Post harvest degreening, storage and quality of sweet orange (*Citrus sinensis* Osbeck.) as influenced by ethephon and carbendazim

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For degreening of sweet orange fruits post-harvest application of ethephon (2-chloroethyl phosphonic acid) was tried alone and in combination with carbendazim (fungicide) 0.05%. Ethephon 0.2% degreened the fruits in 3-5 days, while the untreated fruits remained green. There was no effect of ethephon on T.S.S., ascorbic acid, acidity and juice content. Higher rate of ethephon increased the storage rot as compared to lower rate. The storage rot was effectively controlled when ethephon was applied along with 0.05% carbendazim. Use of carbendazim with ethephon neither increased the efficacy for degreening nor, had adverse effect on the fruit quality.

Key words : Degreening, starage, quality, sweet Orange ethephon, carbendazim.

INTRODUCTION

The sweet orange (*Citrus sinensis* Osbeck.) is harvested during September to December. The fruits do not develop colour even though the fruits attain minimum maturity requirement resulting in poor acceptability by the consumer. The poor colour development is probably prevented by unfavorable environmental conditions. The colour development of rind is characterized by a rapid loss in chlorophyll and rise in carotenoid pigments. The post harvest application of ethylene results in substantial development of colour associated with the synthesis of specific carotenoid (Steward and Wheaton, 1971).

The post harvest degreening of citrus species have been found to increase the decay (Mc Cormack and Brown, 1970) and the inclusion of fungicide at the time of degreening has been found to check the decay. Therefore, the present study was undertaken to find out the suitable concentrations of ethephon along with carbendazim for post harvest degreening as well as internal quality of sweet orange fruits.

MATETERIAL AND METHODS

Three trials were carried out during the month of October, November and December 2000, in the laboratory of Horticulture, Allahabad Agricultural Institute, Deemed University, Allahabad. Fresh, mature and uniform fruits of sweet orange were collected from the orchard. In each trial four concentration of ethephon viz. 0, 0.1, 0.2 and 0.4 per cent in all possible combinations with and without carbendazim (fungicide) 0.05% were tried. The fruit after sampling were washed by water, wiped, dried with cloth and were dipped in solution of various treatments for one minute. Then they were stored under laboratory condition (60^0-98^0F). There were eight treatments replicated four times, each replication consisted of six fruits. The experiment was laid out in complete randomized design.

The observations were recorded for colour developments, physical and chemical characters and decay of fruits till the colour changes remained static (4-5 days). The colour changes were referred to colour dictionary by Maerz and Paul (1930). The fruits were analyzed for juice content, acidity, ascorbic acid, TS.S. and TSS/acidity ratio by standard procedure (A.O.A.C., 1990). Physiological loss in weight and decay loss were estimated on weight basis as suggested by Srivastava and Tondon (1968). The juice of the fruit was extracted by cone electric juice extractor. It was trained, weighed and expressed on percentage basis.

RESULTS AND DISCUSSION

Ethephon at 0.2 per cent was found to be optimum (Table 1) for degreening in sweet orange and this is within the range

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Table 1. Effect of ethephon and carbendazim on sweet orange fruit rind colour

Treatment	Days after treatment				
	1	2	3	4	5
Control	22-K-3 Box green	-	22-K-6 Box green	22-K-6 Box green	22-J-5 Leek green
Carbendazim 0.05%	23-L-1 Holly green	-	22-L-8 Civet green	22-J-6 Crass green	22-J-5 Leek green
Ethephon 0.1%	22-K-3-Box green	-	19-K-1Linden green	19-K-1 Linden green	19-L-1 Grape green
Ethephon 0.1%+ Carbendazim 0.05%	22-K-6 Leek green	-	19-L-1 Grape green	18-L-1 Grape green	18-L-1 Chalcedony yellow
Ethephon 0.2%	22-K-7 Spinach green	-	17-L-2 Sea foam green	10-L-2 Aurelin	10-L-2 Aurelin
Ethephon 0.2% + Carbendazim 0.05%	22-L-8 Civet green	-	18-K-1 Chalcedony yellow	10-L-5 Primuline yellow	10-L-2 Aurelin
Ethephon 0.4%	23-L-1 Holly green	-	9-L-4 Sunflower Yellow	9-L-5 Apricot yellow	9-L-4 Sunflower
Ethephon 0.4%+Carbendazim 0.05%	22-K-3 Box green	-	9-L-3 Empire yellow	9-L-4 Sunflower Yellow	9-L-1 Martin yellow

reported by john (1973). Salazar (1969) reported that 5000-ppm ethephon dip for one minute gave best colour in Valle Washington orange where colour appeared three days after storage at room temperature. In present investigation the storage period at room temperature was very short being 5-7 days. The degreening continued upto fifth day and colour intensity remained static this may be attributed to the drying out, of the fruits at room temperature. Decay (fruit rot) due to Phompsis citri, Diplodia was observed in fruit treated with ethephon only. The intensity of decay increased with the increase in ethephon concentration (Table 2). The decay loss was significantly affected by different treatments. The fruits treated with ethephon alone exhibited rotting during the period of storage indicating that decay loss increase with increase in ethephon concentration. However, none of fruits showed rotting when ethephon applied along with carbedazim, which resulted, reduced rate of respiration and microbial activity, responsible for rotting. This is an agreement with the findings of John (1973) in citrus and Singh et al. (1978) in mandarin and sweet orange. Carbendazim (fungicide) 0.05% controlled the fruit decay effectively (Table 2). Effective control of fruit decay is reported by Mc Cormack and Brown (1970) in Citrus.

It is evident from the data, that the loss in weight of fruits was significantly reduced over control during the

Table 2. Effect of ethephon and carbendazim on the physiological loss in weight, volume, juice content and fruit decay

Treatments	PLW%	Difference in fruit volume	Juice content (%)	Fruit decay at 20 DAT (%)
Control	2.24	2.56	41.25	-
Carbendazim 0.05%	1.83	2.13	41.32	-
Ethephon 0.1 %	1.95	2.4	41.29	10
Ethephon0.1%+ Carbendazim 0.05%	1.83	2.19	41.23	-
Ethephon 0.2%	2.18	2.42	41.24	30
Ethephon 0.2%+ Carbendazim 0.05%	1.67	1.96	42.30	-
Ethephon 0.4 %	2.08	2.25	41.24	50
,Ethephon0.4%+ Carbendazim	1.85	2.0	41.25	-
CD (p = 0.05)	0.08	0.03	0.09	25.56

Table 3. Effect of ethephon and carbendazim on the quality of fruits

Treatments	TSS (%)	Ascorbic acid (mg/100g)	Acidity (%)	Reducing sugar (%)	Non-Reducing sugar (%)	Total sugar (%)	TSS/ acidity
Control	7.80	48.39	0.503	2.64	3.443	6.083	15.60
Carbendazim 0.05%	7.76	48.38	0.500	2.64	3.444	6.084	15.52
Ethephon 0.1 %	7.81	48.40	0.496	2.65	3.430	6.080	15.72
Ethephon0.1%+ Carbendazim 0.05%	7.80	48.39	0.496	2.65	3.431	6.081	15.72
Ethephon 0.2%	7.82	48.92	0.495	2.66	3.420	6.080	15.79
Ethephon 0.2%+ Carbendazim 0.05%	7.83	48.43	0.495	2.66	3.421	6.081	15.80
Ethephon 0.4 %	7.82	48.42	0.486	2.67	3.410	6.080	16.11
,Ethephon0.4%+ Carbendazim	7.82	48.42	0.486	2.67	3.411	6.081	16.11
C.D.(p=0.05)_	0.009	-	0.003	-	0.002	-	1.002

storage. Maximum loss in weight of 2.24 per cent was observed in control, whereas minimum was 1.67 per centin treatment of ethephon 0.2 + carbendazim 0.05 per cent. A marked reduction in fruit volume differences was recorded with ethephon 0.2% + carbendazim 0.05% over control. This may be attributed to reduce physiological loss in weight (PLW) of the fruit.

Application of ethephon with carbendazim did not alter the quality of sweet orange fruit (Table 3). The present results are in agreement with Singh et al. (1978) in mandarin and sweet orange and John (1973) in citrus fruits. TSS, T.S.SI acidity ratio, ascorbic acid increased and acidity decreased during storage. This may be due to progressive loss in fruit weight caused by moisture loss. EI-Hammady and Kedar (1974) also observed 81% loss in fruit weight on storage at room temperature (20^0C) for 7 days.

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