03	11.68	11.80	12.53	12.16	12.26	13.07	12.66
10.	W E. 4 % + Carbendazim 500 ppm	10.36	11.00	10.68	10.70	11.30	11.00	11.13	11.73	11.43	11.50	12.23	11.86
II.	W E. 8 % + Carbendazim 500 ppm	10.30	11.80	10.95	10.47	11.17	11.82	10.90	11.57	11.23	11.30	12.03	11.66
12.	W. E. 12 % + Carbendazim 500 ppm	10.10	11.60	10.35	10.27	11.93	11.60	10.80	11.37	11.08	11.07	11.80	11.43
13.	Sesame Oil 1 % + Carbendazim 500 ppm	10.60	11.20	10.90	10.90	11.57	11.23	11.40	12.10	11.75	11.83	12.60	12.21
14.	Sesame Oil 2 % + Carbendazim 500 rpm	10.47	11.10	10.78	10.73	11.40	11.69	11.23	12.00	11.61	11.07	12.43	12.05
15.	Linseed Oil 1 % + Carbendazim 500 ppm	10.70	11.33	10.01	10.07	11.87	11.47	11.70	12.47	12.08	12.03	12.97	12.50
16.	Linseed Oil 2 % + Carbendazitn 500 ppm	10.60	11.20	10.90	10.93	11.93	11.33	11.57	12.33	11.95	11.90	12.83	12.36
	Storage condition mean	10.54	11.10		10.85	11.55		11.37	12.04		11.73	12.53	
		SE D	CD 5%		SE D	CD 5%		SE D	CD 5%		SE D	CD 5%	
	Treatment (T)	0.10	0.203		0.12	0.251		0.158	0.31		0.17	0.35	
	Storage condition (S)	0.03	0.07		0.04	0.08		0.05	0.11		0.06	0.12	
	TXS Interaction	0.14	NS		0.17	NS		0.22	0.44		0.25	0.50	

W. E.= means Wax Emulsion, NS = Non Significant, ZECC= Zero Energy Cool Chamber, AC= Ambient Conditions

emulsion + 500 ppm carbendazim followed by the fruits which were treated with wax emulsion 12 % alone. Storage conditions had a significant effect on TSS content of fruits throughout the storage. Zero energy cool chamber stored fruits showed minimum increase in TSS while fruits which were stored at ambient condition exhibited fastest increase in TSS. Gupta *et al.* (1980) reported increase in TSS content of kinnow fruits and Singhrot *et al.* (1987) in lemon. The increase in TSS must be accounted to the moisture loss and hydrolysis of polysaccharides as also discussed by Jwanda *et al.* (1978) in mandarin. TSS content of the fruits was significantly affected by wax, oil emulsions and carbendazim treatment. The increase in TSS content was appreciably higher under control as compared to wax and oil emulsions treated fruits. High TSS content in control treatment fruits may be due to high rate of transpiration as compared to wax and oil emulsions treated fruits. Carbendazim treated fruits showed slower rate of increase in TSS as compared to control. This might be due to lower PLW in these fruits. Similar observations have been observed by Sandhu *et al.* (1989) in Kinnow and Verma (1997) in Kagzi lime.

The data presented in Table 3 shows that the acidity of stored fruits decreased with the advancement of storage period. The mean maximum acidity (0.81%) on 28th day was found in the fruits treated with 12% wax emulsion + carbendazim 500 ppm closely followed by 8 % wax emulsion + carbendazim 500 ppm treated fruits (0.79%). Fruits placed

Table3. Effect of post harvest treatments and storage conditions on acidity of kinnow fruits (%)

S.No. Treatment	Storage period (days) 7 days			14 days			21 days			28 days		
	ZECC	AC	Mean	ZECC	AC	Mean	ZECC	AC	Mean	ZECC	AC	Mean
1. Control	0.77	0.74	0. 75	0.76	0.72	0.74	0.75	0.70	0.72	0.73	0.68	0.70
2. WE 4%	0..83	0.79	0. 81	0.82	0.78	0.80	0.81	0.77	0.79	0.79	0.75	0.77
3. WE. 8%	0.83	0.80	0.81	0.82	0.78	0.80	0.81	0.76	0.78	0.79	0.75	0.77
4. WE 12%	0.84	0.80	0.82	0.83	0.79	0.81	0.82	0.78	0.80	0.80	0.77	078
5. Sesame Oil I%	0.80	0.77	0.78	0.78	0.75	0.76	0.77	0.73	0.75	0.75	0.71	073
6. Sesame Oil 2%	0.82	0.78	0.80	0.81	0.77	0.79	0.80	0.76	0.78	0.79	0.75	0.77
7. Linseed Oil %	0.79	0.76	0.77	0.78	0.74	0.76	0.77	0.72	0.74	0.75	0.70	0.72
8. Linseed Oil 2%	0.80	0.77	0.77	0.79	0.75	0.77	0.78	0.73	0.75	0.77	0.71	0.74
9. Carbendazim 500 ppm	0.77	0.74	0.75	0.76	0.72	0.74	0.75	0.70	0.72	0.73	0.68	0.70
10. W E. 4 % + Carbendazim 500 ppm	0.83	0.80	0..81	0.82	0.78	0.80	0.81	0.76	0.78	0.78	0.75	0.76
I I. W E. 8 % + Carbendazim 500 ppm	0.84	0.80	0.82	0.83	0.79	0.81	0.82	0.78	0.80	0.81	0.77	0.79
12. W. E. 12 % + Carbendazim 500 ppm	0.86	0.82	0.84	0.85	0.81	0.83	0.84	0.80	0.82	0.83	0.79	0.81
13. Sesame Oil I% + Carbendazim 500 ppm	0.80	0.77	0.78	0.79	0.75	0.77	0.78	0.73	0.75	0.76	0.71	0.73
14. Sesame Oil 2% + Carbendazim 500 rpm	0.83	0.79	0.81	0.82	0.78	0.80	0.81	0.77	0.79	0.80	0.75	0.77
15. Linseed Oil I% + Cairbendazim 500 ppm	0.80	0.76.	0.78	0.78	0.74	0.76	0.77	0.72	0.74	0.75	0.70	0.72
16. Linseed Oil 2% + Carbendazitn 500 ppm	0.80	0.78	0.79	0.79	0.76	0.775	0.78	0.75	0.16	0.77	0.72	0.74
Storage condition mean	0.81	0.77	0.80	0.16	0.78	0.74	0.78	0.73				

	SE D	CD 5%	SE D	CD 5%	SE D	CD 5%	SE D	CD 5%
Treatment (T)	0.20	0.014	0.024	0.048	0.026	.051	0.024	0.048
Storage condition (S)	0.07	0.040	0.008	0.017	0.009	.0]8	0.008	0.017
TXS interaction	0.28	NS	0.034	NS	0.036	NS	0.034	NS

W. E.= means Wax Emulsion, NS = Non Significant, ZECC= Zero Energy Cool Chamber, AC= Ambient Conditions

under zero energy cool chamber exhibited the high acid content (0.81%) on 7th day and had the same trend throughout the storage period. Room temperature stored fruits showed the minimum acid content throughout the storage period. As regards to storage condition, maximum acidity content (0.83%) was recorded in fruits treated with wax emulsion 12 % + carbendazim 500 ppm and placed under zero energy cool chamber. Minimum acidity content (0.68%) was noted in control as well as carbendazim 500ppm treated fruits kept at ambient condition on 28th day of storage. Gradual decline in total acidity content of the fruits during storage period, irrespective of the treatments may be due to utilization of acid in the respiration process. These results are in conformity to the findings of Bhullar *et al.* (1981). The acid content of the fruits was significantly affected by all the treatments containing wax and oil emulsions over control. It may be due to lesser availability of oxygen in wax and oil treated fruits. It appears that organic acid which participates in the respiratory process did not oxidize, therefore, their level remained high (Singh *et al.*, 1978). Meena (1997) ascribed similar reason in ber and Khan (1995) in Nagpur mandarin.

Carbendazim was found effective in retaining the acidity of fruits during storage. Jwanda *et al.* (1978) reported application of fungicidal wax quite effective in retention of acidity during storage. Zero energy cool chamber lowered the acid decline as compared to ambient condition. This might be due to the delay in ripening and slower degradation of organic acids as a result of low temperature and high humidity prevalent in srorage. Similar findings have also been reported by Naik (1985) and Singh (1987) in mango.

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