Original Research Article

Impact of certain fungicides and calcium nitrate on quality and shelf life of kinnow mandarin

ABSTRACT

An experiment was carried out at CCS Haryana Agricultural University, Hisar during the year 2019-20 to study the effect of different fungicides and calcium nitrate on quality and shelf life of Kinnow mandarin". Spray of carbendazim, copper oxychloride, mancozeb, propiconazole, nimbecidine, calcium nitrate and their combinations was done ten days prior to harvesting on ten years old Kinnow plants. The fruits harvested from the plants treated with fungicides, nimbecidine, calcium nitrate, and their combinations exhibited significantly less decaying in comparison to the fruits of untreated plants. Carbendazim 0.05% + calcium nitrate 1% proved most effective treatment in checking the post-harvest decaying of fruits followed by propiconazole 0.05% + calcium nitrate 1%.TSS, acidity, TSS/acid ratio, reducing sugar, non-reducing sugar, total sugar of Kinnow fruits were found non-significantly affecting with various pre-harvest treatments. Among all the treatments, the maximum ascorbic acid content (24.10 mg/100 ml of juice) was reported in mancozeb 0.2% + calcium nitrate 1% andpropiconazole 0.05% + calcium nitrate 1% during storage in Kinnow fruits. The most prominent pathogens associated with decay loss were identified as *Colletotrichum gloeosporioides*, *Diplodia natalensis* and *Penicillium* sp. during storage period.

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Key words: Kinnow, Decay, Shelf life, Fungicides and Calcium nitrate

Introduction

Kinnow mandarin (*Citrus nobilis* L. x *Citrus deliciosa* L.) a leading citrus fruit grown in India. Citrus group belongs to the family rutaceae. It consists of sweet orange, lime, lemon, mandarin and grapefruit. Kinnow is a cross between King and Willow leaf mandarin developed by Dr. H. B. Frost at California, during the year 1935. In India, this variety was introduced by J.C. Bakhshi in 1958 at Punjab Agricultural University, Regional Fruit Research Station, Abohar. Kinnow has become exceedingly popular with the growers and consumers because of its superb fruit quality coupled with good tree vigour, higher cropping potential and better performance than other citrus fruits. Consumers relished Kinnow mandarin fruit due to its nutritional value, pleasant flavor and refreshing taste. Kinnow fruit contains naturally occuring bioactive compounds viz., ascorbic acid, total carotenoids, hesperidins, naringin, hydrocinnamic acid, ferulic acid and cyaniding glucoside (Sogi and Singh, 2001). Citrus fruits are non-climacteric, having low rate of respiration and they are comparatively poorer in post-harvest life as

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compared to climacteric fruits. It is essential to store the Kinnow fruits for a considerable period to avoid glut in the market after harvesting season.Storage has a ~~impact~~ a great influence on fruit texture, colour, aroma and other various physical and biochemical parameters. Various factors have been reported to be associated with post-harvest losses of Kinnow mandarin. There are 20-30% post-harvest losses in Kinnow mandarin happened during the storage due to bacterial and fungal contamination on the fruit, mismanagement of diseases, poor quality fruit, inappropriate weather condition, delay in harvesting, lack of proper roads and improper cold storage facilities, surplus supply in the market (Singh et al., 2004).The fruits may be infected in orchards right from the fruit setting to harvesting stage leading to pre-mature fruit dropping and incipient pre-harvest infection causes subsequent post-harvest fruit rotting during storage and transit under favorable conditions of temperature and moisture (Naqvi, 1993). Post-harvest impairment caused by green mould rot, blue mould rot, stem end rot and core rot are the most economically significant post-harvest diseases of Kinnow mandarin. Various physiological activities like respiration, ethylene liberation and enzyme were also responsible for limiting the shelf life of fruits (Singh and Mandal, 2006). The best approach to control the post-harvest fruit rotting is pre-harvest field application of fungicides (Sharma, 1990). Pre-harvest application of fungicides has been used to reduce pre-harvest inoculum load and subsequent post-harvest decay in various fruits (Blackarski *et al*.,2001). The present study will contribute in understanding the biochemical status of Kinnow mandarin fruits at harvest as influenced by pre-harvest spray of fungicides and calcium nitrates, which may help in increasing the shelf life and quality of Kinnow mandarin.

Material and Methods

The present investigation was conducted during the year 2019-20 in the experimental orchard, Department of Horticulture, CCS Haryana Agricultural University, Hisar. The objective was determing suitable treatments for better shelf life and quality of kinnow mandarin. The experiment was laid out in 6×6 Randomized block design comprising 12 treatments *i.e*. Carbendazim 0.05% + calcium nitrate 1% (T1), Carbendazim 0.1% (T2), Copper oxy chloride 0.2% + calcium nitrate 1% (T3), Copper oxy chloride 0.3% (T4), Mancozeb 0.2% + calcium nitrate 1% (T5), Mancozeb 0.3% (T6), Propiconazole 0.05% + calcium nitrate 1% (T7), Propiconazole 0.1% (T8): Nimbecidine 0.0009% + calcium nitrate 1% (T9), Nimbecidine 0.0015% (T10), Calcium nitrate 1% (T11), Control (T12) with three replication ~~application~~. Application of above treatments was done on 5th December 2019 and fruits were harvested on 16th December 2019 with the help of secateurs. Harvested fruits were stored in CFB boxes at room temperature. Total soluble solids were determined at room temperature using Hand Refractometer having a range of 0 to 30 °Brix. The method suggested by A.O.A.C. (2000) was followed for the estimation of titratable acidity and Ascorbic acid. Sugars were estimated by the method suggested by Hulme and Narain (1931). Fruits showing rotting due to over ripening and pathogenic infection were considered as decayed over and weighed on the date of each observation. Decay loss of fruits was calculated by the weight of decayed fruits divided by the initial weight of fruits and then converted into percentage value. Pathogens associated with decay loss will be identified and isolation of organism was made on the PDA by infected tissue transplant method according to Richer and Richer (1936).

Results and Discussion

TSS (°Brix)

The present study reveals that total soluble solids of Kinnow fruits increased with advancement of storage period, whereas, the various pre-harvest treatments had non-significant effect on total soluble solids. During storage, the total soluble solids increased significantly (table 1). This might be due to loss in moisture from fruit surface and breakdown of complex organic metabolites into simple molecules or due to hydrolysis of starch into sugars (Wills *et al*., 1980). Secondly increased loss in weight resulted into increase in concentration of juice. The results of present study are in line with Kaur and Kumar (2014) who reported that there was no significant effect of various treatments on total soluble solids content of Kinnow fruits. But total soluble solids content increased with the advancement of storage period. Similar results were obtained by Beniwal *et al*. (2018) in Kinnow, Prakash *et al*. (2014) in pomegranate and Panwar *et al*. (2017) in litchi.

Titratable acidity (%)

In this experiment, acidity of juice decreased with advancement of storage period, whereas, various pre-harvest treatments had non-significant effect on acidity during storage period. The maximum acidity (0.82%) was observed on initial day of storage, while, the minimum (0.59%) was observed on 49th day of storage (Table 2). The decreasing trend in the fruit acidity with the increasing storage period might be due to the oxidation of organic acid and its further utilization in metabolic processes (Obenland *et al*., 2011). The findings of present investigation corroborate the findings of Kaur and Kumar (2014) and Beniwal *et al*. (2018) who reported that the acidity in Kinnow fruit juice decreased with the advancement of storage period and the various treatments had non-significant effect on acidity of fruits. The results are also in line with the findings of Shiri *et al*. (2011) who observed decreased acidity with advancement of storage period in grapes.

TSS/acid ratio

In this experiment data presented in table 3 reveals that TSS/acid ratio of Kinnow fruit with different pre-harvest treatments increased with the advancement of storage period. The increased TSS/acid ratio with advancement of time might be due to increase in TSS and decrease in acidity content of juice during storage. These results are in close conformity with the earlier findings of Dhakad *et al*. (2020) in acid lime and Panwar *et al*. (2017) in litchi who showed that TSS/acid ratio increased during storage period.

Ascorbic acid content (mg/100 ml juice)

In the present study (table 4), the maximum ascorbic acid content (24.1%) was observed in mancozeb 0.2% + calcium nitrate 1% and propiconazole 0.05% + calcium nitrate 1% during the storage period, while, the minimum ascorbic acid content (22.8%) was found in control. The ascorbic acid content of Kinnow fruits decreased with the advancement of storage period. The higher retention of ascorbic acid was found in pre-harvest treatments of fungicides with combinations of calcium nitrate. This might be due to the fact that calcium nitrate probably retarded the oxidation process and hence the rate of conversion of L-ascorbic acid into de-hydro ascorbic acid was slowed down. Activities of oxidizing enzymes might be reduced in 1% calcium nitrate treated fruits resulting in higher ascorbic acid content during the storage of fruits. These results were in agreement with findings of Singh *et al.* (2008) in ber fruits. Similar results were obtained by Kaur and Kumar (2014) who reported that ascorbic acid content decreased with the advancement of storage period and the maximum ascorbic acid content was reported with $CaCl_2$ @2% under ambient storage.

Reducing sugars (%)

The data presented in table 5 reveals that reducing sugars were increased with the advancement of storage period irrespective of pre-harvest treatments. Kinnow is a non-climacteric fruit, so no fresh synthesis of reducing sugars takes place. Increase in reducing sugars content during storage might be due to water loss from fruits. These results are in close conformity with the earlier findings of Beniwal *et al*. (2018) who reported that reducing sugars increased with the advancement of storage period and there was non-significant effect of various pre-harvest application of fungicides on reducing sugar in Kinnow fruits. Similar results were obtained by Gangle *et al*. (2019) in guava fruits.

Non-reducing sugars (%)

The data presented in table 6 reveals that non-reducing sugars of Kinnow increased with the advancement of storage period up to 42nd days of storage and then decreased because the increase in total sugars content was less as compared to increase in reducing sugars during storage period. As a result of which non-reducing sugars decreased during storage after 42nd days of storage. It might be due to utilization of already existing non-reducing sugars in the process of respiration and there was no fresh synthesis of non-reducing sugars. This resulted into decrease in total non-reducing sugars content.The increase in non-reducing sugars up to 42 days of storage might be due to conversion of polysaccharides into soluble sugars and transformation of certain cell wall substances like hemicelluloses and pectin into non-reducing sugars. These results are in close conformity with the earlier findings of Gangle *et al*. (2019) who reported that non-reducing sugars increased with advancement of storage period in guava fruits. Similar results were obtained by Meena *et al*. (2016) in Nagpur mandarin.

Total sugars (%)

The present study reveals that amount of total sugars increased with increase in storage period, whereas, the effect of various treatments was found non-significant on total sugars (table 7). This might be due to increase in loss of moisture and physiological loss in weight which resulted in concentrated soluble sugars. The increase in sugar during storage was probably due to water loss from Kinnow fruits (Ahmed *et al*., 1980). Another reason for the increase in total sugars content might be the conversion of polysaccharides into soluble sugars by increasing enzymatic activity (especially due to the activity of cell wall degrading enzymes) slowly during the entire storage period. These results are in close conformity with the earlier findings of Beniwal *et al*. (2018) who reported that total sugars increased with advancement of storage period and there was non-significant effect of various pre-harvest application of fungicides on total sugars in Kinnow fruits. Similar results were obtained by Gangle *et al*. (2019) in guava, Ganga *et al*. (2019) in acid lime and Sinha *et al*. (2019) in plum fruits.

Decay loss (%)

The data presented in table 8 clearly indicates that the decay loss was increased with the passage of storage period. Under ambient room conditions, no decay loss was recorded up to 7 days of storage. The minimum decay loss (1.45%)was recorded on 14^{th} day of storage, whereas maximum decay loss (17.13%) was observed on 49^{th} day of storage. The extent of decay was reduced to a great extent by use of fungicides, nimbecidine, calcium nitrate and their combinations. The highest reduction in decay loss was recorded with carbendazim 0.05% + calcium nitrate 1% followed by propiconazole 0.05% + calcium nitrate 1%. Both the treatments were statistically at par in respect to reduction of decay loss. The maximum decay loss was reported in control fruits. During storage, the fruit rot incidence increased due to the degradation of fungicides and weakening of defence system of the fruits against the microbial attack due to reduction in pectin substances and growth of already existing pathogens during storage. These results are in close conformity with the earlier findings of Charpe *et al*. (2019) who observed that application of propiconazole @0.1% + citrashine wax @6% was most effective for control of *Colletotrichum* rot of Nagpur mandarin. Similar results were obtained by Baria *et al*. (2016) in citrus, Ingole *et al*. (2018) in Nagpur mandarin, Beniwal *et al*. (2018) in Kinnow and Rajput *et al*. (2008) in guava fruits.

Pathogens associated with decay loss

The decay percent increases with the advancement of storage period. During storage it was observed that many pathogens were responsible for decaying of Kinnow fruits. After isolation and identification, it was noticed that *Colletotrichum gloeosporioides, Diplodia natalensis* and *Penicillium sp*.were the most prominent fungi on the rotted fruits. These results are in close conformity with the earlier findings of Fatima and Iram, 2019 (*Citrus reticulate* Blanco.) and Parida *et al*. (2020) in orange and wood apple fruits.

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A.O.A.C. (2000).Official methods of analysis. Association of Analytical Chemists, 15thEd., Washington, D.C

Baria, T. T., Patil, R. K. and Prajapati, B. K., (2016).Evaluation of fungicides against *Fusarium pallidoroseum*, incitant of fruit rot of citrus. *Journal of Plant Disease Science*, **11**(1): 75-80.

Beniwal, V., Godara, A. K., Goyal, R. K. and Prince (2018).Effect of pre-harvest application of fungicides on fruit quality of Kinnow mandarin stored under ambient conditions. *International Journal of Pure & Applied Bioscences*, **6**(6): 278-286.

Blacharski, R. W., Bartz, J. A., Xiao, C. L. and Legard, D. E. (2001).Control of post-harvest *Botrytis* fruit rot with pre-harvest fungicide applications in annual strawberry. *Plant disease*, **85**(6): 597-602.

Charpe, A. M., Ingole, M. N. and Borkar, P. A. (2019).Management of *Colletotrichumgloeosporioides*, a post-harvest pathogen of Nagpur mandarins.

Dhakad, A., Sonkar, P., Bepari, A. and Kumar, U. (2020).Effect of pre-harvest application of plant growth regulators and calcium salts on biochemical and shelf life of acid lime (*Citrus aurantifolia* Swingle.). *Journal of Pharmacognosy and Phytochemistry*, **9**(4): 1983-1985.

Fatima, S. and Iram, S. (2019). Identification of fungal pathotypes associated with skin disorders of *Citrus reticulata* Blanco. through classical and molecular approach. *Pakistan Journal of Agricultural Research*, **32**(1): 95-101.

Ganga, R., Swaminathan, V., Kumar, S. R. C. and Venkatesan, K. (2019). Effect of pre-harvest spray of chemicals on shelf-life and quality of acid lime (*Citrus aurantifolia* Swingle) var. PKM 1.*International Journal of Chemical Studies*, **7**(3): 1893-1896.

Gangle, A., Kirar, S. K. and Pandey, C. S. (2019).Effect of post-harvest treatments on shelf life and quality of guava (*Psidium guajava* L.) cv. Allahabad Safeda. *International Journal of Current Microbiology and Applied Sciences*, **8**(10): 2104-2114.

Hulme, A. C. and Narain, R. (1931). The ferricyanide method for the determination of reducing sugars: A modification of the Hagedorn-Jensen-Hanes technique. *Biochemical Journal*, **25**(4): 1051-1061.

Ingole, M. N., Gade, R. M., Charpe, A. M. and Dhule, D. T. (2018).Efficacy of fungicides, chemicals, oils, wax and bio-agent against post-harvest pathogens of Nagpur mandarin. *Journal of Plant Disease Sciences*, ***13***(1): 80-85.

Kaur, N. and Kumar, A. (2014).Impact of post-harvest treatments on shelf life of Kinnow mandarin. *International Journal of Advance Research*, **2**(5): 290-295.

Meena, M. K., Jain, M. C., Singh, J., Sharma, M., Shing, B. and Maurya, I. B. (2016).Effect of pre-harvest spray of calcium nitrate, boric acid and zinc sulphate on yield and quality of Nagpur mandarin (Citrus reticulata Blanco). *International Journal of Horticultural Science*, **22**(1-2): 23-28.

Naqvi, S. A. M. H. (1993). Benzimidazole fungicides in control of post-harvest diseases of Nagpur mandarin. *Plant Disease Research*, **8**(1): 19-24.

Obenland, David, Sue Collin, Bruce Mackey, James Sievert and Mary Lu Arpaia.(2011). Storage temperature and time influences sensory quality of mandarins by altering soluble solids, acidity and aroma volatile composition. *Postharvest Biology and Technology*, **59**(2): 187-193.

Panwar, N., Kumar, J., Rai, P. N. and Shankar, D. (2017).Effect of pre-harvest foliar sprays of different chemicals on fruit quality and shelf life of litchi fruits. *International Journal of Chemical Studies*, **5**(4): 419-424.

Prakash, K., Ponnuswami, V. and Kulkarni, D. N. (2014).Effect of pre-harvest chemical spray on quality of pomegranate *(Punica granatum* L.) cv. Bahgwa. *Trends in Biosciences*, ***7***(11): 1090-1092.

Rajput, B. S., Lekhe, R., Sharma, G. K. and Singh, I. (2008). Effect of pre and post-harvest treatments on shelf life and quality of guava fruits (*Psidium guajava* L.) cv. Gwalior-27. *The Asian Journal of Horticulture*, ***3***(2): 368-371.

Richer, A. J. and Richer, R. S. (1936).Introduction to Research on Plant Disease.

Sharma, R. L. (1990). Efficacy of pre-harvest fungicidal sprays in controlling post-harvest diseases of China pear. *Plant Disease Research*, ***5***(1): 109-111.

Shiri, M. A., Ghasemnezhad, M., Bakhshi, D. and Dadi, M. (2011).Changes in phenolic compounds and antioxidant capacity of fresh-cut table grape (*Vitis vinifera*) cultivar Shahaneh as influence by fruit preparation methods and packagings. *Australian Journal of Crop Science*, ***5***(12): 1515.

Singh, D. and Mandal, G. (2006). Improved control of *Rhizopus stolonifer* induced storage rot of peach with hot water and antagonistic yeast, *Debaryomyces hansenii. Indian Phytopathology*, ***59***(2): 168-173.

Singh, I.P., Srivastava,A.K.,Shivankar,V.J. and Singh, S. (2004). Storage of citrus fruits. In: M.S. Ladaniya (ed.),*Advances in Citriculture*. Jagmander Book Agency, Delhi; p. 608-645.

Singh, S., Singh, A. K., Joshi H. K., Bagle, B.G. and Dhandar, D.G. (2008) Storability of ber (*Zizyphus mauritiana* Lamk.) fruit in semi-arid environment. *Journal of Food Science and Technology*, **45**: 65-69.

Sinha, A., Jawandha, S. K., Gill, P. P. S. and Singh, H. (2019). Influence of pre-harvest sprays of calcium nitrate on storability and quality attributes of plum fruits. *Journal of food science and technology*, **56**(3): 1427-1437.

Sogi, D. S., and Singh, S. (2001). Studies on bitterness development in Kinnow juice, ready-to-serve beverage, squash, jam and candy. *Journal of food science and technology (Mysore)*, **38**(5): 433-438.

Wills, R. B. H., Bambridge, P. A. and Scott, K. J. (1980).Use of flesh firmness and other objective tests to determine consumer acceptability of Delicious apples. *Australian Journal of Experimental Agriculture*, **20**(103): 252-256.

Table 1 Effect of pre-harvest spray of fungicides, nimbecidine, calcium nitrate and their combinations on TSS (^{o}brix) in Kinnow mandarin during storage at room temperature

Treatments	**Days in storage**								
	0	**7**	**14**	**21**	**28**	**35**	**42**	**49**	**Mean**
Control	9.45	9.75	10.10	10.70	11.50	12.30	12.70	12.80	11.16
Carbendazim 0.05% + calcium nitrate 1%	9.55	9.85	10.25	10.75	11.55	12.35	12.72	13.10	11.27
Carbendazim 0.1%	9.50	9.80	10.20	10.70	11.45	12.20	12.70	12.90	11.18
Copper oxychloride 0.2% + calcium nitrate 1%	9.50	9.80	10.20	10.70	11.50	12.30	12.70	12.90	11.20
Copper oxychloride 0.3%	9.50	9.80	10.10	10.65	11.50	12.30	12.70	12.90	11.18
Mancozeb 0.2% + calcium nitrate 1%	9.50	9.80	10.20	10.70	11.50	12.30	12.70	12.90	11.20
Mancozeb 0.3%	9.50	9.80	10.20	10.70	11.50	12.30	12.70	12.90	11.20
Propiconazole 0.05% + calcium nitrate 1%	9.50	9.80	10.20	10.70	11.50	12.30	12.70	12.90	11.20
Propiconazole 0.1%	9.50	9.80	10.20	10.70	11.50	12.30	12.70	12.90	11.20
Nimbecidine 0.0009% + calcium nitrate 1%	9.45	9.75	10.20	10.70	11.45	12.20	12.60	12.85	11.15
Nimbecidine 0.0015%	9.40	9.75	10.10	10.65	11.45	12.20	12.60	12.80	11.12
Calcium nitrate 1%	9.50	9.80	10.20	10.70	11.50	12.30	12.70	12.90	11.20
Mean	9.49	9.79	10.18	10.70	11.49	12.28	12.68	12.90	
C.D. at 5%	Treatment(T)=NS, Storage(S)=0.14, T×S=NS								

Table 2 Effect of pre-harvest spray of fungicides, nimbecidine, calcium nitrate and their combinations on titratable acidity (%) inKinnow mandarin during storage at room temperature

Treatments	**Days in storage**								
	0	**7**	**14**	**21**	**28**	**35**	**42**	**49**	**Mean**
Control	0.82	0.77	0.74	0.72	0.65	0.63	0.61	0.59	0.69

Carbendazim 0.05% + calcium nitrate 1%	0.83	0.83	0.78	0.74	0.69	0.67	0.60	0.62	0.72
Carbendazim 0.1%	0.79	0.75	0.72	0.70	0.63	0.62	0.58	0.57	0.67
Copper oxychloride 0.2% + calcium nitrate 1%	0.83	0.79	0.78	0.74	0.68	0.65	0.65	0.60	0.72
Copper oxychloride 0.3%	0.79	0.76	0.72	0.70	0.63	0.62	0.62	0.57	0.68
Mancozeb 0.2% + calcium nitrate 1%	0.82	0.80	0.76	0.73	0.68	0.66	0.61	0.58	0.70
Mancozeb 0.3%	0.81	0.78	0.72	0.69	0.63	0.61	0.58	0.57	0.67
Propiconazole 0.05% + calcium nitrate 1%	0.83	0.79	0.78	0.74	0.69	0.68	0.63	0.61	0.72
Propiconazole 0.1%	0.82	0.74	0.73	0.71	0.64	0.62	0.60	0.56	0.68
Nimbecidine 0.0009% + calcium nitrate 1%	0.83	0.81	0.79	0.74	0.67	0.65	0.65	0.62	0.72
Nimbecidine 0.0015%	0.82	0.76	0.73	0.70	0.65	0.62	0.60	0.56	0.68
Calcium nitrate 1%	0.82	0.80	0.76	0.72	0.68	0.65	0.64	0.60	0.71
Mean	0.82	0.78	0.75	0.72	0.66	0.64	0.62	0.59	
C.D. at 5%	Treatments(T)=NS, Storage(S)=0.04, T×S=NS								

Table 3 Effect of pre-harvest spray of fungicides, nimbecidine, calcium nitrate and their combinations on TSS/acid ratio in Kinnow mandarin during storage at room temperature

Treatments	**Days in storage**								
	0	**7**	**14**	**21**	**28**	**35**	**42**	**49**	**Mean**
Control	11.65	12.41	13.65	14.86	17.85	19.52	20.82	21.69	16.56
Carbendazim 0.05% + calcium nitrate 1%	11.33	11.71	13.01	14.32	16.74	18.21	20.00	20.32	15.70
Carbendazim 0.1%	11.85	13.13	14.31	15.36	18.41	20.00	21.50	22.98	17.19
Copper oxychloride 0.2% + calcium nitrate 1%	11.33	11.91	13.14	14.32	16.91	18.77	19.23	21.17	15.85
Copper oxychloride 0.3%	11.79	12.96	14.31	15.29	18.49	19.92	20.48	22.54	16.97
Mancozeb 0.2% + calcium nitrate 1%	11.39	12.06	13.25	14.52	17.06	18.48	19.84	21.25	15.98
Mancozeb 0.3%	11.65	12.56	14.31	15.65	18.49	20.41	21.17	22.63	17.11
Propiconazole 0.05% + calcium nitrate 1%	11.39	11.85	13.08	14.32	16.88	17.94	19.92	20.08	15.68
Propiconazole 0.1%	11.71	13.07	14.18	15.21	18.13	19.92	21.42	23.07	17.09
Nimbecidine 0.0009% + calcium nitrate 1%	11.39	11.98	12.72	14.39	17.24	18.77	19.23	20.48	15.77
Nimbecidine 0.0015%	11.65	12.79	14.11	15.29	17.85	19.92	20.83	22.54	16.87
Calcium nitrate 1%	11.59	12.13	13.22	14.72	16.91	18.92	19.69	21.08	16.03
Mean	11.54	12.37	13.59	14.86	17.55	19.23	20.20	21.65	

Table 4 Effect of pre-harvest spray of fungicides, nimbecidine, calcium nitrate and their combinations on Ascorbic acid content (mg/100 ml juice) in Kinnow mandarin during storage at room temperature

Treatments	**Days in storage**								
	0	**7**	**14**	**21**	**28**	**35**	**42**	**49**	**Mean**
Control	27.01	24.80	23.90	23.04	21.80	21.10	20.70	19.75	22.76

Carbendazim 0.05% + calcium nitrate 1%	27.70	25.60	25.01	24.01	22.90	22.60	22.02	21.65	23.94
Carbendazim 0.1%	27.18	25.16	24.70	23.84	22.75	22.10	21.70	20.14	23.45
Copper oxychloride 0.2% + calcium nitrate 1%	27.25	25.22	24.92	23.87	22.82	22.18	22.00	21.50	23.72
Copper oxychloride 0.3%	27.21	25.19	24.90	23.85	22.80	22.18	21.90	20.48	23.56
Mancozeb 0.2% + calcium nitrate 1%	27.90	25.85	25.10	24.10	23.15	22.95	22.20	21.95	24.15
Mancozeb 0.3%	27.09	25.07	24.20	23.70	22.65	22.80	21.85	21.24	23.58
Propiconazole 0.05% + calcium nitrate 1%	27.85	25.85	25.05	24.15	23.04	22.90	22.20	21.90	24.12
Propiconazole 0.1%	27.18	25.16	24.70	23.88	22.80	22.20	21.95	20.60	23.56
Nimbecidine 0.0009% + calcium nitrate 1%	27.25	25.13	24.62	23.90	22.70	22.10	21.95	20.60	23.53
Nimbecidine 0.0015%	27.09	25.07	24.20	23.70	22.65	22.80	21.80	20.40	23.46
Calcium nitrate 1%	27.09	25.07	24.20	23.72	22.65	22.10	21.90	20.40	23.39
Mean	27.32	25.26	24.63	23.81	22.73	22.33	21.85	20.88	
C.D. at 5%	Treatments(T)=0.32, Storage(S)=0.26, T×S=NS								

Table 5 Effect of pre-harvest spray of fungicides, nimbecidine, calcium nitrate and their combinations on reducing sugars (%) in Kinnow mandarin during storage at room temperature

Treatments	**Days in storage**								
	0	**7**	**14**	**21**	**28**	**35**	**42**	**49**	**Mean**
Control	2.90	3.32	3.62	3.90	4.15	4.43	4.73	5.06	4.02
carbendazim 0.05% + calcium nitrate 1%	3.01	3.44	3.76	3.96	4.21	4.51	4.80	5.16	4.11
Carbendazim 0.1%	3.00	3.34	3.67	3.94	4.17	4.50	4.76	5.10	4.06
Copper oxychloride 0.2% + calcium nitrate 1%	2.98	3.34	3.71	3.99	4.17	4.51	4.76	5.10	4.07
Copper oxychloride 0.3%	2.98	3.36	3.77	3.96	4.12	4.48	4.76	5.10	4.07
Mancozeb 0.2% + calcium nitrate 1%	3.03	3.44	3.71	3.92	4.13	4.48	4.74	5.10	4.07
Mancozeb 0.3%	2.98	3.36	3.67	3.93	4.12	4.49	4.77	5.11	4.05
Propiconazole 0.05% + calcium nitrate 1%	2.96	3.34	3.65	3.93	4.12	4.48	4.73	5.10	4.04
Propiconazole 0.1%	2.92	3.34	3.67	3.92	4.12	4.47	4.73	5.06	4.03
Nimbecidine 0.0009% + calcium nitrate 1%	2.98	3.39	3.67	3.97	4.19	4.53	4.77	5.10	4.07
Nimbecidine 0.0015%	2.91	3.34	3.71	3.97	4.12	4.48	4.75	5.10	4.05
Calcium nitrate 1%	2.92	3.34	3.65	3.89	4.13	4.44	4.73	5.08	4.02
Mean	2.96	3.36	3.69	3.94	4.15	4.48	4.75	5.10	
C.D. at 5%	Treatments(T)=NS, Storage(S)=0.05 T×S=NS								

Table 6 Effect of pre-harvest spray of fungicides, nimbecidine, calcium nitrate and their combinations on Non-reducing sugars (%) in Kinnow mandarin during storage at room temperature

Treatments	**Days in storage**								
	0	**7**	**14**	**21**	**28**	**35**	**42**	**49**	**Mean**
Control	2.98	3.95	4.72	5.21	5.90	6.66	6.87	6.83	5.39
Carbendazim 0.05% + calcium nitrate 1%	2.95	3.88	4.63	5.24	5.90	6.67	6.86	6.80	5.37
Carbendazim 0.1%	2.96	3.95	4.70	5.18	5.95	6.63	6.87	6.80	5.38

Copper oxychloride0.2% + calcium nitrate 1%	2.92	3.99	4.68	5.16	5.92	6.62	6.89	6.82	5.38
Copper oxychloride 0.3%	2.94	3.93	4.58	5.17	5.96	6.66	6.88	6.82	5.37
Mancozeb 0.2% + calcium nitrate 1%	2.90	3.87	4.68	5.22	5.98	6.66	6.89	6.81	5.38
Mancozeb 0.3%	2.96	3.92	4.69	5.18	5.99	6.63	6.85	6.80	5.38
Propiconazole 0.05% + calcium nitrate 1%	2.95	3.98	4.74	5.24	5.96	6.68	6.92	6.82	5.41
Propiconazole 0.1%	3.00	3.97	4.71	5.25	5.96	6.65	6.89	6.86	5.41
Nimbecidine 0.0009% + calcium nitrate 1%	2.95	3.92	4.71	5.18	5.92	6.61	6.85	6.84	5.37
Nimbecidine 0.0015%	3.01	3.98	4.64	5.17	5.95	6.67	6.88	6.81	5.39
Calcium nitrate 1%	2.99	3.95	4.72	5.24	5.95	6.68	6.89	6.85	5.41
Mean	2.96	3.94	4.68	5.20	5.95	6.65	6.88	6.82	

Table 7 Effect of pre-harvest spray of fungicides, nimbecidine, calcium nitrate and their combinations on Total sugars (%) in Kinnow mandarin during storage at room temperature

Treatments	**Days in storage**								
	0	**7**	**14**	**21**	**28**	**35**	**42**	**49**	**Mean**
Control	5.88	7.27	8.34	9.11	10.05	11.09	11.60	11.89	9.40
Carbendazim 0.05% + calcium nitrate 1%	5.96	7.32	8.39	9.20	10.11	11.18	11.66	11.96	9.47
Carbendazim 0.1%	5.96	7.29	8.37	9.12	10.12	11.13	11.63	11.90	9.44
Copper oxychloride0.2% + calcium nitrate 1%	5.90	7.33	8.39	9.15	10.09	11.13	11.65	11.92	9.44
Copper oxychloride 0.3%	5.92	7.29	8.35	9.13	10.08	11.14	11.64	11.92	9.43
Mancozeb 0.2% + calcium nitrate 1%	5.93	7.31	8.39	9.14	10.11	11.14	11.63	11.91	9.44
Mancozeb 0.3%	5.94	7.28	8.36	9.11	10.11	11.12	11.62	11.91	9.43
Propiconazole 0.05% + calcium nitrate 1%	5.91	7.32	8.39	9.17	10.08	11.16	11.65	11.92	9.45
Propiconazole 0.1%	5.92	7.31	8.38	9.17	10.08	11.15	11.62	11.92	9.44
Nimbecidine 0.0009% + calcium nitrate 1%	5.93	7.31	8.38	9.15	10.11	11.14	11.62	11.94	9.45
Nimbecidine 0.0015%	5.92	7.32	8.35	9.14	10.07	11.15	11.63	11.91	9.44
Calcium nitrate 1%	5.91	7.29	8.37	9.13	10.08	11.12	11.62	11.93	9.43
Mean	5.92	7.30	8.37	9.14	10.09	11.14	11.63	11.92	
C.D. at 5%	Treatments(T)= NS, Storage(S)=0.06, T×S=NS								

Table 8 Effect of pre-harvest spray of fungicides, nimbecidine, calcium nitrate and their combinations on Decay loss (%) in Kinnow mandarin during storage at room temperature

Treatments	**Days in storage**					
	14	**21**	**28**	**35**	**42**	**49**
Control	4.30 (11.96)	10.08 (18.50)	16.40 (23.88)	21.80 (27.82)	26.70 (31.10)	29.10 (32.63)
Carbendazim 0.05% + calcium nitrate 1%	0.01 (0.48)	3.05 (10.05)	5.20 (13.18)	8.15 (16.58)	9.05 (17.50)	12.10 (20.35)
Carbendazim 0.1%	0.08 (1.62)	3.60 (10.93)	5.90 (14.05)	8.85 (17.30)	9.70 (18.14)	13.10 (21.21)

Copper oxychloride 0.2% + Calcium nitrate 1%	1.10 (6.02)	5.20 (13.18)	7.35 (15.72)	11.15 (19.50)	14.10 (22.05)	16.10 (23.64)
Copper oxychloride 0.3%	1.30 (6.54)	5.40 (13.43)	7.40 (15.78)	11.30 (19.64)	14.40 (22.29)	16.20 (23.72)
Mancozeb 0.2% + Calcium nitrate 1%	1.15 (6.15)	4.10 (11.68)	6.20 (14.41)	9.10 (17.55)	11.30 (19.64)	14.00 (21.96)
Mancozeb 0.3%	1.25 (6.42)	4.30 (11.96)	6.40 (14.65)	9.30 (17.75)	11.40 (19.73)	14.20 (22.13)
Propiconazole 0.05% + Calcium nitrate 1%	0.01 (0.57)	3.15 (10.22)	5.35 (13.37)	8.25 (16.69)	9.05 (17.50)	12.25 (20.48)
Propiconazole 0.1%	0.06 (1.41)	3.40 (10.62)	5.70 (13.81)	8.75 (17.20)	9.60 (18.04)	12.90 (21.04)
Nimbecidine 0.0009% + Calcium nitrate 1%	2.20 (8.53)	6.00 (14.17)	9.45 (17.90)	13.00 (21.13)	17.00 (24.34)	19.75 (26.37)
Nimbecidine 0.0015%	2.40 (8.91)	6.20 (14.41)	9.50 (17.94)	13.10 (21.21)	17.20 (24.49)	19.90 (26.48)
Calcium nitrate 1%	3.50 (10.78)	8.40 (16.84)	14.20 (22.13)	19.70 (26.34)	23.24 (28.81)	26.00 (30.64)
Mean A	1.45 (5.78)	5.24 (13.00)	8.25 (16.40)	11.87 (19.89)	14.40 (21.97)	17.13 (24.22)
C.D. at 5%	0.12	0.28	0.40	0.37	0.50	0.63