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EFFECT OF POSTHARVEST ETHREL, GA_3 AND $CACL_2$ APPLICATIONS ON THE RESISTANCE TO GREEN AND BLUE MOULDS ON BALADY MANDARIN FRUITS DURING STORAGE

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Abstract: Balady mandarin fruits were sprayed with Ethrel, GA_3 and $CaCl_2$ after harvest and then inoculated with *P. digitatum* (green mould) and *P. italicum* (blue mould) in lab during 2002 and 2003 seasons. The treated fruits were stored at room temperature and some of their physical and chemical properties were determined

Generally, the storage period of the fruits treated with Ethrel as well as those inoculated with *P. digitatum* and *P. italicum* without GA_3 and $CaCl_2$ was about 15 days, while the other fruits were stored for 30 days. Gradual decreases of weight loss % and increased of decay % were found in all investigated fruits with prolonging of storage period.

GA_3 and $CaCl_2$ applications significantly decreased decay, weight loss and peel weight percentages comparing with control of inoculated and non-inoculated fruits with *P. digitatum* and *P. italicum*, while Ethrel treatments had the opposite effect. T.S.S. % gradually increased during storage period and were higher in the fruits treated with GA_3 and $CaCl_2$, which also increased the fruit content of acidity comparing with control. Inoculated fruits with *P. digitatum* and *P. italicum* had higher acidity content as well as lower non-reducing and total sugar percentages as compared with non-inoculated fruits. The fruits treated with GA_3 and $CaCl_2$ contained higher non-reducing and total sugar during storage as compared with untreated ones. According to the results of the present study, it could be recommended to spray mandarin fruits with $CaCl_2$ or GA_3 to increase its resistance to green and blue moulds during storage.

Key words : Ethrel, GA_3, $CaCl_2$, green, blue moulds, mandarin

Introduction

Mandarin fruits (*Citrus reticulate* Blanko, L.) is one of the most popular fruits in Egypt. It will be a great value to prolong the shelf life of these fruits by the storage at suitable conditions to supply the consumers with mandarin for a longer period. Green mould, caused by *Penicillium digitatum* Sacc., and blue mould, caused by *Penicillium italicum*, are a worldwide post-harvest diseases of citrus fruits.

Several investigators studied the resistance of rind tissues of citrus fruits to *P. digitatum* and *P. italicum*

infection (Cole and Wood, 1970; Palou *et al.*, 2002; Porta *et al.*, 2003 and Prusky *et al.*, 2004). The effect of growth regulators such as Gibberellic acid, Ethrel, benzyladenine ... etc. on physical and chemical properties, quality and shelf life of fruits during storage period was also studied by several investigators (Kumar *et al.*, 1977; Ahmed Amen, 1992; El-Hamady *et al.*, 2000; Hussein *et al.*, 2001).

Also, calcium is an important factor in fruit physiology during storage. It helps to increase fruit firmness, fruit resistance to a number of physiological and pathological disorders and its direct effect on senescence processes (Singh *et al.*, 1981; Banuelos, 1986; Roovaiah, 1987; Ahmed Amen, 1992; El-Hamady *et al.*, 2000; Hussein *et al.*, 2001).

The present investigation amid to study:

1- The relation between the treatment of Balady mandarin fruits with Ethrel, GA_3 and $CaCl_2$ and its resistance to green and blue mould infection during storage.

2- The changes occurred in some physical and chemical properties of these fruits during storage.

Materials and Methods

This study was carried out during two successive seasons 2002 and 2003 on Balady mandarin fruits. Fruits were taken from mature trees grown in the Orchard of the Faculty of Agricultural, Assiut University. At harvest time, the mature fruits were carefully picked, transferred to lab., washed by tap water and surface sterilized by dipping in mercuric chloride solution (2-3 min.) followed by washing with distilled water.

These fruits were divided into 4 groups, each containing 180 fruits and selected for one treatment as follow:

I- Control (sprayed with distilled water).

II- Spraying by Gibberellic acid (GA_3) at 50 ppm.

III- Spraying by Ethrel at 200 ppm.

IV- Spraying by Calcium chloride ($CaCl_2$) at 4%.

The fruits of each treatment were divided into 3 sections (each of 60 fruits) to carry out the following treatments:

1- Control (no-inoculation).

2- Inoculation with *Pinicillium digitatum*.

3- Inoculation with *Pinicillium italicum*.

The inoculation was carried out by spraying the surface of fruits with spores suspension of *P. digitatum* or *P. italicum* ($10^6 \pm 25$ spores/ml.) previously isolated from diseased mandarin fruits. The inoculated and non-inoculated fruits of each treatment were placed in

polyethylene bags in 3 replicates each containing 10 fruits plus 30 fruits from each treatment were kept to determine the decay percentage and weight loss % during storage period. All fruits were kept at room temperature (20-25°C).

1- Fruit decay %: The diseased fruits were recorded and calculated in relation to the total fruits (30 fruits).

2- Weight loss %: Fruit weights were biweekly recorded and the percentages of weight loss were calculated.

Samples (3 fruits) from each replicate were biweekly intervals taken to determine the peel weight % and chemical properties of the studied fruits as follow:

1- Peel weight % was determined as follow:

$$Peel\ weight\ \% = \frac{Peel\ weight}{Fruit\ weight} \times 100$$

2- Total soluble solids (T.S.S.): were determined by hand refractometer.

3- Total acidity: was determined (as citric acid) by titrating fruit juice with 0.1 N NaOH using phenolphthalein as an indicator.

4- Total soluble solids/acid ratio was calculated by obtaining the ratio between T.S.S. and acid percentages.

5- Sugars: The sugars (reducing, non-reducing and total) were determined by Lane-Eynon general volumetric method as described in the A.O.A.C. (1975).

This experiment was arranged in a split split plot design with 3 replicates for each treatment. The storage periods were set as whole units, inoculation with *P. digitatum* and *P. italicum* in sub-plots and treatments with Ethrel, GA_3 and $CaCl_2$ in sub-sub-plots. All obtained data were tabulated and statistically analyzed according to methods described by Snedecor and Cochran (1980), using L.S.D. test to recognize the significances of the differences among various treatments.

Results and Discussion

A-1- Fruit decay percentage:

Date in Table 1 show the fruit decay % during storage period. It is clear to notice that the decay percentage of all tested fruits significantly increased with the progress of storage stages during the both experimental seasons. Moreover, the results of the two studied seasons took similar tendency. It could be observed that storage period (shelf life) of the fruits treated with Ethrel (inoculated and non-inoculated fruits) as well as the inoculated fruits without treatments was about 2 week (15 days), while the other fruits could be stored about 30 days. These periods were mainly correlated with the disease percentage during storage.

Concerning the effect of applied treatments, it could be mentioned that Ethrel significantly increased the decay % during storage comparing

Table(1): Effect of Ethrel, GA_3 and $CaCl_2$ applications on decay % of Balady mandarin fruits inoculated with *P. digitatum* and *P. italicum* during 2002 and 2003 seasons.

Inoculation	Control				*P. digitatum*				*P. italicum*			
Period(days) / Treatment	0	15	30	Mean	0	15	30	Mean	0	15	30	Mean
2002												
Control	0.0	10.0	69.0	26.63	0.0	43.0	100.0	47.77	0.0	39.0	100.0	76.63
Ethrel 200 ppm	0.0	26.6	100.0	42.20	0.0	53.3	100.0	51.10	0.0	50.0	100 0	40.00
GA_3 50 ppm	0.0	6.0	50.0	18.87	0.0	20.0	68.2	32.73	0.0	26.7	69.8	32.16
$CaCl_2$ 4%	0.0	3.3	46.6	16.63	0.0	26.7	73.3	33.33	0.0	23.3	76.6	33.30
Mean	0.0	11.48	66.63		0.0	35.83	85.40		0.0	34.98	79.09	
2003												
Control	0.0	13.3	72.3	28.53	0.0	50.0	100.0	50.00	0.0	49.6	100.0	50.00
Ethrel 200 ppm	0.0	30.2	93.3	41.17	0.0	56.6	100.0	52.20	0.0	56.6	100.0	52.20
GA_3 50 ppm	0.0	10.0	46.6	18.87	0.0	25.6	66.6	30.73	0.0	30.0	73.3	34.43
$CaCl_2$ 4%	0.0	6.7	43.3	16.67	0.0	30.0	69.9	33.30	0.0	31.0	74.4	35.13
Mean	0.0	15.05	63.87		0.0	40.56	84.13		0.0	41.80	86.93	

L.S.D. at 5%:	**2002**	**2003**		**2002**	**2003**
(Treatments) A	5.83	0.89	(Period) C	1.16	0.57
(Inoculation) B	4.32	0.58	AC	8.25	1.14
AB	8.64	4.12	BC	7.14	0.98
			ABC	7.22	0.99

with control and other treatments (Table 1). The contrary effect was found by GA_3 and $CaCl_2$ treatments which significantly decreased the percentage of decayed fruits as compared with control in both inoculated and non-inoculated fruits. The lowest decay % was found with GA_3 application in inoculated fruits, while $CaCl_2$ gave the lowest values of decay % of the non-inoculated fruits.

Meanwhile, the percentages of decay in the infected fruits with *P. digitatum* and *P. italicum* were significantly higher than those uninfected ones during all stages of storage. These results indicated that mandarin fruits treated with GA_3 and $CaCl_2$ had a considerable tolerance to green and blue mould caused by *P. digitatum* and *P. italicum*, respectively.

These results are in agreement with those found by Ahmed *et al.* (1987), Salem and Ali (1991), Ahmed Amen (1992), Hussein *et al.* (2001).

A-2- Weight loss percentage:

Weight loss percentage significantly increased by prolonging the storage period for all tested fruits during both seasons (Table 2). Concerning the non-inoculated fruits, it could be noticed that Ethrel treatment had the highest weight loss values % of mandarin fruits after 2 weeks of storage as compared with untreated fruits (control). GA_3 and $CaCl_2$ treatments during both experimental seasons. At the end of storage period (30 days), GA_3 treatment gave the lowest values of weight loss % followed by $CaCl_2$, while untreated fruits had the highest values of weight loss % in both 2002 and 2003 seasons. Meaning that GA_3 and $CaCl_2$ significantly decreased the weight loss % comparing with control. On the other hand, the response of inoculated fruits with *P. digitatum* and *P. italicum* to the applied treatments was approximately similar with the non-inoculated fruits during the two studied seasons. Also, the loss in fruit weight % was the highest in the fruits treated with Ethrel after 2 weeks followed by untreated fruits. On the other hand, $CaCl_2$ and GA_3 significantly decreased the weight loss % of inoculated fruits as compared with control at the end of storage period. The loss in fruit weight with extending storage period could be due to water loss by transpiration (Park *et al.*, 1975). The reduction in weight loss in the fruits treated with $CaCl_2$ and GA_3 could be attributed to the effect of both substances in increasing firmness in fruits which led to reduce water evaporation (Sharples and Johnson, 1977). Moreover, a major part of the cementing properties of cell walls is presumed to be through the binding of pectic substances with Ca ions to form calcium pectate (Banuelos, 1986 and Roovaiah, 1987).

Table(2): Effect of Ethrel, GA_3 and $CaCl_2$ applications on weight loss % of Balady mandarin fruits inoculated with *P. digitatum* and *P. italicum* during 2002 and 2003 seasons.

Inoculation	Control				*P. digitatum*				*P. italicum*			
Period(days) / Treatment	0	15	30	Mean	0	15	30	Mean	0	15	30	Mean
2002												
Control	0.00	9.23	17.60	13.42	0.00	9.77	-	9.77	0.00	9.63	-	9.63
Ethrel 200 ppm	0.00	12.93	-	12.93	0.00	13.77	-	13.77	0.00	14.10	-	14.10
GA_3 50 ppm	0.00	7.00	14.10	10.55	0.00	7.63	14.80	11.22	0.00	7.67	15.03	11.35
$CaCl_2$ 4%	0.00	7.40	14.30	10.85	0.00	8.20	19.93	14.07	0.00	8.10	14.90	11.50
Mean	0.00	9.14	15.33		0.00	9.84	17.37		0.00	9.88	14.97	
2003												
Control	0.00	10.13	18.00	14.07	0.00	10.90	-	10.90	0.00	10.43	-	9.63
Ethrel 200 ppm	0.00	13.50	-	15.50	0.00	13.70	-	13.70	0.00	14.40	-	14.10
GA_3 50 ppm	0.00	7.30	13.80	10.55	0.00	8.10	14.57	11.34	0.00	7.87	14.87	11.35
$CaCl_2$ 4%	0.00	7.80	14.00	10.90	0.00	7.57	14.90	11.23	0.00	8.37	14.97	11.67
Mean	0.00	9.68	15.27		0.00	10.07	14.73		0.00	10.27	14.92	

L.S.D. at 5%:	2002	2003		2002	2003
A	0.498	0.043	C	0.338	0.034
B	0.473	0.044	AC	0.676	0.070
AB	0.795	0.094	BC	0.585	0.060
			ABC	0.592	0.061

Similar results were found by Ahmed Amen (1992) in mandarin, Hussein *et al.* (2001) in Apple and Singh *et al.* (1981) who reported that calcium reduced respiration rate and delayed ultrastructural changes in guava cells. Also, Johnson (1979) suggested that $CaCl_2$ is hygroscopic (absorbs moisture), which is believed to be one of the resons for its effectiveness in controlling weight loss.

B-1- Peel weight %:

Data obtained in Table 3 showed the effect of Ethrel, GA_3 and $CaCl_2$ treatments on the peel weight percentage in mandarin fruits inoculated *P. digitatum* and *P. italicum* during 2002 and 2003 seasons.

The obtained results indicate that mandarin fruits reacted differently to the applied treatments concerning peel weight %. Meaning that the response of infected fruits to the applied treatments was different comparing with non-infected fruits by *P. digitatum* and *P. italicum*, Ethrel increased peel weight % of the inoculated and non-inoculated fruits comparing with control and other treatments. This may be due to the increasing of respiration rate by Ethrel leading to increase in water evaporation from fruit juice which increased the percentage of peel weight %.

On the other hand, GA_3 at 50 ppm and 4% $CaCl_2$ treatments significantly decreased the percentage of peel weight in both inoculated and non-inoculated fruits during the two investigated seasons. Moreover, GA_3 spraying gave the lowest values of peel weight % in the inoculated fruits by *P. italicum* (blue mould) followed by $CaCl_2$ treatments at the end of storage period in both studied seasons. Similar results were obtained during the second season in both infected and non-infected fruits, while $CaCl_2$ gave the lowest peel weight % followed by GA_3 treatment during the first experimental season (2002). These results could be attributed to the reduction of water evaporation from fruit juice with GA_3 and $CaCl_2$ which resulted in reduction of the percentage of peel weight comparing with pulp weight.

The obtained results are in agreement with those obtained by Ahmed Amen (1992).

B-2-Total soluble solids (T.S.S.) %:

The obtained results in Table 4 showed that T.S.S. % of tested mandarin fruits took approximately the same tendency during the two investigated seasons and ranged between 11, 27 to 12.86% in the first season (2002) and 11.87 to 13.00% in 2003 season. The percentages of T.S.S. were slightly heigher during the second season as comparing with the first one.

From Table 4 it was observed that, T.S.S. percentages gradually

Table(3): Effect of Ethrel, GA_3 and $CaCl_2$ applications on peel weight % of Balady mandarin fruits inoculated with *P. digitatum* and *P. italicum* during 2002 and 2003 seasons.

Inoculation	Control				*P. digitatum*				*P. italicum*			
Period(days) / Treatment	0	15	30	Mean	0	15	30	Mean	0	15	30	Mean
2002												
Control	30.03	30.07	29.70	29.93	30.03	30.37	-	30.20	30.03	30.60	-	30.32
Ethrel 200 ppm	30.03	30.20	-	30.12	30.03	30.39	-	30.21	30.03	30.23	-	30.13
GA_3 50 ppm	30.03	29.73	29.00	29.59	30.03	29.67	29.43	29.71	30.03	29.40	29.20	29.54
$CaCl_2$ 4%	30.03	29.37	28.73	29.37	30.03	29.70	29.10	29.61	30.03	29.67	29.30	29.67
Mean	30.03	29.84	29.14		30.03	30.02	29.27		30.03	29.98	29.25	
2003												
Control	30.37	30.20	29.77	30.11	30.37	30.57	-	30.47	30.37	30.67	-	30.52
Ethrel 200 ppm	30.37	30.47	-	30.42	30.37	30.50	-	30.44	30.37	30.33	-	30.35
GA_3 50 ppm	30.37	29.53	28.93	29.61	30.37	29.77	29.23	29.79	30.37	29.60	29.10	29.69
$CaCl_2$ 4%	30.37	29.70	29.00	29.68	30.37	30.00	29.40	29.92	30.37	30.03	29.50	29.97
Mean	30.37	29.98	29.14		30.37	30.20	29.32		30.37	30.16	29.30	

L.S.D. at 5%:	2002	2003		2002	2003
A	0.066	0.061	C	0.064	0.039
B	0.044	0.052	AC	0.130	0.079
AB	0.087	0.102	BC	0.112	0.068
			ABC	0.113	0.069

Table(4): Effect of Ethrel, GA_3 and $CaCl_2$ applications on total soluble solids (T.S.S.) % of Balady mandarin fruits inoculated with *P. digitatum* and *P. italicum* during 2002 and 2003 seasons.

Inoculation	Control				*P. digitatum*				*P. italicum*			
Period(days) / Treatment	0	15	30	Mean	0	15	30	Mean	0	15	30	Mean
2002												
Control	11.27	11.87	12.20	11.78	11.27	11.60	-	11.43	11.27	11.67	-	11.46
Ethrel 200 ppm	11.27	12.33	-	11.80	11.27	12.73	-	12.00	11.27	12.87	-	12.07
GA_3 50 ppm	11.27	12.20	12.87	12.11	11.27	12.73	12.87	12.29	11.27	12.60	12.87	12.24
$CaCl_2$ 4%	11.27	12.20	12.53	12.00	11.27	12.60	12.53	12.13	11.27	12.73	12.80	12.27
Mean	11.27	12.15	12.53		11.27	12.15	12.53		11.27	12.42	12.84	
2003												
Control	11.87	12.27	12.27	12.13	11.87	12.60	-	12.23	11.87	12.43	-	12.15
Ethrel 200 ppm	11.87	12.93	-	12.40	11.87	13.00	-	12.43	11.87	12.93	-	12.40
GA_3 50 ppm	11.87	12.73	12.93	12.51	11.87	12.87	12.93	12.56	11.87	12.70	12.87	12.48
$CaCl_2$ 4%	11.87	12.53	12.67	12.36	11.87	12.73	12.87	12.49	11.87	12.80	12.93	12.53
Mean	11.87	12.62	12.62		11.87	12.80	12.90		11.87	12.64	12.90	

L.S.D. at 5%:	2002	2003		2002	2003
A	0.095	0.073	C	0.060	0.065
B	0.044	0.067	AC	0.120	0.131
AB	0.088	0.137	BC	0.104	0.114
			ABC	0.105	0.114

increased by extending the storage period and reashed its maximum values at the end of this period in all studied fruits during both seasons. This may be due to the losses of moisture (water) content of fruits through the respiration and evaporation during storage. Concerning the effect of the applied treatments, it could be noticed that Ethrel, GA_3 and $CaCl_2$ significantly increased the fruit content of T.S.S. as compared with untreated fruits (control) during all storage stages (15 and 30 days). Ethrel treatments gave the highest values of T.S.S. content after 15 days comparing with control and other treatments. This could be due to the enhancing of ripening process and the increasing of weight loss % (Table 2) with Ethrel application. In addition, GA_3 and $CaCl_2$ significantly increased the fruit content of T.S.S. comparing with untreated fruits, which could be attributed to the reduction of respiration rate and acculation of sugars and other substances (Singh *et al.*, 1981).

Similar findings were obtained by Daidda (1971) in Washington Navel orange Kumar *et al.* (1977) in sweet lime, Ahmed Amen (1992) in lime and Ibrahim *et al.* (1994) in Washington Navel orange. On the other hand, the inoculated and non-inoculated fruits by *P. digitatum* and *P. italicum* differently responsed to the applied treatments. Meaning that non-inoculated fruits without treatments (control) contained higher T.S.S. percentages than inoculated fruits after 15 days of storage (the end of shelf life of these fruits) during 1st season and lower T.S.S.% in the second one.

On the contrary, results proved that in the treated fruits with Ethrel, GA_3 and $CaCl_2$ which contained higher T.S.S. % when infected with both diseases than those non-inoculated. Similar results were found by Abdel Razik and El-Kassas (1975).

B-3- Total acidity %:

As shown in Table 5 acidity percentages in mandarin fruits were in general higher during the first season (2002) than those of the second one. In addition, acidity % gradually increased by prolonging the storage period during the two experimental seasons. This may be due to the weight loss through water (moisture) transpiration. Moreover, the highest acidity % was found in the fruits treated with GA_3 followed by $CaCl_2$ treatments, while untreated fruits contained the lowest percentages of acidity. Randhawa *et al.* (1965) recorded higher acidity in grapefruits juice by GA_3 application. The increasing of acidity content in treated fruits with GA_3 and $CaCl_2$ could be attributed to the effect of GA_3 on delaying senescense (Bangerth *et al.*, 1972) and the effect of Ca on delaying acid decomposition including that of ascorbic acid (Steckel and Gross,

Table(5): Effect of Ethrel, GA_3 and $CaCl_2$ applications on acidity % of Balady mandarin fruits inoculated with *P. digitatum* and *P. italicum* during 2002 and 2003 seasons.

Inoculation	Control				*P. digitatum*				*P. italicum*			
Period(days) / Treatment	0	15	30	Mean	0	15	30	Mean	0	15	30	Mean
2002												
Control	1.04	1.02	1.11	1.06	1.04	1.12	-	1.08	1.04	1.14	-	1.08
Ethrel 200 ppm	1.04	1.11	-	1.08	1.04	1.14	-	1.09	1.04	1.15	-	1.09
GA_3 50 ppm	1.04	1.17	1.20	1.13	1.04	1.21	1.24	1.16	1.04	1.19	1.21	1.15
$CaCl_2$ 4%	1.04	1.07	1.16	1.09	1.04	1.10	1.18	1.11	1.04	1.11	1.20	1.12
Mean	1.04	1.09	1.16		1.04	1.14	1.21		1.04	1.15	1.20	
2003												
Control	1.00	1.01	1.09	1.03	1.00	1.02	-	1.01	1.00	1.03	-	1.02
Ethrel 200 ppm	1.00	1.02	-	1.01	1.00	1.11	-	1.06	1.00	1.11	-	1.06
GA_3 50 ppm	1.00	1.12	1.15	1.09	1.00	1.16	1.18	1.11	1.00	1.15	1.20	1.12
$CaCl_2$ 4%	1.00	1.06	1.12	1.06	1.00	1.08	1.15	1.08	1.00	1.08	1.16	1.08
Mean	1.00	1.07	1.12		1.00	1.09	1.17		1.00	1.09	1.18	

L.S.D. at 5%:	2002	2003		2002	2003
A	0.004	0.063	C	0.007	0.047
B	0.005	0.048	AC	0.015	0.094
AB	0.010	0.096	BC	0.012	0.081
			ABC	0.013	0.082

1978). Ethrel decreased acidity % in non-inoculated fruits, while it increased acidity content in inoculated fruits with both *P. digitatum* and *P. italicum*.

Concerning the effect of inoculation on acidity %, it could be notice that the infected fruits with both diseases had higher acidity content than the healthy one. The obtained results are in line with those found by Coggins *et al.* (1960), Abdel Razik and El-Kassas (1975), Singh *et al.* (1981), Ahmed Amen (1992) and Prusky *et al.* (2004) who reported that in decayed citrus fruits with both *P. digitatum* and *P. italicum* produced significant amounts of citric and gluconic acid in the decayed tissue and reduced the host pH by 0.5 to 1.0 units.

B-4- Total soluble solids/acid ratio

General looking at the data in Table 6 showed that T.S.S./acid ratio took different trend as affected by certain applied treatments. Meaning that Ethrel application increased T.S.S./acid ratio in non-inoculated fruits during both studied seasons and in inoculated fruits with *P. italicum* during 1st season (2002). On the other hand, T.S.S./acid ratio gradually decreased with extending of storage period in all fruits treated with GA_3 and $CaCl_2$ except those infected with *P. italicum* in the 1st season. The decreasing of T.S.S./acid ratio could be due to the higher rate of acidity increasing as compared with the increment of T.S.S.% with prolonging the storage period.

In conclusion, it could be observe that the reduction or increase of T.S.S./acid ratio were mainly correlated with the changes occurred in T.S.S. and acidity content during each stage of storage.

B-5- Sugar contents:

1 – Reducing sugar %:

It could be noticed from data in Table 7 that the reducing sugar % of non-inoculated fruits took different tendency compared with the inoculated one during the two investigated seasons. Ethrel treatment increased reducing sugar % in non-inoculated fruits during both seasons, while decreased it during the second season (2003) in inoculated fruits. In addition, reducing sugar % gradually increased during 1st season and decreased in 2nd season in healthy and diseased fruits without treatments of Ethrel, GA_3 and $CaCl_2$.

Also, reducing sugar content in the fruits treated with GA_3 and $CaCl_2$ gradually increased with progress of storage period in the non-inoculated fruits and was higher than those untreated one. Both treatments (GA_3 and $CaCl_2$) took contrary trend with inoculated fruits with *P. digitatum* and *P. italicum* The obtained results are in agreement with those reported by AbdelRazik and El-Kassas (1975) and Randhawa *et al.* (1965) who found that spraying GA_3 increased reducing sugar % in grapefruit.

Table(6): Effect of Ethrel, GA_3 and $CaCl_2$ applications on T.S.S./acid ratio of Balady mandarin fruits inoculated with *P. digitatum* and *P. italicum* during 2002 and 2003 seasons.

Inoculation	Control				*P. digitatum*				*P. italicum*			
Period(days) / Treatment	0	15	30	Mean	0	15	30	Mean	0	15	30	Mean
2002												
Control	10.84	11.56	10.99	11.13	10.84	10.33	-	10.59	10.84	10.21	-	10.53
Ethrel 200 ppm	10.84	12.21	-	11.53	10.84	10.20	-	10.52	10.84	11.22	-	11.03
GA_3 50 ppm	10.84	10.46	10.75	10.68	10.84	10.55	10.38	10.59	10.84	10.59	10.64	10.68
$CaCl_2$ 4%	10.84	10.37	10.77	10.99	10.84	10.49	10.55	10.96	10.84	10.51	10.64	10.99
Mean	10.84	11.15	10.83		10.84	10.89	10.47		10.84	10.88	10.64	
2003												
Control	11.87	12.19	11.29	11.78	11.87	12.19	-	12.03	11.87	12.07	-	11.97
Ethrel 200 ppm	11.87	12.68	-	12.27	11.87	11.75	-	11.81	11.87	11.65	-	11.76
GA_3 50 ppm	11.87	11.34	11.21	11.47	11.87	11.09	10.99	11.31	11.87	11.10	10.70	11.22
$CaCl_2$ 4%	11.87	11.86	11.31	11.68	11.87	11.95	11.15	11.66	11.87	11.82	11.12	11.60
Mean	11.87	11.84	11.27		11.87	11.74	11.07		11.87	11.58	10.91	

L.S.D. at 5%:	**2002**	**2003**		**2002**	**2003**
A	0.94	0.100	C	0.099	0.102
B	0.050	0.049	AC	0.194	0.204
AB	0.101	0.098	BC	0.168	0.176
			ABC	0.170	0.178

Table(7): Effect of Ethrel, GA_3 and $CaCl_2$ applications on reducing sugars % of Balady mandarin fruits inoculated with *P. digitatum* and *P. italicum* during 2002 and 2003 seasons.

Inoculation	Control				*P. digitatum*				*P. italicum*			
Period(days) / Treatment	0	15	30	Mean	0	15	30	Mean	0	15	30	Mean
2002												
Control	3.99	4.04	4.07	4.03	3.99	4.10	-	4.05	3.99	4.03	-	4.01
Ethrel 200 ppm	3.99	4.12	-	4.06	3.99	3.99	-	3.99	3.99	3.99	-	3.99
GA_3 50 ppm	3.99	4.07	4.10	4.06	3.99	4.00	3.99	3.99	3.99	3.95	3.92	3.95
$CaCl_2$ 4%	3.99	4.05	4.08	4.04	3.99	3.99	4.00	3.99	3.99	3.96	3.91	3.96
Mean	3.99	4.07	4.08		3.99	4.02	4.00		3.99	3.98	3.92	
2003												
Control	4.15	4.10	4.10	4.12	4.15	4.01	-	8.08	4.15	4.00	-	4.08
Ethrel 200 ppm	4.15	4.19	-	4.17	4.15	4.07	-	4.11	4.15	4.01	-	4.08
GA_3 50 ppm	4.15	4.18	4.20	4.18	4.15	4.08	4.05	4.09	4.15	4.00	3.96	4.04
$CaCl_2$ 4%	4.15	4.17	4.23	4.15	4.15	4.01	3.95	4.04	4.15	4.03	3.89	4.02
Mean	4.15	4.16	4.18		4.15	4.04	4.02		4.15	4.01	3.93	

L.S.D. at 5%:	2002	2003		2002	2003
A	0.20	0.023	C	0.015	0.011
B	0.019	0.010	AC	0.027	0.021
AB	0.038	0.021	BC	0.026	0.018
			ABC	0.026	0.019

2 – Non-reducing sugar %:

The obtained results in Table 8 indicated that non-reducing sugar % significantly and sharply decreased with extanding the storage period in all investigated fruits during the two experimental seasons.

In addition, non-reducing sugar % in mandarin fruits was generally higher during the 2nd season than those in the first one. Moreover, GA_3 treatment had the highest values of non-reducing sugar % comparing with other treatments and control (untreated fruits) in both healthy and infected fruits during the two studied seasons. This may be due to the reduction of respiratory quitent (rate) by GA_3 application and hence the accumulation of non-reducing sugar.

The illustrated data in Table 8 showed also that non-reducing sugar % in the inoculated fruits were significantly lower than in the non-inoculated one during all stages of storage period in both 2002 and 2003 seasons. This could be attributed mainly to utilization of non-reducing sugar and high H^+ ion concentration of the juice of decayed fruits could also stimulate the inversion of non-reducing sugar to reducing ones, which are utilized by the pathogen (Bartholomew and Sinclair, 1951).

3 - Total sugar %:

General looking at the Table 9, it is clearly mentioned that total sugars % took approximately similar trend of non-reducing sugar. Meaning that total sugar contents of all tested fruits significantly decreased with prolonging the storage period during the two investigated seasons.

In addition, the inoculated fruits by both *P. digitatum* and *P. italicum* had lower content of total sugars comparing with non-inoculated ones. These findings were paralled with the sharply decrease of non-reducing sugars % in diseased fruits as shown discussed.

These results are in accordance with those reported by AbdElrazik and El-Kassas (1975) and Baraka (1989) who found a considerable decrease in sugar contents of inoculated citrus fruits with *C. gloeosporioides* during storage.

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Table(8): Effect of Ethrel, GA_3 and $CaCl_2$ applications on non-reducing sugar % of Balady mandarin fruits inoculated with *P. digitatum* and *P. italicum* during 2002 and 2003 seasons.

Inoculation	Control				*P. digitatum*				*P. italicum*			
Period(days) / Treatment	0	15	30	Mean	0	15	30	Mean	0	15	30	Mean
2002												
Control	4.40	3.83	2.93	3.61	4.40	3.65	-	4.02	4.40	3.54	-	3.97
Ethrel 200 ppm	4.40	3.98	-	4.19	4.40	3.89	-	4.14	4.40	3.80	-	4.10
GA_3 50 ppm	4.40	4.10	3.97	4.15	4.40	3.93	3.56	3.97	4.40	3.91	3.37	3.90
$CaCl_2$ 4%	4.40	3.92	3.12	3.81	4.40	3.76	2.99	3.72	4.40	3.87	3.11	3.79
Mean	4.40	3.96	3.34		4.40	3.80	3.28		4.40	3.78	3.24	
2003												
Control	5.06	4.13	3.46	4.21	5.06	3.82	-	4.44	5.06	3.66	-	4.36
Ethrel 200 ppm	5.06	4.02	-	4.54	5.06	3.92	-	4.49	5.06	3.90	-	4.48
GA_3 50 ppm	5.06	4.18	3.88	4.37	5.06	3.98	3.58	4.21	5.06	3.92	3.31	4.09
$CaCl_2$ 4%	5.06	4.08	3.39	4.18	5.06	3.82	2.87	3.92	5.06	3.92	2.96	3.98
Mean	5.06	4.10	3.58		5.06	3.89	3.23		5.06	3.85	3.13	

L.S.D. at 5%:	**2002**	**2003**		**2002**	**2003**
A	0.070	0.021	C	0.056	0.023
B	0.040	0.015	AC	0.112	0.047
AB	0.080	0.029	BC	0.097	0.041
			ABC	0.098	0.041

Table(9): Effect of Ethrel, GA_3 and $CaCl_2$ applications on total sugars % of Balady mandarin fruits inoculated with *P. digitatum* and *P. italicum* during 2002 and 2003 seasons.

Inoculation	Control				*P. digitatum*				*P. italicum*			
Period(days) / Treatment	0	15	30	Mean	0	15	30	Mean	0	15	30	Mean
2002												
Control	8.40	7.86	7.00	7.75	8.40	7.75	-	8.08	8.40	7.55	-	7.98
Ethrel 200 ppm	8.40	8.10	-	8.25	8.40	7.88	-	8.14	8.40	7.79	-	8.15
GA_3 50 ppm	8.40	8.17	8.07	8.21	8.40	7.90	7.29	7.95	8.40	7.86	7.29	7.85
$CaCl_2$ 4%	8.40	7.97	7.20	7.86	8.40	7.75	6.98	7.71	8.40	7.82	7.02	7.75
Mean	8.40	8.03	7.42		8.40	7.82	7.14		8.40	7.76	7.16	
2003												
Control	9.21	8.23	7.56	8.33	9.21	7.82	-	8.52	9.21	7.67	-	8.44
Ethrel 200 ppm	9.21	8.21	-	8.71	9.21	8.00	-	8.61	9.21	7.91	-	8.56
GA_3 50 ppm	9.21	8.36	8.08	8.55	9.21	8.06	7.62	8.30	9.21	7.92	7.27	8.13
$CaCl_2$ 4%	9.21	8.25	7.62	8.32	9.21	7.83	6.82	7.95	9.21	7.93	6.85	7.67
Mean	9.21	8.26	7.75		9.21	7.92	7.22		9.21	7.61	7.06	

L.S.D. at 5%:	2002	2003		2002	2003
A	0.047	0.190	C	0.029	0.167
B	0.027	0.171	AC	0.058	0.335
AB	0.054	0.342	BC	0.051	0.290
			ABC	0.051	0.293

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تأثير استخدام الايثريل والجبرالين وكلوريد الكالسيوم على مقاومة أمراض العفن الأخضر والأزرق فى ثمار اليوسفي البلدى أثناء التخزين

طلعت كامل المهدى

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أجريت هذه التجربة على ثمار اليوسفى البلدى خلال موسمى ٢٠٠٢ ، ٢٠٠٣ وذلك بهدف دراسة استخدام الايثريل والجبريلين وكلوريد الكالسيوم على مقاومة ثمار اليوسفى البلدى لمرض العفن الأخضر والأزرق أثناء تخزينها . ولقد تم جمع الثمار عند وصولها لمرحلة اكتمال النمو وغسلها بالمعمل ثم معاملتها بمبيد فطرى وغسلها مرة أخرى بالماء المقطر وقسمت الثمار إلى أربعة مجاميع تم معاملتها كالتالى :

١- رشت بالماء المقطر (كنترول) . ٢- رشت بالايثريل تركيز ٢٠٠ جزء فى المليون .

٣- رشت بالجبريلين ٥٠ جزء فى المليون . ٣- رشت بمحلول كلوريد الكالسيوم ٤% .

ثم أخذت ثمار كل معاملة وقسمت إلى ٣ مجاميع وعوملت كالتالى :

١- ثمار غير معاملة (كنترول) . ٢- ثمار رشت بمحلول جراثيم العفن الأخضر .

٢- ثمار رشت بمحلول جراثيم العفن الأزرق .

خزنت الثمار السابق معاملتها تحت درجة حرارة الغرفة وخصص جزء منها لتقدير نسبة الإصابة وكذلك الفقد فى الوزن وأخذت عينات دورية من باقى الثمار لتقدير وزن القشرة وكذلك نسبة المواد الصلبة الذائبة الكلية والحموضة والسكريات المختزلة والغير مختزلة والكلية وكانت أهم النتائج :

- أمكن تخزين الثمار المعاملة بالايثريل وكذلك التى تم رشها بمحلول جراثيم العفن الأخضر والأزرق لمدة ١٥ يوما بينما أستمر تخزين باقى الثمار لمدة ٣٠ يوم .

- زادت نسبة الإصابة معنويا وكذلك نسبة الفقد فى الوزن بزيادة فترة التخزين وكانت هذه النسبة أعلى فى الثمار التى تم إجراء العدوى لها بمرض العفن الأخضر والأزرق .

- أدت المعاملة بالجبريلين وكلوريد الكالسيوم إلى تقليل نسبة الإصابة والفقد فى الوزن معنويا بينما زاد استخدام الايثريل من هذه النسب مقارنة بالكنترول .

- زادت نسبة المواد الصلبة الكلية بزيادة فترة التخزين وكانت أعلى فى الثمار المعاملة بكلوريد الكالسيوم والجبريلين والتى أدت كذلك إلى زيادة الحموضة فى الثمار .

- احتوت الثمار التى تم إجراء العدوى لها على نسبة أعلى من الحموضة ونسبة أقل من السكريات الغير مختزلة والكلية مقارنة بالثمار التى لم يتم إجراء عدوى لها .

- احتفظت الثمار المعاملة بكلوريد الكالسيوم والجبريلين بنسبة أعلى من السكريات الكلية والغير مختزلة أثناء التخزين .

يمكن تحت ظروف هذه التجربة التوصية بمعاملة الثمار بكلوريد الكالسيوم أو الجبريلين لزيادة مقاومتها لأضرار الإصابة بمرض العفن الأخضر والأزرق أثناء التخزين .