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CONTROLLING POST HARVEST DECAY OF NAVEL ORANGE FRUITS

BY

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ABSTRACT

Inoculating Navel orange fruits with the tested bioagents decreased the severity of fruit-rot and resulted in an increase in the firmness and ascorbic acid content with considerable decrease in fruit acidity These changes differed according to the concentration of the tested bioagents. Also, exposing orange fruits to different doses of UV light after inoculation with any of the three pathogenic fungi has significantly reduced fruit-rot severity after storage The reduction in fruit-rot severity due to UV irradiation was reflected on increasing firmness and ascorbic acid and decreased titratable acidity compared with unexposed fruits. In addition, the fungus *G. candidum* was most inhibited by UV irradiation more titan *A. citri* and *B. theobromae.* Also, dipping Naval orange fruits in some safety chemical agents, at different concentrations after inoculation with pathogenic fungi led to significant reduction in fruit rot severity compared with untreated fruits. SOPP followed by sorbic acid in addition to Kaligreen were the best chemical salts for controlling fruit-rot Increasing the concentration of these sails from 500 to 1500 ppm caused great reduction of fruit rot. it also caused considerable increase in the firmness and ascorbic acid with considerable decrease in titratable acidity compared with untreated fruits with the tested salts (control).

INTRODUCTION

Citrus is one of the most important fruit crops in Egypt and many other countries in the world. Several pathogenic fungi attack citrus fruits during fruit development as well as after harvesting, marketing, exportation and storage causing serious losses. **Brown and McCornack (1972)** and **Eckert (1981)** reported that *Alternaria citri* is one of the causative fungi of navel orange fruit rot occurring during cold storage. While, **Pelser (1975). Ahmed (1980).** and **Abdel-Aziz (1980)** reported that *Geotrichum candidum. Diplodia natalensis.* and some other fungi cause serious post-harvest decay of orange, lemon and grapefruits **Vazquez *et al.* (1992)** indicated that stem-end rot (*Diplodia natalensis*). Sour rot (*G. candidum*) and blue and green mould (*P. digitatum* and *P italicum*) were the most important fungi, which increased with increasing storage time. **Naqve and**

Dass (1994) indicated that 43 and 47% of the total losses of mandarins in truck and train transport, respectively, were due to post-harvest diseases.

On the other hand, Chalutz and Wilson (1990) and Huang *et al.* (1992) reported that the yeast *Debaryomyces hansenii* isolated from the surface of lemon fruit and *Bacillus pumilus* at 1.6×10^{10} to 1.6×10^{12} cfu/ml inhibited disease incidence of *P. digitatum*, *P. italicum* and *G.candidum* of seven citrus fruit cultivars. Rivka and Kahan (1967) observed that the combined action of 20mg diphenyl/Petri dish and sublethal dose, 60 krad of Co^{60} gamma rays had completely inhibited the growth of *P. digitatum* and *Diplodia natalensis*.

Ben Yehoshua *et al.* (1992), and Droby *et al.* (1993) minimized postharvest decay *caused by P. digitatum* on different harvested citrus species and grapefruit rot, *Monilia fructicola* on peach, *Alternaria* spp., *Colletotrichum gloeosporoides* on apples using heat treatment or UV illumination. El-Sheikh Aly and Baraka (1997) exhibited that combination treatments of hot water (53°C) plus UV at 365nm for 3 minutes, followed by hot water plus UV at 254nm or hot Kaligreen plus UV at 365 for 3 minutes had significantly decreased the decay of mangoes.

Wild (1976) obtained good control of *P. digitatum* and some control of sour rot, *G. candidum* on Valencia and Navel oranges with sodium orthophenylphenate at 1.0%, applied by shower or flood for 30 second, followed by foam wax treatment. Wild (1981) found that the incidence of orange molds treated with SOPP at 0.6% was only 2% compared with 20% incidence with potassium sorbate at 2.0%. Nelson *et al.* (1983) showed that potassium sorbate (2% dip.) used in combination with benomyl or TBZ has significantly reduced *P. digitatum* decay in citrus fruits.

This work aimed for searching about new applicable techniques such as biological control, Ultraviolet light, chemical salts to minimize post-harvest losses and consequently to minimize using fungicides in this field.

MATERIALS & METHODS

Post-harvest manipulation techniques

Three different isolates of fungi, i.e., *Giotrichum candidum*, *Alternaria citri* and *Botryodiplodia theobromae* isolated from rotted navel orange and tested previously for their pathogenicity (Ahmed, 2001) were used in this study.

1-Biological control:

The effect of the bioagents *T. harzianum* and *T. hamatum*;" and the commercial biocides Plant-Guard (one ml contains about 30×10^6 spore of *T. harzianum*) and Rizo-N (one g contains about 30×10^6 cfu of *Bacillus subtilis*) on major post-harvest Navel orange fruit rots was studied under cold storage conditions during 1999 and 2000 seasons. The tested bioagents obtained kindly from Integrated Control Dept., Phytopathology Institute, Agric., Res., Center,

(ARC), Giza. Also, the commercial products were obtained from El-Nasr Co. for fertilization and bio-fungicides at Sadat City.

Healthy mature Navel orange fruits free from mechanical injury and wounding were selected and surface sterilized in sodium hypochlorite 1.0% for 5 minutes. Fruits were inoculated by spraying with spore suspension ($1x10^5$ spore/ml) of any of *A. citri*, *B. theobromae* or *G. candidum* prepared by collecting the surface growth of 10 day-PDA cultures with sterilized brush in sterilized distilled water. After inoculation, fruits were sprayed immediately with different concentrations of spore suspension, i.e. $4x10^6$, $9x10^6$ and $13x10^6$ spores/ml prepared for the 2 grown bioagents (*T. harzianum* and *T. hamatum)* and also of commercial biocides (Plant-guard and Rizo-N). Inoculated fruits but sprayed with sterilized distilled water were used as a check. Fruits were left to air dry, then packed in carton boxes and stored at 8°C and 90% RH for two months in storage refrigerator of Miser-California Project, Fac. Agric., Cairo Univ. Each treatment was replicated three times, each replicate containing 10 fruits. At the end of storage period (60 days), severity of infection, titratable acidity (Ta), ascorbic acid (Vitamin C) and firmness were estimated for both inoculated-treated and -untreated fruits as follows:

a- Severity of infection

Severity of infection was determined according to the numerical rates suggested by Fallik *et al.* (1993) as follows:

Grade	Description
0	No decay development.
1	Decay up 0.5 cm in diameter without sporulation.
2	Decay between 0.5 to 1.0 cm in diameter with sporulation.
3	Decay between 1.0 to 2.5 cm in diameter.
4	Decay between 2.5 to 4.0 cm in diameter.
5	Fruits completely rotten and heavily covered with mycelium.

Infection degrees per each replicate were converted to disease index (disease severity) according to the equation suggested by Townsend and Heuberger (1943) as follows:

$$\text{Disease severity (\%)} = \frac{\Sigma (n \times r)}{5\,N} \times 100$$

Where: n= Number of fruits in each numerical disease grade; r = Number of the disease grade and N= Total number of inoculated fruits multiplied by the maximum numerical disease grade i. e. 5.

b. Firmness:

Firmness of the treated and untreated mature Navel orange fruits was determined as pound/inch^2 by using Idaho pressure tester with a No. 16 brass wire (27/1000 of an inch in diameter) for a plunger, reading from 0 to 400 grams.

c. Ascorbic acid (Vitamin C):

An extract from fruits was obtained by blending 25 g pulp tissues of navel orange fruits in a blender for 5 minutes in 25 ml oxalic acid 6% equivalent to the tissues (w/v). The homogenated tissues were filtered through several layers of cheesecloth. The liquid fraction was then centrifuged at 1200 rpm for 5 minutes. The cleared filtrate was used to determine ascorbic acid. Twenty milliliters of filtrate (for each treatment) was transferred to Erlenmeyer flask (100ml) then the volume of filtrate sample was completed to 100 ml using oxalic acid 3%. The sample was centrifuged again for 5 minutes, then 10 ml was transferred to flask (100 ml) and titrated with stain (6.2 dichlorophenol-endophenol) until appearance of pink color. Amount of ascorbic acid was calculated according to the following formula (A.O.A.C., 1970):

$$\text{Ascorbic acid (mg/100g sample)} = \frac{V \times S \times D}{\text{Weight of sample}} \times 100$$

Where: V = Volume of stain that needed for equation,
S = Stain vigor (No. of Vitamin C milligrams that equate with 1 ml of stain, and
D = Dilutions of prepared sample.

- Stain vigor was achieved by taking 10 ml of prepared Vitamin C, then the stain solution was pipetted till appearance of pink color, then stain vigor could be determined by calculating number of stain milliliters that need for equating 1 mg of Vitamin C.
- Stain solution was prepared by solving 50 mg of stain in 250 ml of warm distilled water and the solution was kept in brown bottle in refrigerator till use.

d. Titratable acidity (Ta):

Titratable acidity in the treated and untreated mature Navel orange fruits were determined by titration 10 ml of the juice against 0.1 N NaOH using phenolphthaline as indicator The percentage of acidity was calculated as citric acid according to the following equation (A.O.A.C., 1970)

$$\textbf{Acidity \%} = \frac{\text{Volume of NaOH (ml)} \times \text{N of NaOH (0.1)} \times 0.064}{\text{Volume of sample (ml)}} \times 100$$

2- Ultraviolet radiation

Prepared mature Navel orange fruits as previously mentioned were sprayed with spore suspension of *G. candidum*, *A. citri* and *B. theobromae* ($1x10^5$ spore/ml) using sterilized atomizer for each fungus. Twenty-four hours after inoculation, fruits were divided into lots, each of 30 fruits. Three lots from the inoculated fruits with each fungus were used for each particular treatment and exposed to UV light at 254 or 365nm for 1,3 and 5 minutes. Another inoculated lots of each fungus were left without exposing and served as a check. All treatments were packed and stored as mentioned above. Severity of infection and quality constituents was determined for inoculated-treated and -untreated fruits as mentioned before.

3- chemical salts:

Harvested mature Navel orange fruits were prepared as mentioned before, inoculated with spore suspensions of any of, *A. citri*, *B. theobromae* and

G. candidum ($1x10^5$ spore/ml). Fruits were put in polyethylene bags for 24 hours after inoculation, then immersed for 5 minutes in 500, 1000 or 1500 ppm solution of sodium ortho-phenyl-phenate 35% (SOPP), potassium hydro-carbonate 80% (Kaligreen), ascorbic acid, salicylic acid and sorbic acid. In check treatment, inoculated fruits immersed in sterile distilled water.

Each treatment contained 3 replicates and each replicate contained 10 fruits. Treated fruits were allowed to dry at room temperature (22-24°C). All treatments were packed and stored as mentioned above. Severity of infection and quality constituents was determined for inoculated-treated and -untreated fruits as mentioned before.

Statistical analysis:

Most of the obtained data were statistically analyzed using the completely randomized, and the split plot designs (Snedecor and Cochran, 1967).

EXPERIMENTAL RESULTS

1-Biological control:

A- Effect on fruit rot severity:

As shown in Tables (1a &1b) of seasons1999 and 2000. Data indicate that the two tested bioagents, i.e. *T. hamatum* and *T. harzianum* as well as the two commercial products of Plant Guard and Rizo-N caused significant reduction to the severity of fruit-rot.

Data of 1999 season (Table 1a) show that the most effective treatment was *T. hamatum* followed by *T. harzianum*, Rizo-N and Plant Guard.

The tested pathogenic fungi were greatly differed in their response to the inhibitory effect of the tested bioagents. In this respect, severity of infection caused by *G. candidum* was greatly decreased by using the tested bioagents, which recorded 2.22%. Meanwhile, in case of inoculation with any of *B. theobromae* and *A. citri*, the severity of fruit-rot was higher, being 12.78 and 11.11%, respectively. The concentration of the tested bioagents has significantly effect on reducing severity of fruit-rot. Increasing the used concentration significantly increased the efficacy.

During 2000 season (Table 1b), the effect of the tested bioagents on reducing fruit-rot severity was greatly different. Rizo-N followed by *T. hamatum*, *T. harzianum* and Plant Guard recorded the highest efficacy in case of infected fruits with *G. candidum* respectively. Meanwhile, The same trend was recorded in case of infected fruits with *A. citri* and *B. theobromae* comparing with control treatment but lesser than the efficacy in case of the first pathogenic fungus.

The same trend of the efficacy of the tested bioagents on the pathogenic fungi was also, recorded during 2000 season, but with low averages compared with 1999 season. No obvious symptoms of fruit-rot were noticed on fruits inoculated with *G. candidum* at any of the tested concentrations with the

exception of Plant-Guard at $4x10^6$ spores/ml. Meanwhile, *B. theobromae* followed by *A. citri* were less affected respectively. Fruit-rot severity has also significantly decreased by increasing the concentration of the tested bioagents.

B- Effect on fruit quality characters

Data of season 1999 in Table (2a) indicate that there was an increase in fruit firmness of the inoculated fruits with the spore suspension of the tested pathogens. The same trend was observed in case of ascorbic acid in inoculated fruits and treated with the three concentrations of spore suspension of the tested bioagents compared with the infected fruits and untreated ones. Increasing the concentrations of the bioagents increased ascorbic acid content. However, the highest concentration gave the highest levels of these contents. On contrary, acidity showed the converse effect, whereas acidity content decreased by increasing of the bioagent concentration. In this respect, inoculated fruits with *G. candidum*, *A. citri* and *B. theobromae* and untreated with bioagents have more acidity.

The same trend was observed during season 2000. It is clear from data presented in Table (2b) that firmness of both inoculated and treated fruits showed higher levels than those inoculated with the same fungi and untreated with the spore suspension of the tested bioagent.

Concerning ascorbic acid and acidity, inoculated and treated fruits with different concentrations of spore suspension of the tested bioagents demonstrated the lowest levels if compared with untreated ones, however untreated fruits contained higher amounts of ascorbic acid and acidity than treated ones.

2-Effect of exposure to ultra-violet radiation

A- On fruit-rot severity:

Data of 1999 season (Table 3a) indicate that both UV wavelength, i.e. 254 and 356-nm have significantly reduced fruit-rot severity compared with the control treatment. The average percentage of fruit-rot severity caused by the tested fungi was greatly differed due to the inoculated fungus.

In this respect, the fungus *G. candidum* was the most affected fungus, which caused the lowest average of fruit-rot severity after exposing to UV. Meanwhile, the fungus *A. citri* was the least affected one followed by *B. theobromae*. Fruit-rot severity decreased due to increasing the exposure time to UV radiation, i.e. 1, 3 and 5 minutes. The respective averages of fruit-rot severity were 19.34, 14.28 and 9.56%, respectively.

Analogous results were also obtained during 2000 season (Table 3b) where fruit-rot severity was significantly decreased by increasing UV dose and time of exposure to UV. Also, the fungus *G. candidum* was the most affected one. Meanwhile, both *B. theobromae* and *A. citri* were less affected.

Table (1-a): Effect of treating Navel orange fruits with the tested bioagents before storage on controlling fruit-rot during storage for 60 days at season 1999.

Bio-agents	No. of Spores/ ml	% severity of infection		
		*1	*2	*3
T. harzianum	4×10^6	6.67	13.33	13.33
	9×10^6	4.44	11.11	11.11
	13×10^6	0.00	8.89	8.89
T. hamatum	4×10^6	2.22	11.11	15.56
	9×10^6	2.22	8.89	13.33
	13×10^6	0.00	6.67	11.11
Plantguard	4×10^6	2.22	17.78	17.78
	9×10^6	0.00	13.33	15.55
	13×10^6	0.00	8.89	11.11
Rizo-N	4×10^6	6.67	15.55	17.78
	9×10^6	2.22	11.11	11.11
	13×10^6	0.00	8.89	8.89
Check (control)		17.78	31.11	33.33

*1=*G. candidum.* *2= *A. citri* *3= *B. theobromae*

L.S.D. at 5% for:

Bioagents (B) = 2.99 B x C = 2.98

Concentrations (C) = 2.68 B x F = 1.34

Fungi (F) = 3.97 C x F = 1.93

B x C x F = 6.56

Table (1b): Effect of treating Navel orange fruits with the tested bioagents before storage on controlling fruit-rot during storage for 60 days at season 2000.

Bio-agents	No. of Spores/ml	% severity of infection		
		*1	*2	*3
T. harzianum	4×10^6	0.00	17.78	13.33
	9×10^6	0.00	15.55	11.11
	13×10^6	0.00	11.11	6.67
T. hamatum	4×10^6	0.00	13.33	17.78
	9×10^6	0.00	11.11	11.11
	13×10^6	0.00	6.67	8.89
Plant-Guard	4×10^6	4.45	13.33	13.33
	9×10^6	0.00	8.89	11.11
	13×10^6	0.00	6.67	6.67
Rizo-N	4×10^6	0.00	11.11	15.55
	9×10^6	0.00	8.89	11.11
	13×10^6	0.00	6.67	8.89
Check (control)		22.22	32.22	35.11

*1= *G. candidum.* *2= *A. citri* *3= *B. theobromae*

L.S.D. at 5% for:

Bioagents (B) = 2.81 B x C = 2.17

Concentrations (C) = 2.15 B x F = 2.10

Fungi (F) = 3.07 C x F = 1.03

B x C x F = 5.37

Table (2a): Effect of treating Navel orange fruits with the tested bioagents before storage on fruit quality characters after storage for 60 days at season 1999.

Bioagents	No of spores/ ml	Quality characters											
		Firmness (pound/inch^2)				Ascorbic acid (mg/100g)				Titrable acidity			
		1*	2*	3*	Mean	1*	2*	3*	Mean	1*	2*	3*	Mean
T. harzianum	$4x10^6$	5.43	9.28	8.88	7.86	26.65	26.65	19.50	24.27	15.92	15.48	12.08	14.49
	$9x10^6$	7.98	10.50	10.18	9.55	27.95	27.30	21.45	25.57	12.08	14.84	10.18	12.39
	$13x\ 10^6$	9.60	11.85	12.00	11.15	28.60	31.20	24.70	28.17	11.44	13.56	10.16	12.45
T. hamatum	$4x10^6$	6.08	8.90	8.75	7.91	25.35	26.65	24.70	25.57	12.08	15.12	11.44	12.88
	$9x10^6$	6.80	9.63	9.75	8.73	26.65	28.60	25.35	26.87	11.44	14.48	11.44	12.45
	$13x\ 10^6$	9.95	10.75	11.10	10.60	27.30	28.60	26.65	27.52	7.68	13.84	10.16	10.56
Plant-Guard	$4x10^6$	3.83	8.68	9.73	7.41	26.65	21.45	22.75	23.62	9.52	15.48	12.72	12.57
	$9x10^6$	8.55	10.05	12.43	10.34	26.65	26.65	26.00	26.43	7.60	15.48	12.08	11.72
	$13x\ 10^6$	10.40	12.73	14.90	12.68	28.60	28.60	26.65	27.95	6.96	14.84	11.44	11.08
Rizo-N	$4x10^6$	5.80	10.94	8.75	9.67	25.35	26.00	27.30	26.22	8.32	15.12	15.84	13.09
	$9x10^6$	11.20	12.68	10.22	11.37	26.65	27.30	27.30	27.08	7.04	11.92	13.00	10.65
	$13x\ 10^6$	12.00	13.38	11.15	12.18	27.30	28.60	27.95	27.95	7.04	7.44	13.00	9.16
Check (control)		3.50	7.50	7.25	6.08	24.00	19.65	17.75	20.47	18.80	18.44	18.64	18.63

*1= *G. candidum.* *2= *A. citri* *3= *B. theobromae*

Table (2b): Effect of treating Navel orange fruits with the tested bioagents before storage on fruit quality characters after storage for 60 days at season 2000.

Bioagents	No of spores/ ml	Quality characters											
		Firmness (pound/inch^2)				Ascorbic acid (mg/100g)				Titrable. acidity			
		1*	2*	3*	Mean	1*	2*	3*	Mean	1*	2*	3*	Mean
T. harzianum	$4x10^6$	8.88	7.80	9.25	8.64	38.50	17.50	23.00	26.33	12.80	10.88	10.24	11.31
	$9x10^6$	10.75	9.80	11.75	10.77	38.50	25.67	27.00	30.39	11.52	10.24	8.96	10.24
	$13x\ 10^6$	12.25	10.83	13.00	12.03	44.00	26.63	29.00	33.21	11.52	8.96	8.96	9.81
T. hamatum	$4x10^6$	8.88	9.30	9.00	9.06	38.50	25.67	26.00	30.06	10.24	10.24	11.52	10.88
	$9x10^6$	9.25	10.43	11.50	10.39	38.50	28.00	26.00	30.83	9.60	8.96	10.24	9.60
	$13x\ 10^6$	13.25	11.20	14.13	12.86	44.00	28.00	27.00	33.00	9.60	8.32	6.40	8.11
Plant-Guard	$4x10^6$	9.00	17.13	11.30	12.48	33.00	24.50	22.00	26.50	12.16	9.60	11.52	10.88
	$9x10^6$	10.88	9.88	11.88	10.88	44.00	26.83	25.00	31.94	10.88	9.60	10.88	10.45
	$13x\ 10^6$	14.50	11.00	12.13	12.54	44.00	26.83	28.00	32.94	10.88	8.96	10.24	10.03
Rizo-N	$4x10^6$	10.13	9.38	8.43	9.31	44.00	19.83	22.00	28.61	11.52	12.16	12.16	11.95
	$9x10^6$	10.60	10.63	9.08	10.10	49.50	19.83	22.00	30.44	10.88	10.88	11.52	11.09
	$13x\ 10^6$	11.10	13.63	10.15	11.63	60.50	24.50	23.00	36.00	10.24	9.60	10.24	10.03
Check (control)		7.38	7.25	8.00	7.54	30.50	50.50	60.00	40.50	13.88	14.75	14.88	14.50

*1= *G. candidum.* *2= *A. citri* *3= *B. theobromae*

Table (3-a): Effect of exposure Navel orange fruits to ultra violet radiation before storage on controlling fruit-rot during storage for 60 days at season 1999.

Wave length (nm)	Exposure time (min.)	% severity of infection		
		*1	*2	*3
254	1	13.33	26.67	25.33
	3	8.0	21.33	18.67
	5	5.33	14.67	13.33
365	1	10.67	20.0	20.0
	3	6.67	14.67	16.33
	5	4.0	10.67	9.33
Check (control)		22.67	41.33	40.0

*1= *G. candidum.* *2= *A. citri* *3= *B. theobromae*

L.S.D. at 5% for:

Exposure doses (D) = 2.0.3 D x T = 4.02

Fungi (F) = 3.41 D x F = 4.28

T x F = 2.01 D x T x F = 2.14

Table (3-b): Effect of exposure Navel orange fruits to ultra violet radiation before storage on controlling fruit-rot during storage during season 2000.

Wave length (nm)	Exposure time (min.)	% severity of infection		
		*1	*2	*3
254	1	5.33	28.00	32.00
	3	2.22	22.67	26.67
	5	0.00	13.33	18.67
365	1	0.00	24.00	25.33
	3	0.00	20.00	21.33
	5	0.00	9.33	13.33
Check (control)		29.33	44.00	44.00

*1= *G. candidum.* *2= *A. citri* *3= *B. theobromae*

L.S.D. at 5% for:

Exposure doses (D) = 2.30 D x T = 2.10

Time (T) = 5.10 D x F = 2.60

Fungi (F) = 2.81 T x F = 2.06

D x T x F = 3.07

B- Effect on fruit quality characters of Navel orange fruits

Results in Table (4a) show that firmness was increased by increasing UV doses and with increase of exposure time. However orange fruits exposed to 365nm for 1, 3 and 5 minutes were firmer than those exposed to 254 for the same time. At the same time, the UV-exposed fruits exhibited higher amounts of ascorbic acid compared with unexposed fruits. Meantime, the lowest wavelength

of UV increased ascorbic acid, while UV at 365 affected on these contents and gave the lowest levels during 1999 season. On the contrary, there was a remarkable decrease in the titrable acidity of the exposed treatments to UV radiation comparing with inoculated fruits but un-exposed.

The same trend was observed during 2000 season where results in Table (4b) revealed that UV at 365 nm gave the highest levels of firmness if compared with UV at 254 nm and non-irradiated fruits. While, in case of ascorbic acid, exposed fruits to UV at 254 nm for 1, 3 and 5 minutes exhibited high amounts than those exposed to UV at 365 nm for the same time. However, non-exposed fruits to UV radiation were acidic. While, exposed fruits to UV at 254 nm have higher amounts than exposed to 365 nm. The exception was the inoculated fruits with *A. citri* and exposed to 365nm for 3 minutes, which showed highest levels of titrable acidity compared with exposed fruits to 254 nm for 3 minutes.

3-Effect of some chemical salts:

A- On fruit-rot severity:

Data of 1999 season (Table 5a) revealed that SOPP followed by sorbic acid were the most effective salts in reducing fruit-rot severity, being 14.57 and 15.80%, respectively without significant difference. Meanwhile, ascorbic acid, kaligreen and salicylic acid were, comparatively, less effective. Also, increasing the concentration increased the efficacy of the tested salts. In this respect, the averages of the fruit-rot severity after the treatment with 500, 1000 and 1500 ppm of the tested salts were 25.34, 15.95 and 8.15%, respectively with significant differences among the three values. Control treatment recorded 40.47% fruit-rot severity after 60 days storage. The tested chemical salts did not exert significant variation among the figures of fruit-rot severity due to the inoculated fungus, where *A. citri*, *B. theobromae* and *G. candidum* caused 15.56, 16.44 and 17.41% fruit-rot severity.

Data of 2000 season (Table 5b) show that the efficacy of the tested chemical salts was more efficient in reducing fruit-rot severity compared with 1999 season. In addition, SOPP followed by Kaligreen were the most efficient, being 10.37 and 12.84% fruit-rot severity, respectively, without significant difference. The treatment with sorbic acid recorded the third in its effect, being 14.32%. On the other hand, both ascorbic acid and salicylic acid caused the lowest effect, being 16.30 and 17.53%, respectively, without significant difference. Control treatment showed 45.19% fruit-rot severity. Also, increasing the concentration has increased the efficacy of the tested salts. On the other hand, *B. theobromae* was not able to cause infection to the fruits treated with SOPP at 1500 ppm. In addition, the previous fungus was the most affected by the treatment with the tested salts followed by *A. citri* then *G. candidum*. The respective averages of fruit-rot severity were 11.70, 13.18 and 17.93%, respectively.

Table (4a): Effect of exposing Navel orange fruits to ultra-violet irradiation before storage on fruit quality characters after storage for 60 days at season 1999.

Wave length (nm)	Exposure time (min.)	Quality characters											
		Firmness (pound/inch^2)				Ascorbic acid (mg/100g)				Titrable acidity			
		1*	2*	3*	Mean	1*	2*	3*	Mean	1*	2*	3*	Mean
254	1	1.63	9.55	10.30	7.16	33.15	29.15	29.25	30.52	11.52	10.88	10.88	11.09
	3	2.28	10.08	11.35	7.90	33.15	29.25	30.55	30.98	11.52	10.24	8.96	10.24
	5	6.50	12.23	13.80	10.84	33.80	31.85	31.85	32.50	10.88	10.24	8.96	10.03
365	1	8.13	10.63	9.50	9.42	31.85	26.65	28.60	29.03	11.52	12.44	10.88	11.61
	3	9.20	11.50	13.48	11.39	31.85	27.30	29.90	29.68	11.52	10.88	8.33	10.24
	5	11.15	13.63	16.25	13.68	32.50	29.90	29.90	30.77	10.24	10.88	7.68	9.60
Check (control)		1.48	6.85	5.38	4.48	28.00	25.85	24.60	26.15	13.80	13.88	12.52	13.40

Table (4b): Effect of exposing Navel orange fruits to ultra-violet irradiation before storage on fruit quality characters after storage for 60 days at season 2000.

Wave length (nm)	Exposure time (min.)	Quality characters											
		Firmness (pound/inch^2)				Ascorbic acid (mg/100g)				Titrable acidity			
		1*	2*	3*	Mean	1*	2*	3*	Mean	1*	2*	3*	Mean
254	1	4.95	7.58	8.58	7.04	85.00	68.00	64.00	72.33	7.68	14.00	14.88	12.19
	3	5.63	8.65	10.28	8.19	85.00	72.00	72.00	76.33	7.04	11.44	11.00	9.83
	5	7.20	10.55	11.88	9.88	90.00	76.00	76.00	80.67	6.40	11.44	10.16	9.33
365	1	9.00	8.43	8.75	8.73	50.00	64.00	70.00	61.33	6.40	14.00	10.80	10.40
	3	10.50	9.25	11.33	10.36	75.00	64.00	72.00	70.33	6.40	13.36	10.16	9.97
	5	12.28	10.85	12.40	11.84	85.00	72.00	84.00	80.33	5.76	11.44	9.52	8.91
Check (control)		3.70	6.13	6.10	5.31	50.00	64.00	72.00	62.00	12.80	15.08	15.08	14.32

*1= *G. candidum.* *2= *A. citri* *3= *B. theobromae*

Table (5a): Effect of dipping Navel orange fruits with some chemical salts in different concentrations on fruit-rot severity of stored fruits for 60 days during season 1999.

Chemical salts	Conc. (ppm) (a-i)	% severity of rot infection		
		*1	*2	*3
SOPP	500	22.22	20.00	15.55
	1000	17.78	17.78	15.55
	1500	8.89	0.00	13.33
Kaligreen	500	20.00	28.89	24.45
	1000	17.78	15.55	20.00
	1500	8.89	11.11	17.78
Ascorbic acid	500	42.22	24.45	17.78
	1000	17.78	22.22	13.33
	1500	6.67	11.11	2.22
Salicylic acid	500	42.22	24.45	24.45
	1000	22.22	8.89	17.78
	1500	13.33	4.45	11.11
Sorbic acid	500	26.67	24.45	22.22
	1000	11.11	13.33	17.78
	1500	6.67	6.67	13.33
Check (control)		48.89	35.56	37.78

*1= *G. candidum* *2= *A. citri* *3= *B. theobromae*

L.S.D. at 5% for: Salts (S) = 3.53; Concentrations (C) = 2.36; Fungi (F) = n.s.; S x C = 3.99; S x F = 10.2; C x F = 6.95; S x C x F = 8.83

Table (5b): Effect of dipping Navel orange fruits with some chemical salts in different concentrations on fruit-rot severity of stored fruits for 60 days during season 2000.

Chemical salts	Conc. (ppm) (a-i)	% severity of rot infection		
		*1	*2	*3
SOPP	500	17.78	15.55	11.11
	1000	15.56	8.89	6.67
	1500	11.11	6.67	0.00
Kaligreen	500	15.55	17.78	20.00
	1000	13.33	13.33	11.11
	1500	6.67	8.89	8.89
Ascorbic acid	500	35.56	26.67	15.55
	1000	20.00	13.33	8.89
	1500	8.89	11.11	6.67
Salicylic acid	500	33.33	15.55	26.67
	1000	24.45	13.33	13.33
	1500	17.78	8.89	4.45
Sorbic acid	500	22.22	22.22	17.78
	1000	17.78	8.89	13.33
	1500	8.89	6.67	11.11
Check (control)		66.67	33.33	35.56

*1= *G. candidum* *2= *A. citri* *3= *B. theobromae*

L.S.D. at 5% for: Salts (S) = 2.59; Concentrations (C) = 3.09; Fungi (F) = 3.24; S x C = 3.91; S x F = 4.12; C x F = 6.95; S x C x F = 6.05

Table (6a): Effect of dipping Navel orange fruits with some chemical salts in different concentrations on fruit quality characters of stored fruits for 60 days during season 1999.

Chemical salts	Conc. (ppm) (a.i.)	Quality characters											
		Firmness (pound/inch^2)				Ascorbic acid (mg/100g)				Titrable acidity			
		1*	2*	3*	Mean	1*	2*	3*	Mean	1*	2*	3*	Mean
SOPP	500	2.33	9.50	10.58	7.47	31.20	25.00	26.00	27.40	10.88	14.08	12.16	12.37
	1000	8.04	11.28	11.25	10.19	33.15	29.25	26.00	29.47	8.96	12.16	10.24	10.45
	1500	10.60	12.78	11.55	11.64	33.80	31.85	29.90	31.85	8.96	7.68	8.32	8.32
Kaligreen	500	2.45	8.33	8.75	6.51	33.80	29.90	23.40	29.03	12.16	9.64	12.80	11.53
	1000	3.38	9.88	11.58	8.28	34.45	32.50	26.65	31.20	11.52	8.32	9.60	9.81
	1500	7.50	11.30	13.48	10.76	35.10	32.50	26.65	31.42	10.24	7.68	9.60	9.17
Ascorbic acid	500	5.93	10.78	10.05	8.92	33.15	33.15	26.00	30.77	10.88	11.52	10.24	10.88
	1000	8.88	11.25	10.50	10.21	34.45	33.15	26.00	31.20	10.88	10.88	7.68	9.81
	1500	8.90	12.58	11.85	11.11	34.45	33.80	29.25	32.50	10.24	10.24	7.68	9.39
Salicylic acid	500	2.00	8.10	8.95	6.35	34.45	32.50	26.65	31.20	13.44	14.08	12.80	13.44
	1000	2.60	10.18	12.03	7.50	35.75	33.15	27.30	32.06	12.16	14.08	12.80	13.01
	1500	5.32	10.80	13.23	9.78	36.40	33.80	29.25	33.15	11.52	10.88	8.96	10.45
Sorbic acid	500	2.60	9.55	9.40	7.18	33.15	32.50	26.65	30.77	11.52	13.44	15.36	13.44
	1000	5.75	10.50	11.38	9.21	33.80	33.15	27.95	31.63	10.24	13.44	13.44	12.37
	1500	9.30	12.03	11.78	11.04	35.10	33.15	29.25	32.50	10.24	12.80	11.52	11.52
Check (control)		2.15	6.15	6.23	4.84	30.90	23.40	20.50	24.93	15.32	16.68	14.16	15.39

*1= *G. candidum.* *2= *A. citri* *3= *B. theobromae*

B- Effect on fruit quality characters of Navel orange fruits

Data shown in Table (6a) indicate that there was an increase in fruit firmness due to the treatment with the different concentrations of the tested salts compared with untreated fruits. However, SOPP and Kaligreen each of 1500 ppm gave high levels of firmness. The same trend was observed in case of ascorbic acid, which then increased in the treated and inoculated fruits with the tested fungi compared with untreated and inoculated fruits. Meanwhile ascorbic acid reached its higher amount in the inoculated and the treated fruits with 1500 ppm of any of salicylic acid, ascorbic acid and sorbic acid. It is also clear that the amount of acidity was decreased in the infected and the treated fruits with any of the different concentrations of salts. Meanwhile, the amount of acidity was increased in the infected and the untreated ones.

The same trend was obtained during 2000 season.

Data of Table (6b) demonstrate an obvious increase in the firmness of the infected and the treated fruits with the different concentrations of salts. Inoculated and treated fruits with the highest concentration of any of ascorbic acid, SOPP and sorbic acid were firmer more than inoculated, treated and untreated fruits. On the other hand, inoculated and treated fruits with different concentrations of the tested salts exhibited high amounts of ascorbic acid than tissues of untreated fruits and infected with the same fungi. In this respect, treatment with SOPP and salicylic acid at any of 1000 and 1500 ppm showed the highest content of ascorbic acid. Concerning titrable acidity contents, data demonstrate that acidity was decreased in the treated fruits with the different concentrations of the tested salts and inoculated with any of *G. candidum*, *A. citri* and *B. theobromae* compared with infected fruit with the same fungi and untreated with the salts.

DISCUSSION

Navel fruit orange is one of the most important fruit crops all over the world including Egypt. Under Egyptian conditions, Navel orange is liable to attack by many fungal diseases such as *Alternaria* sp., *A. alternata*, *A. citri*, *Botryodiplodia theobromae*, *Cladosporium herbarum*, *Geotrichum candidum*, *Penicillium digitatum*, *P. italicum*, *Phomopsis citri*, *Thielaviopsis paradoxa* and *Nigrospora* sp. (El-Shamaa, 1983 and El-Ashmawy, 1998).

Concerning treating Navel orange fruits with any of the tested bioagents, the severity of fruit-rot was decreased by increasing the concentration of the tested bioagents. In this concern during 1999 season, both Rizo-N and *T. hamatum* were the most effective treatment followed by *T. harzianum* then Plant Guard. Moreover, the fungus *G. candidum* was greatly affected by the tested bioagents. Meanwhile, both *A. citri* and *B. theobromae* were the lowest affected. While during 2000 season, the obtained results were different where the fungus *T. harzianum* was the most effective followed by the commercial products of Plant Guard and Rizo-N. Meanwhile, *T. hamatum* recorded the lowest effect. The use of the bioagents in reducing the infection with many fungal diseases was used for successful control of many diseases such as fruit-rots, soil-borne diseases and

Table (6b): Effect of dipping Navel orange fruits with some chemical salts in different concentrations on fruit quality characters of stored fruits for 60 days during season 2000.

Chemical salts	Conc. (ppm) (a.i.)	Quality characters											
		Firmness (pound/inch^2)				Ascorbic acid (mg/100g)				Titrable. acidity			
		A	B	C	Mean	A	B	C	Mean	A	B	C	Mean
SOPP	500	5.73	9.32	8.68	7.91	36.00	31.50	27.00	31.50	15.92	16.56	14.08	15.52
	1000	7.87	11.55	9.80	9.74	45.00	31.50	36.00	37.50	14.00	15.92	13.44	14.45
	1500	11.78	13.50	10.10	11.79	54.00	45.00	40.50	46.50	13.36	14.64	8.96	12.32
Kaligreen	500	8.73	7.55	8.10	8.11	45.00	31.50	22.50	33.00	14.64	15.92	14.72	15.09
	1000	9.93	10.28	9.25	9.82	45.00	31.50	27.00	34.50	14.00	15.28	14.08	14.45
	1500	12.23	11.24	10.08	11.20	49.50	36.00	27.00	37.50	10.80	11.44	12.88	11.71
Ascorbic acid	500	7.00	10.63	9.10	8.91	27.00	36.00	22.50	28.50	14.64	14.64	12.72	14.00
	1000	11.68	11.03	10.00	10.90	40.50	36.00	22.50	33.00	14.00	13.36	11.44	12.93
	1500	12.08	13.43	11.25	12.25	40.50	45.00	27.00	37.50	14.00	12.72	9.44	12.05
Salicylic acid	500	3.52	10.13	10.65	8.10	36.00	36.00	27.00	33.00	12.08	15.92	13.44	13.81
	1000	7.83	10.93	11.98	10.25	45.00	45.00	22.00	37.33	11.44	14.00	13.44	12.96
	1500	12.50	11.03	12.28	11.94	45.00	45.00	27.00	39.00	10.80	10.80	11.52	11.04
Sorbic acid	500	4.85	7.10	8.70	6.88	27.00	31.50	27.00	28.50	12.72	13.36	13.44	13.17
	1000	11.10	10.18	12.23	11.17	36.00	40.00	27.00	34.33	11.44	11.44	10.88	11.25
	1500	12.45	13.25	13.45	13.05	40.00	45.00	31.50	38.83	10.80	10.16	10.88	10.61
Check (control)		3.98	6.23	7.36	5.86	25.00	29.50	20.50	25.00	18.08	19.72	15.16	17.65

*1= *G. candidum.* *2= *A. citri* *3= *B. theobromae*

foliage diseases. Although the reduction in the controlled diseases by the bioagents still not enough or satisfied, but on the view of the human health, products of biological production are prevalent in many European and American countries as well as, to somewhat, in Egypt. Therefore, the obtained results are of great importance for citrus exporters, in order to reduce or avoid the damage caused by the storage fungi. Inoculating Navel orange fruits with the three tested pathogenic fungi then treated with the tested bioagents resulted in causing an increase in the firmness and ascorbic acid with considerable decrease in fruit acidity. These changes were differed according to the concentration of the tested bioagents. The same trend was observed during both experimental seasons. Many investigators used the bioagents in controlling many fungal diseases, i.e. soil-borne disease, fruit-rots and foliage diseases (Chalutz *et al.*, 1988; Huang *et al.*, 1992; Abada, 1994; Elad and Kapat, 1999 and Moustafa, 1999). Also, the mode of action of the tested bioagents was emphasized by many investigators like Chet (1984) who mentioned that *Trichoderma* spp. apparently acts as a mycoparasite, which detects its host from some distance, binds it self to the pathogenic fungus by sugar-lectin linkage and begins to excrete extra cellular lytic enzymes such as B-1, 3 glucanase, chitinase, protease and/or lipase.

It has been found that exposing orange fruits to different doses of UV light after inoculation with any of the three pathogenic fungi significantly reduced the percentages of fruit-rot severity after storage period lengthened to 60 days. This reduction was more efficient with using dosage of 356 nm than using 254 nm. In addition, the fungus *G. candidum* was the most affected by UV irradiation more than *A. citri* and *B. theobromae*. The results are similar to somewhat during both experimental seasons. The reduction in fruit-rot severity due to irradiation with two doses of UV was reflected on increasing firmness and ascorbic acid compared with unexposed fruits to UV irradiation. In addition, increasing UV dosage from 254 to 356 nm and the exposure time from one minute to five minutes increased this increase. Opposite results were recorded in case of the titratable acidity which decreased due to exposing the inoculated fruits to UV irradiation. The obtained results are very promising and could be used for treating citrus before storage with UV irradiation in order to minimize fruit-rots, especially under natural conditions of fruit infection with the pathogenic fungi. Also, this treatment is very safe for the human health compared with using some toxic chemicals for this concern. In this respect, many investigators used irradiation with UV or gamma ray for controlling postharvest diseases and obtained considerable reduction in fruit-rots caused by many causals like Maxie *et al.*, 1970; Splading and Reeder, 1986; Ben Yehoshua *et al.*, 1992; Droby *et al.*, 1993; Farooqi, 1994 and El-Sheikh Aly and Baraka, 1997.

Also, dipping Navel orange fruits in some safety chemical agents, at different concentrations after inoculation with pathogenic fungi led to significant reduction in fruit rot severity compared with untreated fruits. In addition, increasing the concentration of these salts from 500 to 1500 caused great reduction in the disease. Moreover, the effect of the tested chemical salts on the pathogenic fungi was not greatly differed. However, the fungus *A. citri* was the most affected during 1999 season and *B. theobromae* during 2000 season. Also,

the inoculated fruits with any of the tested pathogenic fungi and dipped in the tested salts caused considerable increase in the firmness and ascorbic acid with considerable decrease in titrable acidity compared with untreated fruits with the tested salts (control). The obtained data revealed that the tested chemical agents could be used for treating citrus fruits including Navel orange fruits before storage in order to minimize the infection with the causals of fruit-rot with no risk from the residuals of these salts. In this respect, these results are in agreement to somewhat to those obtained by Wild (1981), Nelson *et al.* (1983) and Smilanick *et al.* (1995).

REFERENCES

Abada, K.A. (1994): Fungi causing damping-off and root-rot on sugar beet and their biological control with *Trichoderma harzianum*. Agric. *Ecosystem & Environ.*, 51: 333-337.

Abdel-Aziz, A.B. (1980): Studies on pre and post harvest citrus fruit rots and their control. Ph. D. Thesis. Fac. Agric., Al-Azhar Univ., Egypt.

Ahmed, Z.H. (2001): Integrated management for controling post- harvest rots of navel orange. Ph.D Thesis, Fac. Agric., Moshtohor, Benha Branch, Zagazig Univ. 139 pp.

Ahmed, B.H. (1980): Pre-, postharvest citrus, fruit-rots and their control. Ph.D. Thesis, Fac. Agric., Al-Azhar University.

A.O.A.C. (1970): Official methods of analysis of the association of official agricultural chemist's. published by A.O.A., Washington DC.

Ben Yehoshua, S.; Rodov, V.; Kim, J. J. and Carmeli, S. (1992): Preformed and induced antifungal materials of citrus fruit in relation to the enhancement of decay resistance by heat and ultraviolet treatments. *J. of Agric. and Food Chemis*, 40(7): 1217-1221.

Brown, G.E. and McCornack, A.A. (1972): Decay caused by *Alternaria citri* in Florida citrus fruit. *Plant Dis. Report*. 56(10): 909-912.

Chalutz, E. and Wilson, C.L. (1990): Postharvest biocontrol of green and blue mould and sour rot of citrus fruit by *Debaryomyces hansenii*. *Plant Disease*, 74 (2): 134-137.

Chalutz, E.; Cohen, L.; Weiss, B. and Wilson, C.L. (1988): Biocontrol of postharvest diseases of citrus fruit by microbial antagonists. Proceeding of the Sixth International Citrus Congress Middle East, Tel Aviv, Israel, 6-11 March (1988).

Chet, I. (1984): Application of *Trichoderma* as a biocontrol agent. Proc. 6th Cong. Un. Phytopathol. Mediterranean, Cairo, Egypt. Egypt. Phytopathol. Soc., pp. 110-111.

Droby, S.; Chalntz, E.; Horev, B.; Cohen, L.; Gaba, V.; Wilson, C.L. and Wisniewski, M. (1993): Factors affecting UV-induced resistance in grapefruit against the green mould decay caused by *Penicillium digitatum*. *Plant Pathol.*, 42 (3): 418-424.

Eckert, J.W. (1981): Chemical control of citrus fruit decays. International Conference on Tropical crop production. Lyon, France.

Elad, Y. and Kapat, A. (1999): The role of *Trichoderma harzianum* protease in biocontrol of *Botrytis cinerea*. *Eur. J. Plant Pathol.*, 105: 177-189.

El-Ashmawy, Aziza M.M. (1998): Effect of gamma radiation's treatment on some fungi causing citrus fruit-rots during storage with special reference to Navel orange fruits. Ph.D. Thesis. Fac. of Agric., Cairo Univ.

El-Shamaa, S.M. (1983): Studies of fungal postharvest diseases on some citrus spp., fruits under cold storage. M. Sc. Thesis, Fac. Agric., Zagazig Univ., A.R.E. 138pp.

El-Sheikh Aly, M.M. and Baraka, M.A. (1997): Effect of Ultraviolet in combination with physical and biological treatments for checking postharvest decay of mangoes. *Al-Azhar J. Agric. Res.*, 26: 124-130.

Fallik, E.; Klein, J.; Grinberg, S.; Lomaniec, E. ; Lurie, S. and Lalazer, A. (1993): Effect of postharvest heat treatment of tomatoes on fruit ripening and decay caused by *Botrytis cinerea*. *Plant Dis.*, 77: 985-988.

Farooqi, W.A. (1994): Postharvest physiology and pathology of kinnow mandarin (citrus reticulata Blanco). Proceedings of an International Symposium held at Agadir, Morocco, 16-21 January (1994).

Huang, Y.; Wild, B. and Morris, S. (1992): Postharvest biological control of *Penicillium digitatum* decay on citrus fruit by *Bacillus pumilus*. *Annals of Applied Biology*, 120: 367-372.

Maxie, E.C.; Edward, C.M.; Sommer, N.P and Eaks, I.L (1970): Effect of gamma radiation on citrus fruits. Proc. Int. Citrus. Symp. Ist., 19 (31): 75-87.

Mostafa, M.A.; El-Banna, Om-Hashem M. and Abada, K. A. (1999): Biological control of strawberry root and crown rots in Egypt. 8th Nat. Conf. Of Pest & Dis. of Veg. & Fruits in Egypt.

Naqvis, S.A.M. and Dass, H.C. (1994): Assesment of postharvest losses in Nagpur mandarin- a pathological perspective. *Plant Disease Research*, 9 (2): 215-218.

Nelson, P.M., Wheeler, R.W. and McDonald, P.D. (1983): Potassium sorbate in combination with benzimidazole reduces resistant *Penicillium digitatum* decay of citrus. Proceeding of the International Society of Citriculture. 2: 820-823.

Pelser, P.D. (1975): Decay control in mandarin type fruit. *Citrus and Subtropical J.*, 495: 10-15.

Rivka, B.G. and Kahan, R.S. (1967): Combined action of diphenyl and gamma radiation on the *in vitro* development of fungi pathogenic to citrus fruit. *Phytopathology*, 57: 696-698.

Smilanick, J.L.; Margosan, D.A. and Henson, D.J. (1995): Evaluation of heated solutions of sulfur dioxide, ethanol and hydrogen peroxide to control postharvest green mold of lemons. *Plant Dis.*, 79: 742-747.

Snedecor, G. W. and Cochran, W.G. (1967): Statistical Methods. 6th edition. The Iowa State University Press, Ames, IA.

Splading, D.H. and Reeder, W.F (1986): Decay and acceptability of mangoes treated with combinations of hot water, Imazalil and gama radiation. *Plant Disease*, 70: 1199-1151.

Townsend, G.N. and Heuberger, T W. (1943): Methods for estimating losses caused by diseases in fungicide experiments. Plant Dis. Rept., 27: 340-343.

Vazquez, A.; Sanchez, R. and Caceres, E. (1992): Evaluation of postharvest diseases in grapefruit under cool storage. *Centro Agricola*, 19(1): 75-82.

Wild, B.L. (1976): SOPP to control benzimidazole resistant mould. *Rural-Newsletter*, 59: 37-38.

Wild, B.L. (1981): Does potassium sorbate prevent citrus decay or rot. *Rural Newsletter*, 79: 36-37.

مقاومة تلف ما بعد الحصاد على ثمار البرتقال أبو سرة

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أدى تلقيح ثمار البرتقال أبو سرة بعوامل التضاد الحيوى إلى تقليل الشدة المرضية لعفن الثمار وإلى زيادة واضحة فى صلابة الثمار وزيادة محتواها من حمض الأسكوربيك (فيتامين ج) مع إنخفاض واضح فى حموضة تلك الثمار ، وقد كان لتركيز عوامل التضاد الحيوى المختبرة دورا كبيرا فى تلك التغيرات. كما أدى تعريض الثمار إلى جرعات مختلفة من الأشعة فوق البنفسجية بعد ما لقحت بثلاثة من الفطريات الممرضة إلى إنخفاض معنوى فى الشدة المرضية لعفن الثمار بعد التخزين لمدة ستون يوما ، وقد انعكس ذلك على زيادة صلابة الثمار وزيادة محتواها من حمض الأسكوربيك وإنخفاض حموضة الثمار المعاملة مقارنة بالغير معرضة للأشعة الفوق بنفسجية ، فضلا عن ذلك فقد كان الفطر جيوتريكم كانديدم هو الأكثر تأثرا بالأشعة الفوق بنفسجية بدرجة أكبر عن الفطر ألترناريا سيترى والفطر بوتريودبلوديا ثيوبرومى. وكان لمعاملة ثمار البرتقال أبو سرة بعد تلقيحها بالفطريات الممرضة بالغمس فى تركيزات مختلفة لمحاليل بعض الأملاح الكيماوية الآمنة الإستخدام أثرا كبيرا فى تخفيض الشدة المرضية لعفن الثمار مقارنة بالغير معامل ، وكان لزيادة تركيز تلك الأملاح من ٥٠٠ – ١٥٠٠ جزء فى المليون أثرا كبيرا فى تقليل شدة المرض وزيادة صلابة الثمار المعاملة وزيادة محتواها من حمض الأسكوربيك مع إنخفاض واضح فى حموضة عصير تلك الثمار المعاملة عن الغير معاملة بالأملاح الكيماوية.