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RESPONSE OF PAIRI MANGO TREES TO POTASSIUM AND PHENYLALANINE FOLIAR APPLICATIONS: II. STORABILITY

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ABSTRACT

The present study of 1997 and 1998 seasons was conducted to investigate the influence of preharvest potassium and phenylalanine foliar sprays on Pairi mango fruit characteristics during cold storage at 10°C and relative humidity of 85-90%.

Results indicated that potassium and phenylalanine treatments caused a reduction in weight loss, while the percentage of fruit decay and fruit firmness, generally, were not affected by all treatments. In the meantime, all treatments caused an increase in total soluble solids, sugar fractions and reduction in fruit starch.

Results, also, revealed that potassium treatments increased juice acidity, while phenylalanine fioliar application alone did not influence juice acidity during the cold storage.

In both years of study, results revealed that both potassium and phenylalanine caused a decrease in peel total chlorophyll and general increase in both carotene and anthocyanine.

Regarding the effect of storage time, results showed an increase in the percentage of weight loss, fruit decay, total soluble solids, sugar fractions and carotene and anthocyanin. On the contrary, reduction in fruit starch content, juice acidity and destruction in peel chlorophyll occurred as the storage period advanced.

INTRODUCTION

In the past four decades, mangoes were little known to consumers outside the tropics and there was virtually no international trade involving fresh fruit. In the interviewing years, mangoes have become well established as fresh fruit and processed production in world markets in North America, Japan and Europe (Galan, 1993).

Egypt produces a large good quality mango crop. Moreover, its location near both European and Arabian markets gives promise for exporting agricultural commodities.

Pairi cultivar is one of the coloured cultivars grown in Egypt. It is yellow with a red blush, orange fleshed, sweet, rich in flavour, fiberless with firm texture, high quality and small seed (Litz, 1997), which make it acceptable in local as well as foreign markets.

Potassium is perhaps one of the most important minerals for enhancing colour and improving fruit quality (Marschner, 1986).

Sedletskii *et al*. (1988) and Ezz (1994) found that the application of the amino acid phenylalanine to grapevines as foliar spray stimulated the development of red pigmentation as well as other fruit quality parameters.

Nowadays, there is much interest in the storage and transportation of mango fruit. The use of low temperature storage has been involved in an attempt to prolong storage life.

Therefore, this study was carried out during the two successive

seasons of 1997 and 1998, in order to study the effect of preharvest potassium and phenylalanine foliar applications on enhancing colour, improving quality and extending the storage period at 10°C of mangoes cv. Pairi.

MATERIALS AND METHODS

This study was carried out during two successive seasons of 1997 and 1998, on mango trees (*Mangifera indica* L.) cv. Pairi, about 16 years old grown in private orchard in the Alex.-Cairo highway, where the soil is sandy with pH 7.2 and 8.0% $CaCO_3$, using drip irrigation system. The trees were as uniform as possible, planted at 7x7 meters. All trees received ammonium sulphate and potassium sulphate at a rate of 900 g N and 440 g K_2O / tree / year. Phosphoric acid at a rate of 45 L was annually added per feddan in several additions each not exceeding 50 ppm in irrigation water. Irrigation was provided at 1 L/4 hr daily during each growing season through two trickle irrigation emitters per tree, located within 30 cm of the tree.

In both experimental seasons, the trees were sprayed three times at March, May and July with water (control), 1, 2 and 3% of potassium sulphate (K_2O) or 15, 30 and 45 ppm phenylalanine. Each tree received 7 liters of the spray solution which was enough to fully wet all leaves to the runoff stage.

Each plot included one tree and each treatment was replicated four times in a randomized block design.

At harvest, on the first week of August when the fruits reached the mature stage (when the fruit shoulders are filled and at the beginning of colouration) in both experimental seasons, fruits of each replicate were collected and subjected to the following prestorage preparations:

- Defective fruits due to mechanical or pathological or any other 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 open plastic boxes.
- In each box of all treatments, the initial weight of 40 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 10°C and relative humidity of 85-90% in a cold storage room.
- Fruits were kept as long as they were marketable and the percentage of decay less than 50% in all treatments, including the control.
- Fruits of each treatment were replicated in four replicates each replicate consisted of two boxes each box (60x40x18 cm) contained 24 mature fruits packed in one single layer.

During storage period, samples of five fruits were taken from each replicate on time scale of 0, 5, 10, 15, 20, 25 and 30 days from storage.

Decay percentage (either pathological or physiological) of fruit was also recorded during storage period in both experimental seasons. Moreover, the following determinations were made:

- 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 citric acid and vitamin C content was determined using 2,6-dichlorophenol indophenol dye (A.O.A.C., 1980).
- The reducing sugars were determined by Nelson method as illustrated by Malik and Singh (1980). The total soluble sugars were determined after hydrolysis with hydrochloric acid and the non-reducing sugars were calculated by the difference between the total soluble sugars and reducing sugars.
- The starch was determined in 0.1 gram of the residual by hydrolysis using concentrated HCl for three hours under reflux condenser (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).

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 percentage :

Results in Table (1) showed a reduction in weight loss due to potassium and phenylalanine treatments, but significant decrease was only found due to the highest potassium application (3%) in both 1997 and 1998 seasons. Chattopadhyay (1989), working on mango, reported that potassium treatments reduced the percentage of physiological fruit weight loss during storage.

Regarding the effect of storage period on the changes in fruit weight loss (Table 1), data of both experimental seasons indicated that the average fruit weight loss gradually increased with storage time. Significant differences were only found between the first sampling date (after 5 days of storage) and the last three sampling dates in 1997 season and the last four sampling dates in 1998 season. In accordance with these results are those previously reported by Salinas and Lakshminarayana (1985), who worked on different mango varieties, and reported that fruit weight loss increased with storage period.

2. Decay percentage :

It appears from Table (2) that, in both seasons, no significant differences were found between all treatments in the percentage of decay of fruit during storage.

Table (1):Effect of potassium and phenylalanine foliar applications on weight loss percentage of Pairi mango fruit during cold storage at 10°C for both 1997 and 1998 seasons.

Treatment	Storage period (days)							Mean
	0	5	10	15	20	25	30	
1997 season								
Control	-	0.976	1.874	1.974	3.341	4.681	6.799	3.274
K_2O, 1%	-	0.915	1.159	1.263	2.976	3.617	5.301	2.538
K_2O, 2%	-	0.886	1.121	1.241	2.841	3.341	5.210	2.440
K_2O, 3%	-	0.854	0.949	1.031	2.806	3.109	5.017	2.294
φ alanine, 15 ppm	-	0.933	1.279	1.461	3.119	4.461	6.271	2.921
φ alanine, 30 ppm	-	0.908	1.241	1.459	3.079	4.394	6.254	2.889
φ alanine, 45 ppm	-	0.901	1.245	1.464	3.096	4.439	6.311	2.909
Mean	-	0.910	1.269	1.409	3.037	4.006	5.880	
$L.S.D_{0.05}$	Treatment 0.930			Date 0.890		Treatment x Date 2.280		
1998 season								
Control	-	1.129	1.969	3.461	5.690	6.711	7.231	4.365
K_2O, 1%	-	1.031	1.841	3.173	5.541	6.422	6.491	4.083
K_2O, 2%	-	0.991	1.643	2.041	4.328	6.131	6.211	3.558
K_2O, 3%	-	0.969	1.611	2.032	4.176	5.684	6.015	3.414
φ alanine, 15 ppm	-	1.094	1.746	2.641	4.931	6.543	6.874	3.971
φ alanine, 30 ppm	-	1.106	1.735	2.511	4.776	6.601	6.667	3.899
φ alanine, 45 ppm	-	1.099	1.748	2.501	4.871	6.581	6.789	3.931
Mean	-	1.060	1.756	2.623	4.902	6.382	6.611	
$L.S.D_{0.05}$	Treatment 0.928			Date 0.870		Treatment x Date 2.262		

Table (2): Effect of potassium and phenylalanine foliar applications on decay percentage of Pairi mango fruit during cold storage at 10°C for both 1997 and 1998 seasons.

Treatment	Storage period (days)							Mean
	0	5	10	15	20	25	30	
1997 season								
Control	-	-	1.08	2.19	4.93	6.17	6.10	4.09
K_2O, 1%	-	-	1.03	2.17	4.71	5.96	6.01	3.99
K_2O, 2%	-	-	1.10	2.18	4.86	6.06	6.09	4.06
K_2O, 3%	-	-	0.97	2.16	4.79	5.99	6.11	4.01
φ alanine, 15 ppm	-	-	1.05	2.17	4.83	6.03	6.09	4.03
φ alanine, 30 ppm	-	-	0.99	2.12	4.75	6.05	6.10	4.00
φ alanine, 45 ppm	-	-	1.04	2.16	4.81	5.99	6.06	4.03
Mean	-	-	1.02	2.16	4.82	6.04	6.06	
$L.S.D_{0.05}$	Treatment N.S			Date 0.72		Treatment x Date 1.63		
1998 season								
Control	-	-	1.06	2.21	5.09	6.28	6.34	4.20
K_2O, 1%	-	-	1.10	2.25	4.97	6.31	6.33	4.19
K_2O, 2%	-	-	1.09	2.23	4.93	6.27	6.35	4.17
K_2O, 3%	-	-	1.07	2.30	5.07	6.34	6.37	4.23
φ alanine, 15 ppm	-	-	1.11	2.25	4.99	6.31	6.37	4.20
φ alanine, 30 ppm	-	-	1.09	2.28	5.15	6.29	6.34	4.21
φ alanine, 45 ppm	-	-	1.08	2.27	5.11	6.27	6.36	4.21
Mean	-	-	1.09	2.26	5.04	6.30	6.35	
$L.S.D_{0.05}$	Treatment N.S			Date 0.89		Treatment x Date 2.14		

Regarding the effect of storage period on the percentage of Pairi mango fruit decay, the data of both experimental seasons indicated that the percentage of fruit decay was significantly increased by increasing the

storage period, except between the last two sampling dates after 25 and 30 days in storage for 1997 and 1998 seasons, respectively. These results agreed with those obtained by Medlicott *et al*.(1986).

3. Total chlorophyll, carotene and anthocyanin in fruit peel:

Data of Table (3) revealed that, in both seasons, spraying trees with both potassium and phenylalanine caused decrease in peel total chlorophyll. Significant differences were found between the highest potassium treatment of 3% K_2O and the treatments of phenylalanine at 30 and 45 ppm as compared with control (untreated trees). This may be attributed to the effect of potassium and phenylalanine in enhancing colour by destruction of chlorophyll.

Table (3): Effect of potassium and phenylalanine foliar applications on peel chlorophyll content (mg/100 g fresh weight) of Pairi mango fruit during cold storage at 10°C for both 1997 and 1998 seasons.

Treatment	Storage period (days)							Mean
	0	5	10	15	20	25	30	
1997 season								
Control	19.46	19.51	19.01	18.45	18.65	17.86	16.11	18.44
K_2O, 1%	18.11	18.01	17.54	17.28	16.91	16.44	15.96	17.18
K_2O, 2%	16.91	16.67	16.27	16.36	16.12	16.21	15.91	16.35
K_2O, 3%	16.03	15.81	15.05	14.68	14.71	13.89	13.94	14.87
φ alanine, 15 ppm	17.93	17.89	17.13	17.24	16.91	15.59	15.41	16.87
φ alanine, 30 ppm	15.49	15.04	14.81	14.32	13.64	13.26	12.34	14.13
φ alanine, 45 ppm	15.31	14.97	14.64	14.11	13.22	13.01	12.11	13.91
Mean	17.03	16.84	16.35	16.06	15.74	15.18	14.54	
$L.S.D_{0.05}$	Treatment 2.21			Date 2.21		Treatment x Date 5.85		
1998 season								
Control	18.27	18.29	17.97	17.59	17.01	16.35	16.00	17.35
K_2O, 1%	18.01	18.08	17.51	17.23	16.91	16.24	15.84	17.12
K_2O, 2%	16.31	16.11	15.98	15.71	15.18	14.31	14.07	15.38
K_2O, 3%	16.05	15.32	15.01	14.78	14.61	13.89	13.72	14.77
φ alanine, 15 ppm	17.11	17.15	16.41	15.74	15.26	14.11	13.67	15.64
φ alanine, 30 ppm	15.44	15.05	14.71	14.35	14.28	12.21	12.25	14.04
φ alanine, 45 ppm	15.19	15.24	14.44	14.29	13.78	12.18	12.03	13.88
Mean	16.63	16.46	16.00	15.67	15.29	14.18	13.94	
$L.S.D_{0.05}$	Treatment 2.00			Date 2.00		Treatment x Date 5.19		

It was evidenced from the data presented in Tables (3, 4 and 5) that all treatments greatly improved colouration of Pairi mango fruit. In 1997 and 1998 seasons, potassium treatments increased both carotenoids and anthocyanin. Significant differences were only found in fruits that were sprayed with K_2O at 3% in both seasons. These results agreed with those reported by Marschner (1986) who found that potassium is a promising element in improving and enhsancing mango fruit colour.

As for the effect of phenylalanine foliar applications, results showed that the treatments of 30 and 45 ppm caused an increase in carotene content in 1997 season and the three concentrations (15, 30 and 45 ppm)caused an increase in the second season, but differences were not big enough to be

significant in both seasons (Table 4).

As for the changes of carotenoids during storage, the results given in Table (4) showed that fruit carotenoids content tended to increase progressively as the storage period advanced. In both seasons, unstored fruit (zero time) and those stored for 5 and 10 days had significantly lower carotenoids content compared with the other storage periods. This foundation might gain support from the work done by Salinas and Lakshminarayana (1985), who found that pulp carotenoids content tended to increase in the fruit during ripening in storage.

Table (4): Effect of potassium and phenylalanine foliar applications on peel carotene content (mg/100 g fresh weight) of Pairi mango fruit during cold storage at 10°C for both 1997 and 1998 seasons.

Treatment	Storage period (days)							Mean
	0	5	10	15	20	25	30	
1997 season								
Control	1.23	1.27	1.44	1.58	1.84	2.03	2.14	1.65
K_2O, 1%	1.39	1.35	1.46	1.63	1.87	2.07	2.15	1.70
K_2O, 2%	1.43	1.41	1.50	1.66	1.89	2.11	2.08	1.73
K_2O, 3%	1.47	1.47	1.53	1.69	2.09	2.21	2.24	1.81
φ alanine, 15 ppm	1.31	1.28	1.37	1.59	1.84	1.93	2.06	1.63
φ alanine, 30 ppm	1.35	1.33	1.46	1.64	1.82	2.09	2.15	1.69
φ alanine, 45 ppm	1.37	1.38	1.47	1.67	1.87	2.11	2.20	1.72
Mean	1.36	1.36	1.46	1.59	1.89	2.08	2.15	
$L.S.D_{0.05}$	Treatment 0.13			Date 0.13			Treatment x Date 0.33	
1998 season								
Control	1.39	1.35	1.48	1.64	1.81	1.93	2.21	1.69
K_2O, 1%	1.41	1.39	1.56	1.67	1.84	1.96	2.24	1.72
K_2O, 2%	1.43	1.44	1.60	1.73	1.89	1.94	2.27	1.76
K_2O, 3%	1.52	1.50	1.78	1.84	2.09	2.19	2.33	1.89
φ alanine, 15 ppm	1.41	1.44	1.52	1.66	1.83	2.03	2.25	1.73
φ alanine, 30 ppm	1.43	1.46	1.53	1.71	1.90	2.00	2.28	1.76
φ alanine, 45 ppm	1.46	1.44	1.59	1.76	1.94	2.05	2.29	1.79
Mean	1.44	1.43	1.58	1.72	1.90	2.01	2.27	
$L.S.D_{0.05}$	Treatment 0.14			Date 0.14			Treatment x Date 0.38	

The data concerning the effect of different potassium and phenylalanine treatments on fruit peel anthocyanin content of Pairi mango trees are listed in Table (5). The present results revealed that, in both seasons, spraying trees with the experimental applications caused an increase in fruit peel anthocyanin. Significant differences were found between the highest potassium concentration (3%) and the control in both seasons of study. These results agreed with those reported by Medlicott *et al*.(1986) working on mango fruits. In addition, results of 1997 and 1998 seasons showed that the phenylalanine treatments (15, 30 and 45 ppm) significantly increased peel anthocyanin as compared with control. These results were in line with those of Sedletskii *et al*.(1988) and Ezz (1994) working on grapes.

The biosynthesis of anthocyanin is believed to operate through the shicimic acid pathway (Malik and Srivastava, 1982). The initial step in this

pathway is the deamination of phenylalanine to trans-cinamic acid by the induced enzyme system phenylalanine ammonia-lyase (PAL). The presence of PAL enzyme system in mango has been identified by Medlicott *et al*.(1986). Thus, the increase in anthocyanine content of mango fruit skin as a response of phenylalanines treatments is expected.

Regarding the effect of the storage period on the changes in anthocyanin, the data of both experimental seasons, generally, indicated that the concentrations of peel anthocyanin tended to increase progressively as the storage period advanced (Table 5). Significant differences were only found between the last two sampling dates (25 and 30 days) as compared with the control (zero time) in both seasons. These results are in agreement with those reported by Rabeh and Allam (1988) working on peach fruits.

Table (5): Effect of potassium and phenylalanine foliar applications on peel anthocyanin content (mg/100 g fresh weight) of Pairi mango fruit during cold storage at 10°C for both 1997 and 1998 seasons.

Treatment	Storage period (days)							Mean
	0	5	10	15	20	25	30	
1997 season								
Control	3.15	3.37	3.51	4.16	4.37	4.87	4.85	4.04
K_2O, 1%	3.81	3.90	4.11	4.24	4.49	4.83	4.91	4.33
K_2O, 2%	4.11	4.08	4.27	4.53	4.71	4.96	5.01	4.52
K_2O, 3%	4.67	4.73	4.80	5.09	5.87	6.64	6.87	5.52
φ alanine, 15 ppm	4.84	4.91	4.86	5.15	6.34	6.71	6.95	5.68
φ alanine, 30 ppm	5.14	5.09	5.26	5.79	6.60	6.88	7.05	5.97
φ alanine, 45 ppm	5.33	5.29	5.56	6.64	6.83	7.00	7.07	6.25
Mean	4.44	4.48	4.62	5.09	5.60	5.98	6.10	
$L.S.D_{0.05}$	Treatment 1.44			Date 1.44		Treatment x Date 3.25		
1998 season								
Control	3.22	3.28	3.49	3.61	4.12	4.29	4.51	3.79
K_2O, 1%	3.93	4.01	4.31	4.59	4.61	4.64	4.73	4.40
K_2O, 2%	4.07	4.25	4.46	4.73	4.91	5.11	5.29	4.69
K_2O, 3%	4.84	4.91	5.07	5.47	6.11	6.31	6.53	5.61
φ alanine, 15 ppm	4.17	4.44	4.61	4.86	5.11	5.31	5.54	4.86
φ alanine, 30 ppm	4.86	4.81	5.36	5.87	6.47	6.59	6.74	5.81
φ alanine, 45 ppm	5.21	5.17	5.62	6.69	6.71	6.86	6.93	6.17
Mean	4.33	4.41	4.70	5.12	5.43	5.59	5.75	
$L.S.D_{0.05}$	Treatment 1.11			Date 1.11		Treatment x Date 2.92		

4. Carbohydrate fractions :

Results (Tables 6, 7 and 8) showed that the higher two potassium concentrations (2 and 3%) in the first season and the higher one (3%) in the second season caused a significant increase in reducing, non-reducing and total sugars.

As for the effect of phenylalanine foliar treatments (15, 30 and 45 ppm) on the fruit reducing, non-reducing and total sugars content, results showed significant differences between the three foliar treatments and the control in 1997 and 1998 seasons, except for the non-reducing and total sugars for the first concentration (15 ppm) in 1998 season. The increase in sugar fractions might be explained on the basis of the high conversion of

starch to sugars and non-reducing sugars to reducing sugars (glucose and fructose). The present results might be in accordance with those reported by Sedletskii *et al*.(1988) and Ezz (1994), who found that foliar application of phenylalanine increased sugar content in grapes.

The present results (Table 9) indicated that, in both experimental seasons, fruit starch content decreased with all foliar treatments either with potassium or phenylalanine. Significant differences were found in the higher two potassium concentrations (2 and 3%) in 1997 season and the highest potassium foliar application in 1998 season as compared with the control.

As for the phenylalanine, treatments 15, 30 and 45 ppm caused a significant decrease as compared with untreated fruits (control) in both seasons of study.

It is clear from the data in Tables (6, 7 and 8) that the decrease in fruit starch might reflect in part the increase in sugar fractions (reducing, non-reducing and total sugars). Potassium treatments increased mangoes sugar content as reported by Marschner (1986) and Malhi *et al*.(1988), as well as phenylalanine effect in increasing grapes sugar content (Sedletskii, 1988 and Ezz, 1994).

Table (6): Effect of potassium and phenylalanine foliar applications on reducing sugars percentage of Pairi mango fruit during cold storage at 10°C for both 1997 and 1998 seasons.

Treatment	Storage period (days)							Mean
	0	5	10	15	20	25	30	
1997 season								
Control	0.261	0.279	0.379	0.611	0.871	0.935	1.269	0.658
K_2O, 1%	0.264	0.291	0.374	0.785	0.827	1.174	1.276	0.713
K_2O, 2%	0.371	0.395	0.431	0.846	1.033	1.213	1.661	0.850
K_2O, 3%	0.515	0.593	0.841	1.051	1.083	1.361	1.773	1.031
φ alanine, 15 ppm	0.296	0.311	0.591	1.145	1.198	1.430	1.699	0.953
φ alanine, 30 ppm	0.497	0.553	0.898	1.019	1.136	1.641	1.769	1.073
φ alanine, 45 ppm	0.581	0.624	0.753	1.115	1.274	1.689	1.861	1.128
Mean	0.398	0.435	0.610	0.939	1.060	1.349	1.615	
$L.S.D_{0.05}$	Treatment 0.123			Date 0.123		Treatment x Date 0.325		
1998 season								
Control	0.249	0.311	0.527	0.787	1.047	1.061	1.094	0.725
K_2O, 1%	0.251	0.318	0.532	0.799	1.051	1.071	1.126	0.735
K_2O, 2%	0.299	0.321	0.750	0.811	1.094	1.135	1.148	0.794
K_2O, 3%	0.496	0.506	0.611	0.989	1.233	1.295	1.311	0.920
φ alanine, 15 ppm	0.269	0.341	0.587	1.051	1.271	1.301	1.346	0.881
φ alanine, 30 ppm	0.347	0.511	0.887	1.311	1.412	1.631	1.691	1.129
φ alanine, 45 ppm	0.587	0.819	1.371	1.516	1.649	1.715	1.751	1.349
Mean	0.357	0.447	0.768	1.038	1.251	1.316	1.352	
$L.S.D_{0.05}$	Treatment 0.104			Date 0.104		Treatment x Date 0.277		

Table (7): Effect of potassium and phenylalanine foliar applications on non-reducing sugars percentage of Pairi mango fruit during cold storage at 10°C for both 1997 and 1998 seasons.

Treatment	Storage period (days)							Mean
	0	5	10	15	20	25	30	
1997 season								
Control	5.79	5.74	5.81	6.11	7.76	8.81	9.17	7.03
K_2O, 1%	5.93	5.90	5.97	6.35	7.81	8.94	9.21	7.16

K_2O, 2%	6.15	6.12	6.08	6.81	7.89	9.31	9.79	7.45
K_2O, 3%	6.28	6.24	6.15	6.99	8.34	9.76	9.93	7.67
φ alanine, 15 ppm	6.04	6.01	6.41	6.97	8.71	9.84	9.95	7.70
φ alanine, 30 ppm	6.41	6.32	6.59	6.99	8.84	9.92	9.97	7.86
φ alanine, 45 ppm	6.64	6.74	6.78	7.05	8.91	9.94	9.99	8.01
Mean	6.18	6.15	6.26	6.75	8.32	9.50	9.72	
$L.S.D_{0.05}$	Treatment 0.38			Date 0.38		Treatment x Date 1.00		
1998 season								
Control	5.51	5.47	5.86	6.25	7.59	8.43	9.04	6.88
K_2O, 1%	5.83	5.71	5.89	6.34	7.64	8.61	9.11	7.02
K_2O, 2%	6.07	6.11	6.24	6.57	7.81	9.15	9.26	7.32
K_2O, 3%	6.19	6.21	6.39	6.71	7.93	9.41	9.56	7.49
φ alanine, 15 ppm	6.03	6.00	6.19	6.30	7.45	8.67	9.00	7.09
φ alanine, 30 ppm	6.27	6.22	6.41	6.69	7.91	9.65	9.67	7.55
φ alanine, 45 ppm	6.39	6.31	6.42	7.01	7.99	9.74	9.77	7.66
Mean	6.04	6.00	6.20	6.55	7.76	9.09	9.34	
$L.S.D_{0.05}$	Treatment 0.56			Date 0.56		Treatment x Date 2.07		

Table (8): Effect of potassium and phenylalanine foliar applications on total sugars percentage of Pairi mango fruit during cold storage at 10°C for both 1997 and 1998 seasons.

Treatment	Storage period (days)							Mean
	0	5	10	15	20	25	30	
1997 season								
Control	6.05	6.02	6.19	6.72	8.63	9.75	10.44	7.69
K_2O, 1%	6.19	6.19	6.34	7.14	8.64	10.11	10.49	7.87
K_2O, 2%	6.52	6.52	6.51	7.66	8.92	10.52	11.45	8.30
K_2O, 3%	6.80	6.83	6.99	8.04	9.42	11.12	11.70	8.70
φ alanine, 15 ppm	6.34	6.32	7.00	8.12	9.91	11.27	11.65	8.66
φ alanine, 30 ppm	6.91	6.87	7.49	8.01	9.98	11.56	11.74	8.94
φ alanine, 45 ppm	7.22	7.36	7.53	8.17	10.18	11.63	11.85	9.13
Mean	6.58	6.59	6.87	7.69	9.38	10.85	11.34	
$L.S.D_{0.05}$	Treatment 0.22			Date 0.22		Treatment x Date 0.59		
1998 season								
Control	5.76	5.78	6.39	7.04	8.64	9.49	10.13	7.60
K_2O, 1%	6.08	6.03	6.42	7.14	8.69	9.68	10.24	7.75
K_2O, 2%	6.37	6.43	6.99	7.38	8.90	10.29	10.41	8.11
K_2O, 3%	6.69	6.72	7.00	7.70	9.16	10.71	10.87	8.41
φ alanine, 15 ppm	6.30	6.34	6.78	7.35	8.72	9.97	10.35	7.97
φ alanine, 30 ppm	6.62	6.73	7.41	8.00	9.33	11.28	11.36	8.68
φ alanine, 45 ppm	6.98	7.13	7.79	8.53	9.64	11.46	11.52	9.01
Mean	6.40	6.45	6.97	7.59	9.01	10.41	10.69	
$L.S.D_{0.05}$	Treatment 0.53			Date 0.53		Treatment x Date 1.43		

As for changes in fruit reducing, non-reducing and total sugars during storage, the results given in Tables (6, 7 and 8) showed that there was continuous increase in the three previous parameters in the Pairi mango fruit flesh throughout the storage period. Significant differences were found between all sampling dates and the initial date (zero time), except for the first sampling date (5 days) for the reducing sugars (Table 6) and total sugars (Table 8) in both experimental seasons. As for the non-reducing sugars, significant differences were only found between the four sampling dates and

unstored fruits (zero time) in the first season and the last two sampling dates and unstored fruits in the second season of study.

On the contrary, a gradual decrease in Pairi mango fruit starch content, due to its conversion to sugars, was found. Results in Table (9) showed a significant decrease in starch in all sampling dates as compared with control, except for the first sampling date (5 days) in the first experimental season. This founding might gain support from the work done by Castrillo *et al*.(1992) working on mango fruits.

Table (9): Effect of potassium and phenylalanine foliar applications on starch percentage of Pairi mango fruit during cold storage at 10°C for both 1997 and 1998 seasons.

Treatment	Storage period (days)							Mean
	0	5	10	15	20	25	30	
1997 season								
Control	2.47	2.43	2.31	2.20	1.94	1.79	1.65	14.79
K_2O, 1%	2.46	2.40	2.28	2.18	1.83	1.75	1.63	14.53
K_2O, 2%	2.31	2.29	2.25	2.11	1.64	1.59	1.41	13.60
K_2O, 3%	2.11	2.09	2.01	1.96	1.64	1.58	1.43	12.82
φ alanine, 15 ppm	2.23	2.18	2.11	1.99	1.79	1.53	1.48	13.31
φ alanine, 30 ppm	2.14	2.08	1.96	1.78	1.61	1.58	1.45	12.60
φ alanine, 45 ppm	2.01	1.91	1.88	1.81	1.64	1.49	1.42	12.16
Mean	15.73	15.38	14.80	14.03	12.09	11.31	10.47	
$L.S.D_{0.05}$	Treatment 0.70			Date 0.70		Treatment x Date 1.84		
1998 season								
Control	2.53	2.34	2.28	1.83	1.90	1.70	1.68	14.26
K_2O, 1%	2.50	2.33	2.14	1.79	1.87	1.84	1.65	14.12
K_2O, 2%	2.42	2.31	2.10	1.91	1.86	1.73	1.69	14.02
K_2O, 3%	2.21	2.11	1.85	1.69	1.63	1.53	1.49	12.51
φ alanine, 15 ppm	2.33	2.23	2.05	1.93	1.86	1.78	1.67	13.85
φ alanine, 30 ppm	2.08	2.03	1.87	1.67	1.53	1.50	1.47	12.15
φ alanine, 45 ppm	2.05	1.99	1.86	1.74	1.70	1.57	1.51	12.42
Mean	16.12	15.34	14.15	12.56	12.35	11.62	11.16	
$L.S.D_{0.05}$	Treatment 0.30			Date 0.30		Treatment x Date 1.44		

5. Total soluble solids :

The results of the present investigation (Table 10) showed that, in both experimental seasons, fruit total soluble solids content, generally, increased with both potassium and phenylalanine treatments. Significant differences were only found in the highest potassium concentration (3%) in the first season and the higher two (2 and 3%) in the second one. In agreement with these results are those previously reported by Abd El-Aal *et al*.(1994) working on Hindi-Bi-Sinnara mango. They noticed that potassium application increased the percentage of total soluble solids in mango fruits.

As for the phenylalanine, the three foliar applications (15, 30 and 45 ppm) caused significant increase in total soluble solids in 1997 and 1998 seasons. In accordance with these results are those previously found by Sedletskii *et al*.(1988) and Ezz (1994) working on grapes.

In the light of these results, the increase in total soluble solids is resulting from the increase in reducing sugars concentration due to

potassium and phenylalanine foliar applications.

As for the changes in total soluble solids during storage, the results given in Table (10) showed that there was a continuous increase in the total soluble solids of the juice of Pairi mango throughout the storage period. The present data indicated that, in both seasons, significant differences were found between all sampling dates and un-stored fruits (zero time), except for the first sampling date (5 days) in the first season. These findings are in line with those obtained by Upadhyay and Tripathi (1985), Medlicott *et al*., 1990) and Hidalgo *et al*. (1997) working on different mango varieties. They found that fruit total soluble solids content increased during storage. Cua (1989) attributed such increase to the conversion of starch to sugar.

Table (10): Effect of potassium and phenylalanine foliar applications on total soluble solids percentage of Pairi mango fruit during cold storage at 10°C for both 1997 and 1998 seasons.

Treatment	Storage period (days)							Mean
	0	5	10	15	20	25	30	
1997 season								
Control	7.22	8.01	8.44	9.14	10.89	13.79	13.21	10.10
K_2O, 1%	7.94	8.22	8.78	9.91	11.41	13.93	13.74	10.56
K_2O, 2%	8.11	8.61	8.89	10.27	12.64	14.32	14.89	11.25
K_2O, 3%	8.17	8.71	10.01	10.71	12.93	14.71	14.93	11.45
φ alanine, 15 ppm	8.02	8.84	10.30	11.76	13.91	15.04	15.33	11.89
φ alanine, 30 ppm	8.18	8.94	10.04	11.21	14.64	15.63	15.99	12.09
φ alanine, 45 ppm	8.22	9.04	10.11	11.42	14.93	15.96	16.03	12.24
Mean	7.98	8.62	9.65	10.63	13.05	14.77	14.87	
$L.S.D_{0.05}$	Treatment 1.17			Date 1.17		Treatment x Date 3.16		
1998 season								
Control	7.27	7.99	8.88	9.28	10.34	12.79	12.98	9.93
K_2O, 1%	7.89	8.09	8.94	9.41	10.59	12.84	13.03	10.11
K_2O, 2%	8.07	8.83	9.63	9.94	11.49	12.91	14.11	10.71
K_2O, 3%	8.19	8.94	9.11	10.32	11.64	13.23	14.15	10.80
φ alanine, 15 ppm	8.00	8.89	9.23	10.49	11.70	13.79	14.45	10.94
φ alanine, 30 ppm	8.12	9.01	9.53	10.73	12.89	14.13	14.91	11.33
φ alanine, 45 ppm	8.21	9.12	9.79	11.47	13.34	14.51	14.96	11.63
Mean	7.96	8.70	9.30	10.23	11.71	13.46	14.07	
$L.S.D_{0.05}$	Treatment 0.70			Date 0.70		Treatment x Date 1.80		

6. Acidity :

The data in Table (11) showed that fruit juice acidity, generally, increased with potassium applications. Significant differences were only found between the highest two potassium treatments (2 and 3%) and control in both 1997 and 1998 seasons. These results agreed with those obtained by Malhi *et al*.(1988) working on Deshehani mango. Also, these results could be explained according to the results of Marschner (1986), who reported that potassium plays a big role in the accumulation of organic acids in fruits.

During the two experimental seasons, spraying Pairi mango trees with the three foliar applications of phenylalanine seemed not to affect fruit

juice acidity during the cold storage period, however (Table 11).

As for the changes in fruit acidity during storage, the results given in Table (11) showed that there was a continuous decrease in the juice acidity of mango throughout the storage period. Significant differences were found between all sampling dates and zero time in both seasons of study, except for the first sampling date in the first season of study, where the differences were not big enough to be significant. These findings are in the line with those obtained by Hare (1995), Kumar *et al*.(1995) and Zambrano and Marzano (1995) working on different mango varieties. They, generally, noticed a decrease in fruit acidity content with storage time. These results may be attributed to the use of acids as substrate for respiration (Echeverria and Valich, 1989).

Table (11): Effect of potassium and phenylalanine foliar applications on acidity percentage of Pairi mango fruit during cold storage at 10ºC for both 1997 and 1998 seasons.

Treatment	Storage period (days)							Mean
	0	5	10	15	20	25	30	
1997 season								
Control	1.82	1.63	1.48	1.44	1.29	1.03	0.89	1.37
K_2O, 1%	1.84	1.71	1.53	1.48	1.38	1.21	1.18	1.48
K_2O, 2%	1.95	1.83	1.69	1.54	1.45	1.27	1.21	1.56
K_2O, 3%	1.97	1.87	1.71	1.62	1.54	1.36	1.29	1.62
φ alanine, 15 ppm	1.80	1.64	1.51	1.45	1.31	1.04	0.89	1.38
φ alanine, 30 ppm	1.79	1.62	1.49	1.43	1.28	1.05	0.89	1.36
φ alanine, 45 ppm	1.82	1.60	1.48	1.43	1.29	1.07	0.88	1.37
Mean	1.86	1.70	1.56	1.48	1.36	1.15	1.03	
$L.S.D_{0.05}$	Treatment 0.18			Date 0.18		Treatment x Date 0.48		
1998 season								
Control	1.80	1.59	1.37	1.19	0.96	0.71	0.67	1.18
K_2O, 1%	1.84	1.64	1.49	1.26	1.11	0.83	0.71	1.27
K_2O, 2%	1.90	1.71	1.63	1.34	1.19	0.99	0.89	1.38
K_2O, 3%	1.92	1.76	1.69	1.39	1.26	1.11	0.93	1.44
φ alanine, 15 ppm	1.79	1.59	1.39	1.20	0.97	0.69	0.67	1.19
φ alanine, 30 ppm	1.82	1.56	1.41	1.19	0.99	0.67	0.70	1.19
φ alanine, 45 ppm	1.81	1.58	1.37	1.19	0.97	0.70	0.69	1.19
Mean	1.84	1.63	1.48	1.25	1.08	0.81	0.75	
$L.S.D_{0.05}$	Treatment 0.20			Date 0.20		Treatment x Date 0.53		

7. Vitamin C :

The increase in juice vitamin C content due to potassium application is greater than that due to the phenylalanine treatments (Table 12). In the same time, significant differences were only found for the higher two potassium concentrations (2 and 3%) in 1997 season and the highest one (3%) in 1998 season as compared with control.

Regarding the changes in fruit ascorbic acid during storage, the results given in Table (12) showed that there was a continuous decrease in the ascorbic acid content of mango fruits throughout the storage period. The present data revealed that juice ascorbic acid slightly decreased with storage period till five days, then it significantly decreased with increasing storage

period in both experimental seasons. These findings are in line with those obtained by Joshi and Roy (1988) and Zambrano and Marzano (1995) working on mango. They found a general decrease in fruit ascorbic acid content with storage time. It may be attributed to its oxidation with time (Kays, 1991 and Salunkhe *et al*., 1991).

Table (12): Effect of potassium and phenylalanine foliar applications on vitamin C content (mg/100 ml juice) of Pairi mango fruit during cold storage at 10ºC for both 1997 and 1998 seasons.

Treatment	Storage period (days)							Mean
	0	5	10	15	20	25	30	
1997 season								
Control	41.5	37.4	32.8	27.6	22.4	19.1	16.3	28.2
K_2O, 1%	42.7	39.5	33.1	29.9	24.3	21.4	17.8	29.8
K_2O, 2%	48.7	43.1	40.7	34.7	30.1	26.1	21.7	35.0
K_2O, 3%	49.9	45.0	41.4	35.8	32.4	29.1	23.4	36.7
φ alanine, 15 ppm	42.6	38.5	33.9	28.1	23.5	19.9	16.1	28.9
φ alanine, 30 ppm	44.1	38.9	33.5	28.0	23.6	20.4	16.2	29.2
φ alanine, 45 ppm	44.7	38.4	33.7	28.3	24.1	20.7	16.4	29.5
Mean	44.9	40.1	35.6	30.3	25.8	22.4	18.3	
$L.S.D_{0.05}$	Treatment 6.48			Date 6.48		Treatment x Date 17.14		
1998 season								
Control	43.7	39.1	31.1	26.4	23.5	18.9	15.0	28.2
K_2O, 1%	44.6	42.3	33.1	27.0	25.1	20.0	16.4	29.8
K_2O, 2%	47.3	43.9	30.7	31.2	27.4	23.1	19.4	31.9
K_2O, 3%	49.6	45.7	40.5	35.1	33.2	23.9	20.3	35.5
φ alanine, 15 ppm	42.9	40.1	32.9	27.4	23.9	19.1	15.7	28.9
φ alanine, 30 ppm	43.5	39.4	32.8	26.9	24.4	19.4	15.9	28.9
φ alanine, 45 ppm	43.8	39.9	32.6	27.7	24.9	19.6	15.9	29.2
Mean	45.1	41.5	33.4	28.8	26.1	20.6	16.9	
$L.S.D_{0.05}$	Treatment 7.08			Date 7.08		Treatment x Date 18.73		

8. Firmness :

In both experimental seasons, results in Table (13) showed that all treatments made the fruits firmer than control fruits. Significant differences were only found between the highest two potassium concentrations (2 and 3%) and control in both seasons of study.

The data of the present study also indicated that appreciable changes occurred in the flesh firmness of Pairi mango fruits during storage (Table 13). It was found that, in both seasons, fruit firmness slightly decreased with storage period till 10 days, then significantly decreased with increasing period of cold storage as compared with zero time. In accordance with these results are those previously reported by numerous investigators working on different mango varieties such as Sankat *et al*.(1994), Kumar *et al*.(1995) and Suntharakingam (1996). They found a marked decrease in mango fruit firmness during storage. They also added that the conversion of insoluble forms of protopectins into soluble pectin compounds might account for the observed decrease in mango fruit firmness.

Table (13): Effect of potassium and phenylalanine foliar applications on firmness (pounds/inch^2) of Pairi mango fruit during cold storage at 10^{o}C for both 1997 and 1998 seasons.

Treatment	Storage period (days)							Mean
	0	5	10	15	20	25	30	
1997 season								
Control	12.11	12.08	11.56	9.97	7.81	7.15	6.11	9.54
K_2O, 1%	12.16	12.17	11.94	10.61	8.35	7.61	6.74	9.94
K_2O, 2%	12.17	12.15	12.03	11.46	9.43	8.27	7.46	10.42
K_2O, 3%	12.21	12.19	12.09	11.83	9.56	8.59	7.89	10.62
φ alanine, 15 ppm	12.14	12.01	11.49	10.39	7.96	7.34	6.39	9.67
φ alanine, 30 ppm	12.16	12.09	12.00	11.34	9.22	8.15	7.23	10.31
φ alanine, 45 ppm	12.17	12.11	12.01	11.31	9.20	8.19	7.25	10.32
Mean	12.16	12.11	11.87	10.99	8.79	7.90	7.01	
L.S.D$_{0.05}$	Treatment 0.84			Date 0.84			Treatment x Date 2.21	
1998 season								
Control	11.33	11.30	10.87	10.11	9.15	8.01	6.08	9.55
K_2O, 1%	11.37	11.31	11.11	10.37	9.61	8.34	6.39	9.79
K_2O, 2%	11.39	11.23	11.19	10.41	9.83	8.74	7.61	10.06
K_2O, 3%	11.41	11.43	11.32	10.05	9.79	9.07	7.74	10.12
φ alanine, 15 ppm	11.35	11.30	10.94	10.19	9.24	8.18	6.21	9.63
φ alanine, 30 ppm	11.37	11.31	10.97	10.27	9.31	8.83	7.25	9.82
φ alanine, 45 ppm	11.42	11.39	11.09	10.31	9.46	8.29	7.36	9.90
Mean	11.38	11.32	11.07	10.24	9.48	8.41	7.00	
L.S.D$_{0.05}$	Treatment 0.42			Date 0.42			Treatment x Date 1.11	

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إستجابة أشجار المانجو صنف بيرى للرش بالبوتاسيوم والفينيل ألانين : 2- القابلية للتخزين

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أجريت هذه الدراسة خلال موسمى 1997 ، 1998 لدراسة تأثير الرش الورقى بالبوتاسيوم والفينيل ألانين قبل الجمع على صفات ثمار المانجو صنف بيرى أثناء التخزين على درجة 10°م ورطوبة نسبية 85-90%.

وقد أوضحت الدراسة أن معاملات البوتاسيوم والفينيل ألانين أدت الى نقص الفقد فى الوزن بينما لم تتأثر نسبة تعفن الثمار وصلابة الثمار نتيجة المعاملات. كذلك سببت المعاملات زيادة فى المواد الصلبة الذائبة والسكريات بصورها المختلفة ونقص فى النشا بالثمار.

وأدت معاملات البوتاسيوم الى زيادة حموضة الثمار بينما لم تؤثر معاملة الفينيل ألانين على نسبة حموضة الثمار أثناء التخزين.

وسببت معاملات البوتاسيوم والفينيل ألانين نقص فى محتوى قشرة الثمرة من الكلوروفيل وزيادة من الكاروتين والأنثوسيانين.

أما بخصوص تأثير مدة التخزين، فقد أدت الى زيادة نسبة الفقد فى الوزن وتعفن الثمار والمواد الصلبة الذائبة والصور المختلفة من السكريات والكاروتين والأنثوسيانين ونقص فى محتوى الثمار من النشا وحموضة العصير ونقص الكلوروفيل.