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RESPONSE OF EARLY GRAND PEACH TO CHEMICAL THINNING; ETHREL, GIBBERELLIC ACID AND UREA: II. STORABILITY OF FRUITS

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ABSTRACT

The results of 1997 and 1998 seasons revealed that increasing the storage period of Early Grand peach markedly increased weight loss, percentage of decay, total soluble solids, total soluble pectin, carotene and anthocyanin, and decreased juice acidity, vitamin C, total phenols, total chlorophyll and fruit firmness.

It was also found that using ethrel as one of the three chemical thinners caused an increase in weight loss, fruit decay percentage, total soluble solids, total soluble pectin, carotene and anthocyanin and decrease in juice acidity, fruit firmness, total phenols and total chlorophyll.

In the meantime, both GA_3, and urea thinning treatments caused a slight decrease in weight loss, decay percentage. No constant trend was found in juice acidity, while an increase in chlorophyll. No effect was found for both thinners on total phenols, carotene and anthocyanin during the storage time.

INTRODUCTION

Peach thinning is connected with profitable peach growing. It increases fruit size, improves fruit colour and quality. Chemical thinning of some peach cultivars was evaluated by Durate and Jauregui (1990) with ethrel, Taylor and Geisler-Taylor (1998) with GA_3 and Zilkah *et al*.(1988) with urea.

On the other hand, proper maturity at harvest greatly influences storage life and final fruit quality which is essential to marketing good quality peach fruits.

This investigation was carried out to explore the behaviour of peach fruits in relation to the effect of chemical thinning with ethrel, gibberellic acid and urea on Early Grand peach cultivar under cold storage.

MATERIALS AND METHODS

The experiment was conducted during 1997 and 1998 growing seasons on 8-year old peach cv. Early Grand on Nemagard rootstock, growing in loamy sand soil at commercial orchard located at El-Nobaria, Behera Governorate. The trees were as uniform as possible, planted at 5 x 5 meters. The orchard was drip irrigated by using 2 x 4 liter h^{-1} emitters per tree. Nutrients were applied via fertigation. Irrigation was provided daily for 4 h during each season (~10 February to 15 October). The irrigation hours increased by one hour every 15 days till the beginning of July and then decreased by 1 hour every 15 days till October, according to local irrigation regime. The experimental trees were sprayed with water (control), 50, 100, 150 ppm of gibberellic acid (GA_3), 2, 3 and 4% urea at pre-bloom stage (18 January) or 25, 50 and 100 ppm ethrel (2-chloroethyl phosphonic acid) at the

spost-bloom stage (18 February). Each plot included one tree and each treatment was replicated four times in a randomized block design.

At harvest (full fruit growth), on April 22nd in both experimental seasons, fruits of each replicate were collected and subjected to the following prestorage preparation steps:

- Defective fruits due to mechanical, pathological or any disorder were discarded.
- Appropriately selected fruits were washed with tap water and rinsed again with distilled water then air-dried using electric fan and packed in cardboard boxes.
- Each treatment was replicated in four replicates each consisted of 3 boxes each box contained 50 mature fruits.
- In each box of all treatments, the initial weight of marked fruits was determined to be used for the determination of weight loss throughout the storage period.
- All boxes of the above mentioned treatments were stored at 0°C and relative humidity of 85-90% in a cold storage room.

Fruits were kept as long as they were less than 50% decay in all treatments included control.

During storage period, samples of ten fruit were taken from each replicate on time scale of 0, 3, 6, 9, 12, 15 and 21 days from storage. In each fruit sample, fruit weight loss was calculated.

Decay pathological or physiological or both percentage was also recorded during storage period in both experimental seasons.

Fruit firmness was determined by Magness and Taylor (1925) measure tester.

In fruit juice, total soluble solids (TSS%) were determined using a hand refractometer, acidity was estimated as malic acid and vitamin C content was determined using 2,6-dichlorophenol indophenol dye (A.O.A.C., 1980).

Peel chlorophyll and carotene (mg/100g fresh weight) were colourimetrically determined according to the procedure outlined by Wensttein (1957). Anthocyanin was determined (mg/100 g fresh weight) according to Rabino *et al*.(1977).

Total soluble pectin was determined according to McComb and McCready (1952). Total phenols were determined according to A.O.A.C. (1980).

The obtained data throughout the two studied growing seasons were statistically analyzed using the analysis of variance (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

1. Weight loss :

The present results (Tables 1 and 2) indicated that, in both seasons, the percentage of weight loss was significantly increased by using ethrel as a chemical thinner compared with the control. This may be due to the faster ripening and more physiological activities of the treated fruits. While, GA_3 and urea applications caused a reduction in weight loss as compared with the

control. Significant differences were only found with the highest GA_3 concentration and control in the first experimental season, while in the second season of study significant differences were found between the highest two gibberellic acid treatments and urea treatments as compared with control. These results are in agreement with those obtained by Muhammed *et al*. (1996).

Table (1): Effect of ethrel, gibberellic acid and urea as chemical thinners on weight loss percentage of Early Grand peach fruits during cold storage at 0°C in 1997 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	-	1.63	1.86	2.97	4.11	6.53	8.20	9.34	4.95
Ethrel 25ppm	-	1.87	1.98	3.21	4.93	6.91	9.15	11.01	5.58
Ethrel 50ppm	-	1.91	2.13	3.97	5.31	7.23	9.63	11.59	5.97
Ethrel 100ppm	-	2.01	2.24	4.05	5.84	7.81	9.95	11.83	6.25
GA_3 50ppm	-	1.42	1.65	2.50	4.08	7.99	8.05	8.45	4.88
GA_3 100ppm	-	1.31	1.53	2.32	3.91	6.61	7.85	7.91	4.49
GA_3 150ppm	-	1.24	1.39	2.23	3.73	6.45	7.58	7.64	4.32
Urea 2%	-	1.61	1.81	2.35	3.59	6.18	8.06	8.61	4.61
Urea 3%	-	1.46	1.67	2.31	3.51	6.11	7.64	8.94	4.53
Urea 4%	-	1.43	1.64	2.42	3.44	6.13	7.71	8.91	4.67
Mean	-	1.59	1.79	2.83	4.25	6.80	8.38	9.42	
$L.S.D_{0.05}$	Treatment 0.54			Date 0.49			Treatment x Date 1.52		

Table (2): Effect of ethrel, gibberellic acid and urea as chemical thinners on weight loss percentage of Early Grand peach fruits during cold storage at 0°C in 1998 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	-	1.81	1.89	2.86	4.97	6.96	8.79	10.06	5.33
Ethrel 25ppm	-	1.93	2.03	3.42	5.15	7.11	9.31	11.41	5.77
Ethrel 50ppm	-	1.99	2.10	3.81	5.34	7.41	9.74	11.65	6.01
Ethrel 100ppm	-	2.05	2.31	4.09	5.52	7.63	10.01	11.93	6.22
GA_3 50ppm	-	1.60	1.75	2.65	4.81	6.94	8.31	9.36	5.06
GA_3 100ppm	-	1.51	1.63	2.48	4.61	6.68	8.08	8.71	4.81
GA_3 150ppm	-	1.38	1.49	2.31	4.40	6.31	7.77	8.59	4.61
Urea 2%	-	1.73	1.77	2.47	3.91	6.20	8.35	8.66	4.73
Urea 3%	-	1.54	1.63	2.44	3.74	6.17	8.15	8.72	4.63
Urea 4%	-	1.51	1.60	2.33	3.55	6.19	7.93	8.85	4.57
Mean	-	1.61	1.82	2.89	4.60	6.76	8.64	9.79	
$L.S.D_{0.05}$	Treatment 0.38			Date 0.34			Treatment x Date 1.07		

In both seasons, the weight loss percentage was significantly increased increasing the storage period, except for the first sampling date (after 3 days) in the second season. This may be due to shrinkage of the fruit during the storage period. These data are in line with those obtained by El-Zayat *et al*.(1996) and Zhang *et al*.(1996) working on peach. They found that the weight loss percentage increased with the advancement of storage period.

2. Decay percentage :

The influence of ethrel, GA_3 and urea foliar applications as chemical

thinners on the percentage of decay in Early Grand peach fruits during storage is shown in Tables (3 and 4). It appears that, in both seasons of the present study, the three ethrel applications markedly increased the decay of fruit during storage, except for first concentration (25 ppm) for the second experimental season. This result can be explained on the basis that ethrel leads the fruit physiologically to ripen and approaches the senescence stage in which fruits are usually more susceptibile to decay (Biale and Young, 1981).

On the other hand, GA_3 and urea treatments caused a decrease in the percentage of decay in both seasons, but this decrease was not big enough to be significant. These results can be attributed to the effect of both GA_3 and urea in delaying ripening as reported by Zilkah *et al*.(1988) and Southwick *et al*.(1995) working on peaches.

Table (3): Effect of ethrel, gibberellic acid and urea as chemical thinners on decay percentage of Early Grand peach fruits during cold storage at 0ºC in 1997 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	-	-	1.89	2.19	3.79	4.86	6.27	8.11	4.52
Ethrel 25ppm	-	-	2.06	3.19	5.54	6.71	7.96	8.89	5.73
Ethrel 50ppm	-	-	2.41	3.79	5.59	6.79	8.62	9.74	6.16
Ethrel 100ppm	-	-	2.47	4.11	6.46	6.99	8.84	9.81	6.45
GA_3 50ppm	-	-	1.52	1.65	2.45	3.71	5.44	7.49	3.71
GA_3 100ppm	-	-	1.46	1.69	2.59	3.64	5.46	7.27	3.69
GA_3 150ppm	-	-	1.33	1.49	2.39	3.59	5.27	7.05	3.52
Urea 2%	-	-	1.80	1.89	3.11	4.27	6.18	7.97	4.20
Urea 3%	-	-	1.67	1.85	3.07	4.31	6.13	7.91	4.16
Urea 4%	-	-	1.64	1.87	3.19	4.27	6.11	7.83	4.15
Mean	-	-	1.83	2.37	3.81	4.91	6.63	8.21	
$L.S.D_{0.05}$	Treatment 1.08			Date 0.97			Treatment x Date 3.04		

Table (4): Effect of ethrel, gibberellic acid and urea as chemical thinners on decay percentage of Early Grand peach fruits during cold storage at 0ºC in 1998 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	-	-	1.94	2.33	4.61	4.99	6.11	7.89	4.65
Ethrel 25ppm	-	-	2.42	3.41	5.11	6.47	7.97	8.11	5.58
Ethrel 50ppm	-	-	2.73	3.11	5.26	7.53	8.21	9.34	6.03
Ethrel 100ppm	-	-	2.79	3.15	5.94	7.68	8.71	9.36	6.27
GA_3 50ppm	-	-	1.71	1.77	2.09	4.71	5.97	7.01	3.88
GA_3 100ppm	-	-	1.56	1.71	2.08	3.91	5.11	6.76	3.52
GA_3 150ppm	-	-	1.59	1.69	2.59	3.85	5.03	6.53	3.55
Urea 2%	-	-	1.91	2.15	3.45	4.79	5.96	7.64	4.32
Urea 3%	-	-	1.83	2.11	3.51	5.03	6.29	7.41	4.36
Urea 4%	-	-	1.81	2.30	3.81	5.09	6.25	7.43	4.45
Mean	-	-	2.03	2.37	3.85	5.41	6.56	7.75	
$L.S.D_{0.05}$	Treatment 1.15			Date 1.03			Treatment x Date 9.17		

In both seasons, the percentage of fruit decay was significantly increased by increasing the storage period, except between the third sampling date (6 days) and the fourth one (9 days) in 1997 and 1998

seasons. These results agreed with other investigators such as Sandhu *et al*.(1982) working on peach fruits.

3. Total soluble solids (TSS) :

Juice TSS was significantly increased with increasing ethrel concentrations as compared with control, except for the lowest concentration (25 ppm) in the first season (Tables 5 and 6). These results agreed with those obtained by Hassan *et al*.(1987) and Muthoo *et al*.(1997) working on peaches.

Data in Tables (5 and 6), also, showed that, in both seasons, GA_3 and urea treatments caused a slight increase in TSS but differences were not big enough to be significant as compared with the control. These results are in the line with those obtained by Abdel-Hamid (1999) working on peach.

Table (5): Effect of ethrel, gibberellic acid and urea as chemical thinners on total soluble solids (TSS%) of Early Grand peach fruits during cold storage at 0ºC in 1997 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	11.04	11.09	11.17	11.22	11.35	12.38	12.60	12.80	11.71
Ethrel 25ppm	12.40	12.45	12.58	12.60	12.89	13.42	13.86	14.13	13.04
Ethrel 50ppm	12.77	12.81	12.99	13.05	13.32	13.49	14.11	14.41	13.37
Ethrel 100ppm	12.82	12.87	13.51	13.48	13.86	13.93	14.06	14.63	13.65
GA_3 50ppm	11.22	11.31	11.64	11.75	11.83	12.14	12.98	13.05	11.99
GA_3 100ppm	11.03	11.12	11.96	12.11	12.19	12.71	12.94	13.17	12.15
GA_3 150ppm	12.11	12.17	12.42	12.55	12.61	12.97	13.71	13.86	12.80
Urea 2%	11.34	11.35	11.86	11.90	12.00	12.38	13.11	13.42	12.17
Urea 3%	11.25	11.31	11.72	11.75	11.82	12.15	12.91	13.27	12.02
Urea 4%	11.15	11.20	11.54	11.60	11.68	11.93	12.73	13.10	11.87
Mean	11.68	11.77	12.14	12.20	12.36	12.75	13.30	13.58	
$L.S.D_{0.05}$	Treatment 1.57			Date 1.40			Treatment x Date 4.40		

Table (6): Effect of ethrel, gibberellic acid and urea as chemical thinners on total soluble solids (TSS%) of Early Grand peach fruits during cold storage at 0ºC in 1998 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	10.52	10.61	10.88	11.18	11.21	11.41	12.47	12.65	11.37
Ethrel 25ppm	11.85	11.92	12.39	12.41	12.64	12.75	13.21	13.98	12.64
Ethrel 50ppm	11.64	12.51	12.79	12.86	13.15	13.18	13.74	14.32	13.03
Ethrel 100ppm	12.00	12.79	13.32	13.40	13.62	13.84	14.00	14.52	13.44
GA_3 50ppm	10.60	10.71	11.44	11.62	11.74	12.08	12.63	12.95	11.72
GA_3 100ppm	10.94	11.01	11.21	11.43	11.72	12.48	12.85	13.04	11.84
GA_3 150ppm	11.55	11.50	12.19	12.39	12.53	12.86	13.23	13.66	12.49
Urea 2%	10.78	10.76	10.89	11.74	11.89	12.15	12.93	13.30	11.81
Urea 3%	10.74	10.72	10.81	11.63	11.70	12.62	12.81	13.21	11.71
Urea 4%	10.43	10.51	10.60	11.65	11.68	11.89	12.54	13.06	11.55
Mean	11.11	11.31	11.65	12.03	12.19	12.47	13.04	13.47	
$L.S.D_{0.05}$	Treatment 1.14			Date 1.02			Treatment x Date 3.21		

The results of both seasons indicated that, total soluble solids were increased by storage period, but significant differences were only found between zero time and 18 and 21 days in the first season and zero time and the last four sampling dates in the second season. These results agreed with

those reported by El-Sheikh and Habiba (1996) working on Early Grand peach.

4. Acidity :

The present results indicated that, in both seasons, juice acidity was decreased by increasing the ethrel concentration. Significant differences were only found between the higher two ethrel concentrations and control (Tables 7 and 8). These results agreed with those reported by Sandhu and Zora (1983), who stated that ethrel treatments depressed the acid content in stored peach fruits.

Generally, no constant trend was found by GA_3 and urea applications as compared with control.

It is also shown from Tables (7 and 8) that juice acidity significantly declined by increasing the storage period as compared with 0 time, which may be attributed to the use of acids as substrate for respiration (Echeverria and Valich, 1989).

5. Vitamin C :

In both experimental seasons no significant differences were found in fruit vitamin C content between control and both the three ethrel and urea applications at the end of storage period. Meanwhile, fruits in the GA_3 treatments contained higher vitamin C than control. Significant differences were found in the highest two GA_3 concentrations in 1997 season and for the three GA_3 concentrations in 1998 season (Tables 9 and 10). This may be explained by the effect of GA_3 in delaying ripening (Sims *et al*., 1974).

Data in Tables (9 and 10), also, showed that vitamin C significantly decreased as storage time increased. It may be attributed to its oxidation with time (Kays, 1991 and Salunkhe *et al*., 1991).

6. Firmness and total soluble pectin :

In both seasons, fruit firmness was significantly decreased with ethrel treatments as compared with control. These results agreed with those found by Khalil *et al*.(1990). On the other hand, GA_3 treatments caused a significant increase, as reported by Muhammad *et al*.(1996). Meanwhile, no significant differences were found between treated and untreated fruits with urea, except for the highest concentration (4%) in the first experimental season (Tables 11 and 12). These results were in line with those found by Zilkah *et al*.(1988) working on peaches and nectarines.

The present results indicated that, in both seasons, firmness significantly decreased with increasing the storage period. These results agreed with those reported by Mollendorff and De Villier (1988) working on “Perrgrine” peach cultivar.

Table (7): Effect of ethrel, gibberellic acid and urea as chemical thinners on acidity % of Early Grand peach fruits during cold storage at 0ºC in 1997 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	

Control	1.01	1.02	0.97	0.99	0.87	0.71	0.64	0.50	0.84
Ethrel 25ppm	0.86	0.83	0.85	0.81	0.76	0.69	0.54	0.48	0.73
Ethrel 50ppm	0.82	0.81	0.78	0.69	0.68	0.56	0.43	0.45	0.72
Ethrel 100ppm	0.78	0.75	0.71	0.65	0.54	0.55	0.47	0.40	0.61
GA_3 50ppm	0.99	0.94	0.96	0.89	0.78	0.64	0.55	0.59	0.79
GA_3 100ppm	1.17	1.15	1.01	0.89	0.90	0.82	0.76	0.63	0.92
GA_3 150ppm	1.19	1.21	1.03	0.94	0.87	0.81	0.65	0.67	0.92
Urea 2%	1.00	0.97	0.85	0.87	0.74	0.69	0.54	0.51	0.77
Urea 3%	1.04	1.06	0.97	0.86	0.79	0.77	0.64	0.56	0.84
Urea 4%	1.01	0.99	0.84	0.87	0.73	0.61	0.58	0.53	0.77
Mean	0.99	0.97	0.90	0.85	0.77	0.69	0.58	0.53	
$L.S.D_{0.05}$	Treatment 0.12			Date 0.11			Treatment x Date 0.33		

Table (8): Effect of ethrel, gibberellic acid and urea as chemical thinners on acidity % of Early Grand peach fruits during cold storage at 0°C in 1998 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	0.95	0.97	0.89	0.84	0.77	0.79	0.68	0.52	0.80
Ethrel 25ppm	0.82	0.80	0.74	0.67	0.69	0.65	0.57	0.50	0.68
Ethrel 50ppm	0.78	0.74	0.76	0.64	0.60	0.54	0.49	0.48	0.63
Ethrel 100ppm	0.70	0.69	0.64	0.60	0.50	0.54	0.47	0.43	0.57
GA_3 50ppm	0.97	0.84	0.87	0.74	0.67	0.61	0.52	0.55	0.72
GA_3 100ppm	1.11	0.97	0.84	0.73	0.74	0.69	0.64	0.61	0.79
GA_3 150ppm	1.13	1.07	1.01	0.89	0.74	0.76	0.67	0.65	0.87
Urea 2%	0.92	0.87	0.79	0.81	0.73	0.67	0.57	0.53	0.74
Urea 3%	0.96	0.91	0.87	0.78	0.69	0.61	0.63	0.57	0.75
Urea 4%	0.95	0.89	0.81	0.75	0.76	0.69	0.61	0.55	0.75
Mean	0.93	0.88	0.82	0.75	0.69	0.66	0.59	0.54	
$L.S.D_{0.05}$	Treatment 0.15			Date 0.14			Treatment x Date 0.44		

Table (9): Effect of ethrel, gibberellic acid and urea as chemical thinners on vitamin C (mg/100 ml) content of Early Grand peach fruits during cold storage at 0°C in 1997 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	18.62	16.01	13.21	10.40	8.75	8.55	7.70	7.43	11.33
Ethrel 25ppm	18.90	16.11	13.36	10.69	8.84	8.62	7.61	7.23	11.42
Ethrel 50ppm	18.81	16.50	13.00	10.71	8.79	8.59	7.74	7.21	11.42
Ethrel 100ppm	19.94	16.24	13.14	10.44	8.69	8.55	7.41	7.14	11.44
GA_3 50ppm	18.66	17.11	14.10	10.61	8.71	8.54	7.15	7.10	11.50
GA_3 100ppm	18.87	17.25	14.16	10.78	8.83	8.61	7.45	7.31	11.66
GA_3 150ppm	19.98	18.47	14.81	10.79	9.00	8.89	7.94	7.64	12.19
Urea 2%	18.65	17.14	14.25	9.64	8.70	8.00	7.65	7.21	11.41
Urea 3%	18.72	17.20	14.31	9.67	8.63	8.03	7.51	7.42	11.43
Urea 4%	18.74	17.28	13.39	9.74	8.75	8.70	7.74	7.61	11.48
Mean	18.99	17.04	13.97	10.76	8.81	8.65	7.65	7.38	
$L.S.D_{0.05}$	Treatment 0.28			Date 0.25			Treatment x Date 0.80		

Table (10):Effect of ethrel, gibberellic acid and urea as chemical thinners on vitamin C (mg/100 ml) content of Early Grand peach fruits during cold storage at 0°C in 1998 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	17.49	16.32	14.48	12.22	11.57	9.90	8.43	8.22	12.33

Ethrel 25ppm	18.20	16.54	14.41	11.97	10.91	9.99	8.75	8.18	12.37
Ethrel 50ppm	18.62	16.83	13.77	11.93	10.89	9.89	8.84	8.28	12.38
Ethrel 100ppm	18.70	16.74	13.83	11.91	10.84	9.94	8.88	8.19	12.11
GA_3 50ppm	18.70	17.44	13.80	12.18	11.79	9.95	8.61	8.48	12.62
GA_3 100ppm	18.85	17.59	14.20	12.79	11.94	9.87	8.78	8.50	12.82
GA_3 150ppm	19.10	18.77	14.43	13.01	12.97	9.99	8.82	8.56	13.21
Urea 2%	17.55	16.44	13.54	12.01	11.30	9.60	8.40	8.22	12.13
Urea 3%	17.46	16.43	13.59	12.08	11.37	9.43	8.46	8.24	12.13
Urea 4%	18.20	16.49	13.61	12.05	11.35	9.49	8.49	8.27	12.23
Mean	18.29	16.94	13.89	12.09	11.46	9.79	8.51	8.29	
$L.S.D_{0.05}$	Treatment 0.28			Date 0.24			Treatment x Date 0.78		

Table (11): Effect of ethrel, gibberellic acid and urea as chemical thinners on firmness (pounds/inch^2) of Early Grand peach fruits during cold storage at 0^{o}C in 1997 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	14.31	13.89	12.50	10.99	10.15	8.44	6.41	5.93	10.33
Ethrel 25ppm	13.80	13.12	12.32	10.57	9.64	8.05	5.97	4.25	9.71
Ethrel 50ppm	13.01	12.87	12.15	10.34	9.22	7.68	5.64	4.11	9.38
Ethrel 100ppm	12.89	12.79	11.74	10.05	9.01	7.24	5.18	4.00	9.10
GA_3 50ppm	14.75	14.35	13.64	11.64	10.52	8.45	7.02	6.11	10.81
GA_3 100ppm	16.89	15.75	13.83	11.95	10.94	8.82	7.22	6.63	11.50
GA_3 150ppm	16.01	15.90	14.00	12.46	11.13	8.65	7.43	6.82	11.55
Urea 2%	14.35	14.20	13.44	11.20	10.35	7.97	6.40	5.95	10.48
Urea 3%	14.41	14.11	13.62	11.24	10.52	7.97	6.44	5.92	10.53
Urea 4%	14.66	14.51	13.97	12.00	10.74	8.05	6.63	5.98	10.82
Mean	14.51	14.14	13.12	11.24	10.22	8.13	6.43	5.57	
$L.S.D_{0.05}$	Treatment 0.26			Date 0.23			Treatment x Date 0.73		

Table (12): Effect of ethrel, gibberellic acid and urea as chemical thinners on firmness (pounds/inch^2) of Early Grand peach fruits during cold storage at 0^{o}C in 1998 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	14.16	12.95	11.98	9.85	7.93	7.32	5.90	5.52	9.45
Ethrel 25ppm	13.62	12.64	11.45	8.66	6.83	6.01	4.79	4.39	8.55
Ethrel 50ppm	13.44	12.18	11.11	8.50	6.77	6.14	4.71	4.20	8.38
Ethrel 100ppm	12.20	12.05	10.90	7.97	6.32	5.91	4.28	4.07	7.96
GA_3 50ppm	15.95	15.68	13.63	11.53	8.93	7.60	6.22	5.99	10.69
GA_3 100ppm	15.91	15.80	13.87	11.84	8.95	7.88	6.56	6.43	10.91
GA_3 150ppm	15.98	15.82	13.88	12.11	9.00	8.23	7.15	6.64	11.10
Urea 2%	14.42	13.05	12.11	10.11	8.05	7.05	5.81	5.50	9.51
Urea 3%	14.56	13.10	11.83	10.17	8.11	7.00	5.75	5.65	9.65
Urea 4%	14.50	13.15	11.95	10.19	8.09	7.11	5.77	5.72	9.56
Mean	14.47	13.68	12.27	10.09	7.90	7.03	5.69	5.44	
$L.S.D_{0.05}$	Treatment 0.32			Date 0.28			Treatment x Date 0.90		

`` It is clear from the data in Tables (13 and 14) that fruit firmness reflected the effect of the three chemical thinners applications on the total soluble pectin of Early Grand fruits during storage time. Data indicated that ethrel treatments raised the total soluble pectin during storage in both seasons, but significant differences were found only between the highest ethrel concentration (100 ppm) in 1997 season and the highest two

concentrations (50 and 100 ppm) and control in 1998 season. This finding is remarkable since raising the total soluble pectin content makes the fruit more edible and is a sign of ripening and palatability. These results agree with Sandhu *et al*.(1982), who reported that the total soluble pectin content increased during the storage. This phenomenon can explain the reduction in firmness of the treated fruits over the untreated ones, where more soluble pectin leads to softening the fruits.

Table (13): Effect of ethrel, gibberellic acid and urea as chemical thinners on total soluble pectin percentage of Early Grand peach fruits during cold storage at 0°C in 1997 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	1.57	1.55	1.85	1.96	1.93	2.45	3.04	3.11	2.21
Ethrel 25ppm	1.70	1.72	1.96	2.11	2.09	2.77	3.21	3.36	2.37
Ethrel 50ppm	1.75	1.75	1.91	2.17	2.14	2.74	3.28	3.41	2.39
Ethrel 100ppm	1.74	1.76	1.93	2.24	2.20	2.89	3.44	3.65	2.48
GA_3 50ppm	1.42	1.45	1.64	1.74	1.86	2.05	2.55	2.84	1.94
GA_3 100ppm	1.40	1.42	1.61	1.68	1.79	2.01	2.44	2.74	1.89
GA_3 150ppm	1.37	1.42	1.59	1.71	1.81	1.97	2.46	2.77	1.89
Urea 2%	1.54	1.56	1.78	1.85	1.91	2.33	2.95	3.05	2.12
Urea 3%	1.57	1.58	1.82	1.84	1.90	2.23	3.00	3.09	2.12
Urea 4%	1.59	1.59	1.79	1.87	1.88	2.21	3.07	3.11	2.14
Mean	1.57	1.58	1.79	1.92	1.95	2.37	2.95	3.11	
$L.S.D_{0.05}$	Treatment 0.24			Date 0.22			Treatment x Date 0.69		

Table (14): Effect of ethrel, gibberellic acid and urea as chemical thinners on total soluble pectin percentage of Early Grand peach fruits during cold storage at 0°C in 1998 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	1.51	1.58	1.79	1.91	2.05	2.56	2.99	3.01	2.18
Ethrel 25ppm	1.70	1.74	1.91	2.09	2.24	2.87	3.09	3.18	2.35
Ethrel 50ppm	1.73	1.70	1.94	2/18	2.41	3.18	3.26	3.32	2.47
Ethrel 100ppm	1.80	1.82	2.04	2.25	2.47	3.24	3.37	3.54	2.57
GA_3 50ppm	1.49	1.53	1.71	1.80	1.84	2.19	2.41	2.62	1.95
GA_3 100ppm	1.33	1.36	1.65	1.74	1.78	2.11	2.34	2.59	1.86
GA_3 150ppm	1.29	1.32	1.62	1.65	1.74	2.05	2.29	2.45	1.80
Urea 2%	1.49	1.51	1.79	1.89	2.03	2.56	2.89	2.94	2.14
Urea 3%	1.45	1.53	1.81	1.90	1.96	2.51	2.77	2.98	2.11
Urea 4%	1.45	1.46	1.75	1.87	1.97	2.53	2.81	2.95	2.10
Mean	1.52	1.56	1.80	1.93	2.05	2.58	2.82	2.96	
$L.S.D_{0.05}$	Treatment 0.19			Date 0.17			Treatment x Date 0.44		

Data, also, showed that both GA_3 and urea treatments caused a decrease in total soluble pectin, but significant differences were only found between the three GA_3 treatments and control in both seasons. These results may be attributed to the effect of GA_3 in delaying ripening as confirmed by Sims *et al*.(1974).

In both seasons, total soluble pectin increased with increasing storage period. Non-stored fruits had a significantly lower total soluble pectin

than those stored for different dates, except the first sampling date (3 days) in both seasons. These findings agreed with those found by Sandhu *et al*.(1982).

7. Total phenols :

The results of both seasons (Tables 15 and 16) revealed that total phenols were significantly decreased with the three ethrel applications. There is no tangible evidence to prove the exact mode of action or the physiological pathway through which ethrel accelerates the reduction in total phenols content. The general concept, that could be adopted in this study, is that ethylene enhances all natural processes involved in ripening. Data, also, showed that no significant differences were found between urea applications and the two lower GA_3 concentrations as compared with control. Meanwhile, the highest GA_3 concentration caused significantly higher total phenols fruit content as compared with control. These results may be explained by the action of GA_3 in delaying ripening.

The results of both seasons indicated that total phenols decreased during storage. Significant differences were found between zero time and all sampling dates in both experimental seasons, except for the first sampling date (3 days) and control in 1998 season. These results agreed with those obtained by Paulson *et al*.(1980).

Table (15): Effect of ethrel, gibberellic acid and urea as chemical thinners on total phenols percentage of Early Grand peach fruits during cold storage at 0°C in 1997 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	95	91	85	85	81	79	77	74	83.38
Ethrel 25ppm	85	82	79	76	71	65	63	58	72.38
Ethrel 50ppm	83	81	78	74	70	64	59	55	70.50
Ethrel 100ppm	81	77	74	67	61	57	54	53	65.50
GA_3 50ppm	93	90	87	83	79	80	74	75	82.63
GA_3 100ppm	95	92	90	83	81	81	79	78	84.88
GA_3 150ppm	98	95	92	84	85	81	79	77	86.38
Urea 2%	91	87	86	80	78	79	76	74	81.38
Urea 3%	91	92	86	82	79	76	74	73	81.63
Urea 4%	94	91	87	82	77	75	73	71	81.25
Mean	90.60	87.80	84.40	79.60	76.20	73.70	70.80	68.80	
$L.S.D_{0.05}$	Treatment 2.85			Date 2.55			Treatment x Date 8.06		

Table (16):Effect of ethrel, gibberellic acid and urea as chemical thinners on total phenols percentage of Early Grand peach fruits during cold storage at 0°C in 1998 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	95	90	89	83	79	77	72	70	81.88
Ethrel 25ppm	84	81	77	72	67	64	61	56	70.25
Ethrel 50ppm	83	74	72	71	67	64	59	55	68.13
Ethrel 100ppm	80	74	71	67	64	57	54	50	64.63

GA_3 50ppm	92	90	87	84	79	79	77	76	83.00
GA_3 100ppm	90	89	86	81	79	79	77	76	82.13
GA_3 150ppm	98	94	91	87	84	85	83	79	87.63
Urea 2%	87	86	86	83	79	75	73	71	80.00
Urea 3%	89	85	86	81	79	75	71	70	79.50
Urea 4%	91	89	87	81	80	76	71	70	80.63
Mean	88.90	85.20	83.20	79.00	75.70	73.10	69.80	67.30	
$L.S.D_{0.05}$	Treatment 4.28			Date 3.83			Treatment x Date 17.09		

8. Total chlorophyll, carotene and anthocyanin :

Ethrel is an ethylene generating compound, which accelerates the ripening of all fleshy fruits. The change in colour including destruction of chlorophyll, revelation of pigments previously masked and synthesis of new pigments (Murphy and Dilley, 1988). Data in Tables (17 and 18) showed that, in both seasons, total chlorophyll significantly decreased by ethrel treatments, except for the lowest concentration (25 ppm) as compared with control in the second experimental season. These results agreed with those reported by Mussini *et al*.(1985) working on different apple varieties.

Data, also, showed that GA_3 treatments caused higher total chlorophyll fruit contents as compared with control, but the increase was not big enough to be significant in both experimental seasons. These results agreed with those reported by Meheriuk *et al*.(1996). These results may be explained by the effect of GA_3 in delaying maturation and destruction of chlorophyll.

In both seasons, total chlorophyll was significantly increased by increasing the three urea applications, except for the lowest concentration (2%) in the second season. These results agreed with those reported by Meheriuk *et al*.(1996), who found that urea-treated apples were greener in most instances than comparable untreated apples after a storage period of 120 days at 0ºC.

Data in Tables (17 and 18), also, showed that, in both seasons, total chlorophyll gradually decreased in Early Grand peach fruits with increasing storage period. Significant differences were found from the third sampling date (9 days) in 1997 season (Table 17) and from the fourth sampling date (12 days) in 1998 season (Table 18) till the end of the sampling dates as compared with the zero time. These findings agreed with those found by Mussini *et al*.(1985) and Knee and Smith (1989) working on different apple varieties.

Table (17):Effect of ethrel, gibberellic acid and urea as chemical thinners on total chlorophyll (mg/100g fresh weight) of Early Grand peach fruits during cold storage at 0ºC in 1997 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	7.30	7.40	7.71	7.71	6.74	6.70	6.31	6.41	7.04
Ethrel 25ppm	6.60	6.81	6.63	5.90	6.21	5.61	5.71	5.70	6.14
Ethrel 50ppm	6.30	6.64	6.50	6.41	5.47	5.33	5.31	5.20	5.90

Ethrel 100ppm	6.10	5.36	5.39	5.25	5.14	5.11	5.11	5.00	5.31
GA_3 50ppm	7.50	7.51	7.54	7.34	7.32	6.69	6.68	6.66	7.16
GA_3 100ppm	7.60	7.53	7.55	7.43	7.41	7.52	6.38	6.49	7.24
GA_3 150ppm	7.80	7.69	7.54	7.55	7.42	7.52	6.69	5.70	7.24
Urea 2%	8.20	7.68	7.65	7.46	7.53	7.43	7.61	5.59	7.52
Urea 3%	8.30	7.69	7.63	7.54	7.51	7.41	7.52	6.47	7.51
Urea 4%	8.30	7.69	7.55	7.47	7.51	7.39	7.33	7.41	7.58
Mean	7.40	7.20	7.17	7.01	6.82	6.67	6.47	6.16	
$L.S.D_{0.05}$	Treatment 0.36			Date 0.32			Treatment x Date 1.03		

Table (18):Effect of ethrel, gibberellic acid and urea as chemical thinners on total chlorophyll (mg/100g fresh weight) of Early Grand peach fruits during cold storage at 0ºC in 1998 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	7.00	6.69	6.54	6.60	6.31	6.42	6.10	6.07	6.47
Ethrel 25ppm	6.40	6.61	6.41	5.57	5.42	5.33	5.11	5.00	5.73
Ethrel 50ppm	6.10	5.55	6.55	5.56	5.11	5.03	5.08	5.01	5.50
Ethrel 100ppm	5.90	5.87	5.57	5.44	5.53	4.49	5.51	4.37	5.34
GA_3 50ppm	7.40	7.52	7.45	6.59	6.46	6.53	6.33	6.24	6.82
GA_3 100ppm	7.30	7.41	6.69	6.55	6.43	6.44	6.22	6.14	6.65
GA_3 150ppm	7.60	7.07	7.53	7.51	6.58	6.66	6.34	6.26	6.92
Urea 2%	7.90	7.56	7.53	7.78	7.40	6.36	6.37	6.29	7.15
Urea 3%	8.70	7.69	7.57	7.50	7.43	6.40	6.37	6.31	7.17
Urea 4%	8.00	8.30	7.66	7.57	7.47	7.33	6.29	6.28	7.36
Mean	7.17	7.03	6.95	6.67	6.42	6.08	5.97	5.80	
$L.S.D_{0.05}$	Treatment 0.77			Date 0.69			Treatment x Date 2.17		

It was evident from the data presented in Tables (19, 20, 21 and 22) that the ethrel greatly improved colouration of Early Grand peach fruits in both experimental seasons. All ethrel applications caused a significant increase in both fruit carotene and anthocyanin in comparison with the control. These results are in agreement with those reported by Rabeh and Allam (1988) working on peach fruits.

As for the effect of different applications of GA_3 and urea, data of both experimental seasons showed no significant differences with control (Tables 19, 20, 21 and 22). These results are confirmed by Casper and Taylor (1989) and Byers (1990) when peach trees were sprayed with GA_3 and by Zilakh *et al*.(1988) and Abdel-Hamid (1999) with urea.

Table (19):Effect of ethrel, gibberellic acid and urea as chemical thinners on carotene (mg/100g fresh weight) of Early Grand peach fruits during cold storage at 0ºC in 1997 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	2.80	3.11	3.15	4.01	3.83	4.53	4.81	5.31	3.94
Ethrel 25ppm	3.30	3.22	3.72	4.31	5.11	5.91	5.73	6.11	4.68
Ethrel 50ppm	3.80	4.31	5.11	5.83	6.33	6.61	7.71	7.93	5.95
Ethrel 100ppm	4.00	4.61	5.91	6.53	7.91	7.82	8.13	8.43	6.67
GA_3 50ppm	3.00	2.81	3.31	4.53	3.93	4.81	5.41	5.31	4.14

GA_3 100ppm	2.70	3.11	2.91	3.31	3.93	4.48	4.37	5.50	3.79
GA_3 150ppm	2.80	3.01	3.33	3.36	4.42	4.45	4.49	4.48	3.79
Urea 2%	3.10	2.91	3.34	3.38	4.43	4.71	5.10	5.10	4.01
Urea 3%	2.80	3.10	3.20	3.41	4.22	4.61	4.43	4.81	3.82
Urea 4%	2.70	3.11	3.05	4.11	4.51	4.12	4.31	4.73	3.83
Mean	3.10	3.33	3.70	4.28	4.86	5.21	5.45	5.77	
$L.S.D_{0.05}$	Treatment 0.64			Date 0.58			Treatment x Date 1.82		

Table (20): Effect of ethrel, gibberellic acid and urea as chemical thinners on carotene (mg/100g fresh weight) of Early Grand peach fruits during cold storage at 0°C in 1998 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	2.50	2.91	3.81	3.61	4.21	4.71	5.13	4.90	3.97
Ethrel 25ppm	3.10	3.41	3.93	4.83	5.11	6.53	6.31	7.21	5.05
Ethrel 50ppm	3.70	4.53	5.81	5.73	7.43	7.11	7.33	8.43	6.26
Ethrel 100ppm	3.90	4.41	6.53	6.31	7.93	7.63	8.91	8.61	6.78
GA_3 50ppm	2.70	3.11	2.91	3.31	3.83	4.41	4.83	4.63	3.72
GA_3 100ppm	3.00	3.34	3.51	4.13	4.53	4.32	4.61	4.81	4.03
GA_3 150ppm	2.90	3.91	3.21	4.63	4.41	4.51	4.43	4.71	4.09
Urea 2%	2.70	2.94	3.51	3.21	4.71	5.31	4.91	5.11	4.05
Urea 3%	3.00	3.31	4.01	4.53	4.32	5.12	5.00	5.31	4.33
Urea 4%	3.00	3.51	3.73	4.03	3.81	4.71	4.51	4.91	4.03
Mean	3.05	3.54	4.10	4.43	5.03	5.44	5.60	5.86	
$L.S.D_{0.05}$	Treatment 0.80			Date 0.71			Treatment x Date 2.25		

Table (21): Effect of ethrel, gibberellic acid and urea as chemical thinners on anthocyanin (mg/100g fresh weight) of Early Grand peach fruits during cold storage at 0°C in 1997 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	14.21	15.21	15.75	16.11	17.21	18.05	17.79	18.27	16.58
Ethrel 25ppm	16.80	16.46	18.95	18.41	21.74	22.39	22.99	22.79	20.07
Ethrel 50ppm	16.74	16.91	19.11	19.79	21.96	22.99	24.27	24.11	20.74
Ethrel 100ppm	17.31	17.23	19.78	19.91	22.51	23.07	24.93	23.77	21.06
GA_3 50ppm	14.17	14.05	14.69	16.71	16.31	18.73	19.51	19.36	16.69
GA_3 100ppm	14.16	14.15	14.51	16.09	16.14	16.46	17.79	17.56	15.86
GA_3 150ppm	14.11	14.19	14.26	15.51	15.25	16.59	16.71	17.19	15.48
Urea 2%	13.96	14.04	14.21	15.65	15.59	16.61	17.24	17.22	15.57
Urea 3%	14.09	14.14	14.26	14.71	15.21	15.16	16.34	17.29	15.15
Urea 4%	14.17	14.11	14.23	14.79	14.94	14.84	15.79	17.01	14.99
Mean	14.97	15.05	15.98	16.74	17.69	18.49	19.34	19.46	
$L.S.D_{0.05}$	Treatment 3.08			Date 2.76			Treatment x Date 4.45		

Table (22): Effect of ethrel, gibberellic acid and urea as chemical thinners on anthocyanin (mg/100g fresh weight) of Early Grand peach fruits during cold storage at 0°C in 1998 season.

Treatments	Storage period (days)								Mean
	0	3	6	9	12	15	18	21	
Control	13.38	13.97	15.24	15.98	17.84	17.76	18.94	18.47	16.45
Ethrel 25ppm	15.11	15.89	17.97	18.74	20.71	20.66	21.47	22.88	19.18
Ethrel 50ppm	16.04	16.24	18.91	20.11	22.17	21.68	22.63	24.31	20.26
Ethrel 100ppm	16.32	16.29	18.84	22.36	23.07	22.87	24.25	24.98	21.12
GA_3 50ppm	13.73	13.61	13.91	14.94	15.21	18.71	19.36	20.01	16.19

GA_3 100ppm	13.89	13.35	14.11	14.61	15.03	16.14	17.93	18.67	15.41
GA_3 150ppm	13.96	13.51	14.02	14.49	15.19	16.21	18.23	18.19	15.44
Urea 2%	13.65	13.71	13.99	15.01	16.91	17.38	17.18	18.07	15.74
Urea 3%	13.72	13.79	14.09	14.81	15.73	17.42	17.11	17.54	15.53
Urea 4%	14.22	14.19	14.61	14.81	15.60	17.37	17.21	17.34	15.67
Mean	14.40	14.46	15.57	16.59	17.75	18.62	19.43	20.05	
$L.S.D_{0.05}$	Treatment 2.46			Date 2.20			Treatment x Date 3.49		

Data, also, revealed that, through the storage period of both experimental seasons, there was a gradual increase in both carotene levels and anthocyanin of peach fruits (Tables 19, 20, 21 and 22). For the carotene, significant differences were found between all sampling dates and zero time, except for the first sampling date (3 days) as compared with control in both seasons (Tables 19 and 20). As for the anthocyanin, significant differences were found between the last three sampling dates (15, 18 and 21 days) in 1997 and the last four sampling dates (12, 15, 18 and 21 days) in 1998 season as compared with control (Tables 21 and 22). These results were confirmed by Rabeh and Allam (1988), who pointed out that yellowing and red colouration of the peach fruit appeared to be caused by chlorophyll degradation rather than by changes in carotenoid and anthocyanin levels.

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إستجابة ثمار الخوخ صنف إيرلى جراند للخف بالإيثريل وحمض الجبرليك واليوريا:
2- قابلية الثمار للتخزين

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بينت نتائج الدراسة فى عامى 1997، 1998 أن زيادة فترة تخزين ثمار خوخ صنف أيرلى جراند أدت إلى زيادة واضحة فى نسبة الفقد فى الوزن، ونسبة الثمار المصابة بالعفن والمواد

الصلبة الذائبة الكلية والبكتين الكلى الذائب والكاروتين والأنثيوسياسين، بينما قللت من حموضة العصير، وفيتامين ج والفينولات الكلية والكلورفيل الكلى وصلابة الثمار.

وقد أدت معاملة الإيثريل لخف الثمار إلى زيادة فى نسبة معدل الفقد فى وزن الثمار ونسبة الثمار المصابة بالعفن والمواد الصلبة الذائبة الكلية والبكتين الكلى الذائب والكاروتين والأنثيوسياسين وقللت من حموضة العصير وصلابة الثمار والفينولات الكلية والكلوروفيل الكلى.

ومن ناحية أخرى فإن معاملتى الخف بحمض الجبريليك واليوريا سببتا نقصاً بسيطاً فى معدل الفقد فى وزن الثمار ونسبة الثمار المصابة بالعفن. ولم تعط إتجاهاً محدداً بالنسبة للتأثير على حموضة العصير بينما زادت من الكلورفيل. ولم تؤثر هاتين المعاملتين على الفينولات الكلية والكاروتين والانثوسيانين خلال فترة التخزين