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EVALUATION OF SOIL TYPE AND ROOTSTOCK INFLUENCES ON: B) QUALITY AND STORABILITY OF 'ANNA' APPLE FRUITS

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ABSTRACT: ***Seven years old 'Anna' apple trees budded on MM.106 or Malus rootstock were investigated to determine effect of soil type and rootstock on fruit quality and storability during 2003 and 2004. Trees were grown at Elbostan region of Elbehira governorate where there a sandy and calcareous soil exists, and clay soil was found at Shopra-Elnamla of Elgharbeia governorate. Fruits were picked at maturity and stored at 0° C with relative humidity 85 - 90 % for 30 days intervals up to 120 days period.***

Fruit weight loss % and water soluble pectin (WSP) were increased, while fruit shelf life, peel firmness and flesh firmness were decreased gradually as storage period advanced. Meanwhile, fruit juice acidity records were decreased with advancing of storage period, without significant differences, except between 0 and 120 day intervals. Soluble solids content (SSC) of fruit juice was not affected with nither rootstocks nor storage intervals. Fruits grown in a sandy soil had the highest SSC records againset those grown in a clay one, while those of calcareous soil recorded intermediate values.

Differences of 'Anna' fruit juice acidity were not significant between both rootstocks in all studied soil types. Shelf life was increased significantly when fruits were grown on Malus in a sandy soil, and insignificantly in a clay one. On the other hand, Malus reduced fruit shelf life insignificantly in calcareous soil compared with MM.106 rootstock. Fruits of trees budded on Malus had the highest significant weight loss percentage in a sandy soil. In spite of rootstocks not affected fruit flesh firmness significantly, but fruits grown on MM.106 were more storeable which recorded highest flesh firmness at picking date and still the highest at the end of storage period compared with those grown on Malus in the sandy or clay soil. Moreover, MM.106 gave the best performance of both fruit peel and flesh firmness in a calcareous soil.

Key Words: ***Apple - Malus domestica – rootstock - soil type - storability***

INTRODUCTION

Apple (*Malus domestica*, Borkh) is the most important deciduous fruit in the world while 'Anna' represents the main cultivated apple variety in Egypt (Saeid and Khalil, 1992). 'Anna' is a cultivar that softens rapidly even in cold storage (Joshua *et al*., 1990). Malus is considered a vigorous apple rootstock and MM.106 is a semi dwarfing rootstock and both are the most spread rootstocks in Egyptian orchards.

Knowledge of apple fruit changes during storage period enables some modulations depending on storage conditions. The respiratory climacteric, the synthesis and action of ethylene, the control of ethylene fruit, the influences of natural phytohormones, synthetic regulators and chemical substances in apples during storage were studied (Rouchaud *et. al.,* 1985). However, little has been published as regards soil types or rootstock differences on the quality characteristics of apples around the harvest date and during storage. Such knowledge is important for more accurate understanding of the soil, rootstock and cultivar relations, and also for the choice of best formulae which produce valuable marketable fruits with high storability.

Apple orchards profitability depends on producing high yield of marketable fruits. Rootstock selection is a critical limit not only for the establishment period but for future performance as well (Thomas Fernandez *et. al.*, 1997). The ideal rootstock should induce good tree survival, high annual yield, and acceptable fruit size (Marini *et. al.,* 2002). Also, it was stated that rootstocks affected fruit internal ethylene levels which seriously affect fruit maturation, quality and storage life of apple fruits (Fallahi *et. al.*, 1985).

In recent years, the production of 'Anna' apples has increased steadily and production has surpassed early seasonal demand. This increment of yield more than fresh market requirements led to increasing interest with post harvest and storage studies to supply the late seasonal demand. So, this study was undertaken to evaluate in a multi-location trial, influences of clay, sandy and calcareous soil which are considered the most spread types of Egyptian soils, as well as the effects of the major two rootstocks in Egypt (Malus and MM.106) on fruit quality, storability and behavior during storage period of 'Anna' apple fruits.

MATERIALS and METHODS

This study has been carried out on seven years old ‘Anna’ apple trees budded on MM.106 or Malus rootstock during two successive seasons of 2003 and 2004. Trees were grown at Elbostan region of Elbehira governorate where there a sandy and calcareous soils exist while clay soil was found at Shobra-Elnamla, Elgharbeia governorate. All trees were subjected to common horticultural practices of the region.

Single tree plot replicated 3 times for each treatment was arranged in random complete blocks design. A statistical analysis of data was computerized by Irristat (1999) package.

Fruits were picked at maturity stage and were packed in carton boxes dressed by polyethylene sheets (30 mm.). All fruits were stored at 0°C and 85 - 90% relative humidity for 120 days. Samples containing 30 fruits from each replicate were taken every thirty days intervals for carrying out the following estimates:

I) Physical changes:

a. Weight loss: Ten fruits of each carton were assigned numbers for each fruit and used for calculating weight loss. These fruits were weighted before storage and again when the samples were taken out of the storage, weight loss percentage was calculated.

b. Fruit firmness: was measured from the two opposite sides after removing the skin using Effige type pressure tester with a standard 5/16 of inch^2 plunger and recorded as Lbf.

II) Chemical properties:

a) Water soluble pectin (WSP) was determined according to procedure of Carré and Haynes (1922).

b) Soluble solids content percentage (SSC%) was determined by using a hand refractometer.

c) Titratable acidity percentage was determined according to the procedure of A.O.A.C. (1990).

III) Shelf life: A sample of 10 fruits of each replicate was taken out of storage, at each ex-storage date and left at room temperature (23-25˚C). When 50% of fruits were scalded, the experiment was terminated and the number of days was calculated and considered as shelf life.

RESULTS

Weight loss percentage:

Data of rootstock influences on weight loss percentage of 'Anna' apple fruits were arranged in Table (1). Generally, weight loss percentage was significantly increased with advancing of storage period, in both studied seasons. It was clear that weight loss percentage was gradually increased from 0 day followed with 30, 60, 90 and then 120 days interval, in all soil types.

Sandy soil:

Data of Table (1) illustrated that regardless of storage interval, trees budded on Malus rootstock had the highest significant weight loss percentage as compared with those budded on MM.106 in both studied seasons (7.38 & 5.19 % against 6.92 & 2.88 %).

As for storage intervals regardless of rootstocks, data showed that weight loss percentage of 'Anna' apple fruits significantly increased as storage

period advanced in both seasons of the study, differences were mostly significant among intervals of storage period.

Referring to interaction between rootstocks and storage intervals, data in Table (1) concerned with weight loss percentage of 'Anna' apple fruits showed that Malus rootstock had the highest significant weight loss percentage (10.87 at 90 days of storage in first season). At the same time, MM.106 gave the highest significant value (10.34) after 120 days of storage in first season.

Clay soil:

With respect to rootstocks influence, data in Table (1) showed that weight loss percentage of 'Anna' apple fruits picked from trees budded on MM.106 decreased significantly than those picked from trees budded on Malus rootstock, in the first season. In the second one, differences between both rootstocks did not reach significance.

As storage period advanced, weight loss percentage was increased, in both seasons of the study. The lowest significant value of weight loss was recorded for 30 days interval (1.80) in second season, while highest significant value was for 120 days interval (8.11) in the first season. Also, other intervals of storage period recorded intermediate values. Differences among intervals of storage period under 0° C were significant, statistically.

Concerning the interaction between rootstocks and storage intervals, data in Table (1) showed that Malus rootstock after 30 days of storage had the lowest significant weight loss percentage as it recorded 1.78 in second season, while recorded the highest significant percent (8.71) at 120 days of storage in the first season. It means more degradation of weight loss for fruits picked from trees budded on Malus rootstock which grown in clay soil.

Calcareous soil:

Concerning rootstocks influence on weight loss of 'Anna' apple fruits, data in Table (1) revealed that regardless of storage interval, Malus rootstock showed a significant increase when compared with MM.106, in the first season. At the same time, differences were not significant between both rootstocks in second season.

As for storage intervals regardless of rootstocks, data in Table (1) showed that differences among intervals of storage period were significant. Fruit weight loss percent were 2.03 and 2.69 at 30 days of storage interval, in both seasons, respectively. While, increased significantly up to 6.35 and 6.48 at the end of storage period (at 120 days) in the two seasons of the study. Other intermediate intervals of storage period recorded intermediate values.

With respect to interaction between rootstocks and storage intervals, data concerning fruit weight loss percentage in Table (1) showed that Malus rootstock had the lowest percentage (1.93 after 30 days of storage in second season). After 120 days of storage in the first season, trees budded on Malus

rootstock gave the highest percentage (7.64). So, it could be said that fruits picked from trees budded on Malus had more weight loss than those picked from trees budded on MM.106 rootstock during storage at 0° C.

Table (1): Effect of soil type and rootstock on weight loss % of 'Anna' apple fruits during cold storage at 0° C.

Treats.#	Storage intervals per days										Mean	
	0		30		60		90		120			
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
SM	-	-	2.55	2.04	5.68	4.02	10.87	6.07	10.42	8.61	7.38	5.19
SMM	-	-	4.63	1.42	5.30	2.36	7.40	3.37	10.34	4.38	6.92	2.88
Mean	-	-	3.59	1.73	5.49	3.19	9.14	4.72	10.38	6.50	7.15	4.04
L.S.D at 5% ##			A			B			A x B			
1st Season			0.46			1.24			1.67			
2nd Season			0.62			1.18			1.41			
CLM	-	-	2.53	1.78	4.84	3.23	6.65	4.81	8.71	6.10	5.68	3.98
CLMM	-	-	1.94	1.82	4.01	3.44	5.62	5.70	7.50	6.88	4.77	4.46
Mean	-	-	2.24	1.80	4.45	3.34	6.14	5.26	8.11	6.49	5.24	4.22
L.S.D at 5% ##			A			B			A x B			
1st Season			0.78			1.69			1.81			
2nd Season			0.55			1.65			1.42			
CAM	-	-	2.06	1.93	3.76	3.70	5.41	6.16	7.64	7.24	4.72	4.76
CAMM	-	-	2.00	3.44	3.58	4.07	5.07	4.48	5.05	5.71	3.93	4.43
Mean	-	-	2.03	2.69	3.67	3.89	5.24	5.32	6.35	6.48	4.32	4.60
L.S.D at 5% ##			A			B			A x B			
1st Season			0.77			1.11			1.16			
2nd Season			0.67			1.32			1.29			

#: S: Sandy soil – CL: Clay soil – CA: Calcareous soil – M: Malus rootstock – MM: MM.106 rootstock.
##: A: Rootstocks. B: Storage intervals A x B: Rootstocks and Storage intervals interaction.

Fruit peel firmness :

Concerning rootstocks influences on fruit peel firmness of 'Anna' apple fruits, data in Table (2) cleared that regardless of storage interval, differences were not significant between both rootstocks in both seasons in the sandy or clay soil. At the same time, MM.106 rootstock showed significant values of fruit firmness as it recorded 11.00 and 10.08 against 9.70 and 9.50 for Malus in both seasons, respectively. Meanwhile, fruit peel firmness was significantly decreased with an ascending order with advancing storage period, in both studied seasons. It was clear that fruit firmness was gradually decreased from 0 day interval followed by 30, 60, 90 and then 120 days in all soil types.

Sandy soil:

As for storage intervals regardless of rootstocks, statistical analyses in Table (2) showed that differences among intervals of storage period were significant. Fruit peel firmness values were 8.89 and 12.93 at 0 day of storage interval, while significantly decreased to 7.31 and 6.89 at the end of storage period (at 120 days) in the two seasons of the study.

With respect to interaction between rootstocks and storage intervals, data in Table (2) concerning fruit peel firmness showed that MM.106 rootstock had the highest fruit peel firmness (12.60 at 30 day of storage in first season) while Malus rootstock gave 13.26 after 30 days of storage in the same season.

Clay soil:

With respect to storage intervals regardless of rootstocks data in Table (2) showed that fruit peel firmness values were 11.24 and 11.23 at 0 and 30 days of storage intervals, respectively, while it significantly decreased to 6.63 and 6.76 at the end of storage period (at 120 days) in the two seasons of the study.

As for the interaction between rootstocks and storage intervals, data concerning fruit firmness showed that Malus rootstock had the highest fruit peel firmness as it was 11.45 compared with 11.03 for MM.106 at picking date (0 day of storage) in first season while it was 11.76 against 10.70 for MM.106 after 30 days of storage.

Calcareous soil:

Concerning storage intervals regardless of rootstocks, data in Table (2) showed that fruit firmness was significantly decreased with advancing storage period, in both studied seasons. It was clear that fruit peel firmness was gradually decreased from 0 day interval followed by 30, 60, 90 and then 120 days. Statistical analysis showed that differences among intervals of storage period were significant.

Table (2): Effect of soil type and rootstock on firmness (Lpf) of 'Anna' apple peel during cold storage at 0° C.

Treats.#	Storage intervals per days										Mean	
	0		30		60		90		120			
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
SM	8.43	10.41	13.26	10.46	10.08	10.76	10.06	6.05	6.95	7.51	9.75	9.03
SMM	9.36	11.68	12.60	10.11	10.50	9.66	8.80	6.51	7.68	6.28	9.78	8.84
Mean	8.89	11.04	12.93	10.28	10.29	10.21	9.43	6.27	7.31	6.89	9.77	8.93
L.S.D at 5% ##		A			B			A x B				
1st Season		0.3675			0.4501			0.7202				
2nd Season		0.402			0.4254			0.5210				
CLM	11.45	10.61	11.76	9.53	9.86	8.00	8.98	6.35	5.30	7.15	9.47	8.32
CLMM	11.03	11.16	10.70	10.2	10.08	9.50	7.40	6.76	7.96	6.38	9.43	8.80
Mean	11.24	10.88	11.23	9.86	9.97	8.75	8.19	6.55	6.63	6.76	9.45	8.56
L.S.D at 5% ##		A			B			A x B				
1st Season		0.3675			0.4501			0.9002				
2nd Season		0.402			0.4254			0.5210				
CAM	10.38	11.85	12.53	10.68	8.93	10.91	8.20	5.55	8.50	8.55	9.70	9.50
CAMM	11.48	12.78	13.25	10.40	11.16	10.98	9.63	7.38	9.51	8.90	11.00	10.08
Mean	10.93	12.31	12.93	10.54	10.04	10.94	8.91	6.45	9.05	8.67	10.73	9.78
L.S.D at 5% ##		A			B			A x B				
1st Season		0.3675			0.4501			0.9002				
2nd Season		0.402			0.4254			0.5210				

#: S: Sandy soil – CL: Clay soil – CA: Calcareous soil – M: Malus rootstock – MM: MM.106 rootstock.
##: A: Rootstocks. B: Storage intervals A x B: Rootstocks and Storage intervals interaction.

With respect to interaction between rootstocks and storage intervals, data in Table (2) concerning fruit firmness showed that MM.106 rootstock had the highest fruit peel firmness as it was 12.53 in the first season while Malus was 13.25 after 30 days of storage in the second one.

Fruit flesh firmness :

Data of fruit flesh firmness of 'Anna' apple fruits was tabulated in Table 3. Data revealed that fruit flesh firmness was significantly decreased as storage period advanced, in both studied seasons. It was clear that fruit flesh firmness was gradually decreased from 0 day interval followed by 30, 60, 90 and then 120 days, in all cases of soil types and rootstocks.

Sandy soil:

Referring to rootstocks influences on fruit flesh firmness, data in Table (3) showed that regardless of storage interval, rootstocks did not affect flesh firmness of 'Anna' apples in both seasons.

With respect to storage intervals, data showed that fruit flesh firmness was varied from season to another and generally was gradually decreased as days of storage period were increased. So, the highest significant value of fruit flesh firmness were recorded for 0 day interval (10.24) in the second season, and lowest significant values were for 120 days interval (5.09) in the first season, while other intervals of storage period recorded intermediate values.

Concerning the interaction between rootstocks and storage intervals, data showed that MM.106 rootstock had the highest fruit flesh firmness as was 10.90 at 0 day interval in the second season while the lowest value (5.00) was at 120 days interval in the first season. On the other hand, Malus rootstock gave the highest fruit flesh firmness (9.78) at 30 days interval while the lowest value (5.00) was at 90 days interval in the first season. So, it could be noticed that fruits grown on MM.106 were more storeable which recorded highest values at picking date (0 day interval) and still the higest at the end of storage period (120 day interval) compared with fruits grown on Malus rootstock.

Clay soil:

As for rootstock influences regardless of storage intervals, data concerning with flesh firmness showed that fruits grown on MM.106 had the highest values compared with those grown on Malus, without significance in the first season while reached significance in the second one.

Concerning storage intervals regardless of rootstocks, data showed that fruit flesh firmness was significantly decreased with an ascending order with advancing storage period, in both studied seasons. It was clear that fruit peel firmness was gradually decreased from 0 day interval followed by 30, 60, 90 and then 120 days. Statistical analysis showed that differences among intervals of storage period were significant in most cases.

With respect to interaction between rootstocks and storage intervals, data concerning fruit flesh firmness showed that MM.106 rootstock had the highest record as gave 10.53 while Malus gave 9.15 at 0 day of storage in the second season. Mainly, MM.106 rootstock had the highest fruit flesh firmness

values compared with Malus during all storage intervals in both seasons, except at 90 days of storage.

Table (3): Effect of soil type and rootstock on firmness (Lpf) of 'Anna' apple flesh during cold storage at 0° C.

Treats.[#]	Storage intervals per days										Mean	
	0		30		60		90		120			
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
SM	6.01	9.58	9.78	6.35	5.61	7.16	5.68	5.71	5.00	5.06	6.41	7.17
SMM	7.36	10.90	9.23	6.81	6.46	6.70	5.10	5.00	5.18	5.61	6.66	7.00
Mean	6.68	10.24	9.50	6.67	6.03	6.93	5.39	5.35	5.09	5.33	6.53	6.90
L.S.D at 5% [##]			A			B			A x B			
1st Season			1.06			0.84			1.22			
2nd Season			1.00			0.92			1.03			
CLM	8.25	9.15	8.05	5.95	6.55	5.98	5.31	6.06	4.20	4.68	6.47	6.36
CLMM	8.68	10.53	9.08	7.70	7.01	6.68	4.95	5.83	5.21	5.45	6.98	7.23
Mean	8.46	9.84	8.56	6.82	6.78	6.33	5.13	5.94	4.70	5.06	6.72	6.79
L.S.D at 5% [##]			A			B			A x B			
1st Season			0.94			0.81			1.02			
2nd Season			0.87			0.88			1.21			
CAM	6.31	8.50	8.65	6.33	7.23	6.20	5.63	3.65	6.28	4.95	6.81	5.92
CAMM	8.13	10.33	9.56	7.13	7.95	6.70	5.68	4.65	5.85	6.90	7.43	7.14
Mean	7.22	9.41	9.05	6.93	7.59	6.45	5.65	4.15	6.06	5.92	7.11	6.57
L.S.D at 5% [##]			A			B			A x B			
1st Season			0.93			0.89			1.12			
2nd Season			0.95			0.92			1.26			

#: S: Sandy soil – CL: Clay soil – CA: Calcareous soil – M: Malus rootstock – MM: MM.106 rootstock.
##: A: Rootstocks. B: Storage intervals A x B: Rootstocks and Storage intervals interaction.

Calcareous soil:

Referring to rootstocks influences on fruit flesh firmness, data in Table (3) revealed that regardless of storage interval, fruits grown on MM.106 rootstock had the highest values compared with those grown on Malus,

without significance in the first season while turned on significance in second one.

With respect to storage intervals regardless of rootstocks data showed that flesh firmness values were significantly decreased as storage period was advanced, in both seasons. Statistical analyses showed that differences among intervals of storage period were significant in most cases.

As for interaction between rootstocks and storage intervals, data concerning with fruit firmness showed that MM.106 rootstock had the highest fruit peel firmness as gave 10.33 in the first season while Malus gave 8.65 after 30 days of storage in the second one.

Fruit content of water soluble pectin (WSP) :

Data of rootstock and soil type influences on content of water soluble pectin (WSP) of 'Anna' apple fruits were arranged in Table (4). Data showed that rootstocks had no clear trend on WSP, while values of water soluble pectin were increased as storage was advanced.

Sandy soil:

Concerning rootstock influences regardless of storage intervals, data demonestrated that fruits grown on MM.106 rootstock had the highest WSP as gave 1.43 in the first season, while those grown on Malus gave the highest value (1.33) in the second one.

With respect to storage intervals, data indicated that WSP values were increased gradually in a significant manner from 0 day (0.95 & 0.84) up to 120 days (1.96 & 1.63) of storage under 0° C conditions, in both seasons. Differences among WSP records were unsignificant up to 90 days interval and then increased significantly at 120 days of storage period as compared with picking date (0 day interval).

Referring to interaction between rootstocks and storage intervals, data in Table (4) concerning WSP of 'Anna' apple fruits showed that MM.106 rootstock had the highest record as gave 2.01 in the first season while Malus gave 1.90 in the second one after 120 days of cold storage.

Clay soil:

As for rootstock influences regardless of storage intervals, data concerning fruit content of water soluble pectin cleared that fruits grown on Malus had the highest WSP as gave 1.28 at 2004 season, while those grown on MM.106 gave the highest value (1.17) during 2003, without significance in all cases.

With respect to storage intervals data in Table (4) showed that WSP values were significantly decreased as storage period was advanced, in both seasons. Statistical analysis showed that differences between WSP records at picking date (0 day interval) and other intervals of storage period were unsignificant up to 60 days interval and then reached to a significance after 90 days of storage .

As for interaction between rootstocks and storage intervals, data showed that MM.106 rootstock had the highest WSP record as gave 2.34 after 120 days interval against 0.26 at 0 day interval in the first season while Malus gave 2.00 against 0.24 for the same intervals of storage.

Table (4): Effect of soil type and rootstock on water soluble pectin (WSP) of 'Anna' apple fruits during cold storage at 0° C.

Treats.#	Storage intervals per days										Mean	
	0		30		60		90		120			
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
SM	0.90	0.84	1.31	1.13	1.35	1.39	1.59	1.43	1.88	1.90	1.40	1.33
SMM	1.00	0.84	1.37	0.91	1.23	1.07	1.58	1.17	2.01	1.37	1.43	1.07
Mean	0.95	0.84	1.34	1.02	1.29	1.23	1.58	1.30	1.96	1.63	1.42	1.20
L.S.D at 5% ##			A			B			A x B			
1st Season			0.97			0.82			0.95			
2nd Season			0.98			0.79			0.99			
CLM	0.24	0.65	0.81	1.05	0.99	1.27	1.33	1.43	1.83	2.00	1.04	1.28
CLMM	0.26	0.75	1.00	0.88	1.13	1.12	1.14	1.23	2.34	1.38	1.17	1.07
Mean	0.25	0.70	0.90	0.96	1.01	1.20	1.23	1.33	2.08	1.67	1.09	1.17
L.S.D at 5% ##			A			B			A x B			
1st Season			0.94			0.85			0.96			
2nd Season			0.91			0.87			1.07			
CAM	0.58	0.91	0.91	0.96	1.01	1.03	1.24	1.08	1.74	1.34	1.09	1.06
CAMM	0.25	0.93	0.92	1.02	1.21	1.15	1.52	1.43	2.05	1.75	1.19	1.25
Mean	0.41	0.92	0.91	0.99	1.11	1.09	1.38	1.25	1.90	1.55	1.14	1.16
L.S.D at 5% ##			A			B			A x B			
1st Season			0.94			0.88			1.08			
2nd Season			0.97			0.80			0.99			

#: S: Sandy soil – CL: Clay soil – CA: Calcareous soil – M: Malus rootstock – MM: MM.106 rootstock.
##: A: Rootstocks. B: Storage intervals A x B: Rootstocks and Storage intervals interaction.

Calcareous soil:

Concerning rootstocks influence on WSP of ‘Anna’ apple fruits, data in Table (4) revealed that MM.106 rootstock showed unsignificant increase when compared with Malus, in both studied seasons.

As for storage intervals regardless of rootstocks, data showed that differences among intervals of storage period were unsignificant. Only differences between WSP values at 0 day interval (0.41 & 0.92) and at 120 days interval (1.90 & 1.55) recorded significance, in both seasons. Other stipulated intervals of storage period recorded intermediate values.

With respect to interaction between rootstocks and storage intervals, data concerning WSP showed that fruits grown on MM.106 rootstock had the highest record as gave 2.05 after 120 days interval against 0.25 at 0 day interval in the first season while those grown on Malus gave 1.74 againset 0.58 for the same intervals of storage period.

Soluble solids content percentage (SSC %) :

Data of soluble solids content percentage (SSC %) of ‘Anna’ apple fruits were tabulated in Table 5. Data revealed that SSC of fruit juice was not affected with neither rootstocks nor storage intervals, in both studied seasons. Generally, it was clear that fruits grown in sandy soil had the highest record as gave (13.58 & 13.53) against those grown in clay soil which gave (12.12 & 12.22) while those of Calcareous soil recorded intermediate values (13.33 & 12.98).

Sandy soil:

Data in Table (5) clearly showed that regardless of storage interval, rootstocks did not affect soluble solids content percentage (SSC) of ‘Anna’ apple juice. Fruits grown on Malus rootstock had the highest SSC as gave 14.06 at 2003 season, while those grown on MM.106 gave the highest value (13.66) at season of 2004.

As for storage intervals, data showed that soluble solids content percentage did not give a clear trend during storage period and any of storage intervals not affected SSC.

Data in Table (5) concerned with interaction between rootstocks and storage intervals showed that both rootstocks gave the highest SSC values after 60 days of storage which Malus rootstock gave 15.20 at 2003 season, while MM.106 gave 14.33 at season of 2004.

Clay soil:

Regardless of storage interval, rootstocks did not affect soluble solids content of ‘Anna’ apple juice. Fruits grown on Malus rootstock had the highest SSC as gave 12.34 in the first season, while those grown on MM.106 gave the highest value (12.47) at second season.

With respect to storage intervals, data showed that SSC were not affected with or even get a clear trend during storage period.

Referring to interaction between rootstocks and storage intervals, data in Table (5) concerning SSC of 'Anna' apple fruits showed that MM.106 rootstock had the highest record as gave 13.06 at 60 days interval while Malus gave 13.00 after 90 days of cold storage, both in the first season.

Table (5): Effect of soil type and rootstock on SSC % of 'Anna' apple fruits during cold storage at 0° C.

Treats.[#]	Storage intervals per days										Mean	
	0		30		60		90		120			
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
SM	13.00	13.66	12.93	13.93	15.20	13.86	15.20	13.00	14.00	12.66	14.06	13.42
SMM	13.00	13.33	12.66	13.60	13.86	14.33	13.00	14.00	13.00	13.00	13.10	13.66
Mean	13.00	13.49	12.79	13.76	14.53	14.09	14.10	13.50	13.50	12.83	13.58	13.53
L.S.D at 5% [##]		A			B			A x B				
1st Season		0.87			1.05			1.23				
2nd Season		0.92			1.11			1.17				
CLM	11.60	11.73	12.60	11.00	12.93	12.00	13.00	12.80	11.60	12.40	12.34	11.98
CLMM	11.13	12.33	11.26	12.46	13.06	13.00	12.20	12.40	12.86	12.66	12.10	12.47
Mean	11.36	12.03	11.43	11.73	12.99	12.50	12.60	12.60	12.23	12.53	12.12	12.22
L.S.D at 5% [##]		A			B			A x B				
1st Season		0.91			1.13			1.28				
2nd Season		0.97			1.19			1.32				
CAM	13.13	12.13	12.00	13.60	13.26	13.00	13.00	13.60	13.40	12.66	12.95	12.99
CAMM	13.80	13.40	12.46	13.40	14.60	13.00	14.00	12.10	13.73	13.00	13.71	12.98
Mean	13.46	12.76	12.23	13.50	13.93	13.00	13.50	12.85	13.56	12.83	13.33	12.98
L.S.D at 5% [##]		A			B			A x B				
1st Season		0.95			1.16			1.22				
2nd Season		0.91			1.08			1.19				

#: S: Sandy soil – CL: Clay soil – CA: Calcareous soil – M: Malus rootstock – MM: MM.106 rootstock.
##: A: Rootstocks. B: Storage intervals A x B: Rootstocks and Storage intervals interaction.

Calcareous soil:

As for rootstocks regardless of storage intervals, data concerning soluble solids content showed that 'Anna' apple fruits grown on MM.106 had the highest SSC as gave 13.71 at 2003 season, while those grown on Malus gave the highest value (12.99) at season of 2004.

Concerning storage intervals regardless of rootstocks data of Table (5) showed that SSC of 'Anna' apple fruits was not affected. 60 days interval had the highest SSC value (13.93) while 30 days interval recorded the lowest one (12.23) in season 2003.

With respect to interaction between rootstocks and storage intervals, data in Table (5) concerning soluble solids content percentage (SSC%) showed that MM.106 rootstock had the highest record as gave 14.60 at 60 days interval in first season while, Malus rootstock gave 13.60 after 90 days of storage in the second season.

Acidity percentage :

Concerning rootstocks influences on acidity percentage of 'Anna' apple fruit juice, data in Table (6) cleared that regardless of storage interval, differences were not significant between both rootstocks in both seasons in all studied soil types. Generally, MM.106 rootstock recorded high values compared with Malus in the sandy and calcareous soils, while Malus was the superior in the clay soil, without significant differences in all cases. Meanwhile, fruit juice acidity records were decreased with advancing storage period, without significant differences in both studied seasons.

Sandy soil:

Regardless of storage interval, data in Table (6) concerned with influences of rootstocks on acidity percentage of juice illustrated that rootstocks did not show any significant effect. Meanwhile, MM.106 rootstock had the highest records as gave 0.57 and 0.58, Malus gave the lowest ones as get 0.49 and 0.46 in both seasons, respectively.

With respect to storage intervals, data showed that acidity percentage was significantly decreased as storage period advanced. It was clear that acidity percentages were gradually decreased from storage start (0.54 & 0.63) up to end of storage period (0.44 & 0.39), while other stipulated intervals gave intermediate values without significant differences among intervals, except between 0 and 120 days interval.

Referring to interaction between rootstocks and storage intervals, data concerning acidity % of 'Anna' apple fruits showed that both rootstocks at picking date (0 day of storage) had the highest significant acidity percentage compared with lowest value of 90 and 120 day intervals, in both seasons. Meanwhile, significance did not observed with any records of 30 and 60 day intervals.

Table (6): Effect of soil type and rootstock on acidity % of 'Anna' apple fruits during cold storage at 0º C.

Treats. #	Storage intervals per days										Mean	
	0		30		60		90		120			
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
SM	0.50	0.57	0.57	0.48	0.53	0.52	0.44	0.43	0.40	0.31	0.49	0.46
SMM	0.59	0.70	0.59	0.66	0.56	0.61	0.65	0.47	0.48	0.47	0.57	0.58
Mean	0.54	0.63	0.58	0.57	0.54	0.56	0.54	0.45	0.44	0.39	0.53	0.52
L.S.D at 5% ##			A			B			A x B			
1st Season			0.114			0.148			0.177			
2nd Season			0.108			0.159			0.163			
CLM	0.56	0.68	0.57	0.55	0.46	0.50	0.48	0.44	0.39	0.39	0.49	0.51
CLMM	0.55	0.57	0.55	0.53	0.48	0.50	0.42	0.36	0.39	0.34	0.48	0.46
Mean	0.55	0.62	0.56	0.54	0.47	0.50	0.45	0.40	0.39	0.36	0.48	0.48
L.S.D at 5% ##			A			B			A x B			
1st Season			0.101			0.162			0.194			
2nd Season			0.126			0.143			0.171			
CAM	0.51	0.55	0.51	0.58	0.51	0.56	0.44	0.40	0.42	0.40	0.48	0.49
CAMM	0.55	0.61	0.52	0.52	0.46	0.48	0.44	0.40	0.43	0.35	0.48	0.47
Mean	0.53	0.58	0.51	0.55	0.48	0.52	0.44	0.40	0.42	0.37	0.48	0.48
L.S.D at 5% ##			A			B			A x B			
1st Season			0.116			0.153			0.185			
2nd Season			0.122			0.147			0.191			

#: S: Sandy soil – CL: Clay soil – CA: Calcareous soil – M: Malus rootstock – MM: MM.106 rootstock.
##: A: Rootstocks. B: Storage intervals A x B: Rootstocks and Storage intervals interaction.

Clay soil:

Concerning rootstocks influence on acidity of 'Anna' apple fruit juice, data in Table (6) revealed that regardless of storage interval, Malus rootstock showed insignificant increase when compared with MM.106, in both investigated seasons.

As for storage intervals, data showed that differences among intervals of storage were insignificant. Only differences between acidity values at 0 day

interval (0.55 & 0.62) and at 120 days interval (0.39 & 0.36) recorded significance, in both seasons. Other stipulated intervals of storage period recorded intermediate insignificant values.

With respect to interaction between rootstocks and storage intervals, data concerning with fruit juice acidity showed that fruits grown on both rootstocks at picking date (0 day of storage) had the highest significant acidity percentage compared with lowest value of 90 and 120 days interval, in both seasons.

Calcareous soil:

Referring to rootstocks influences on fruit juice acidity, data showed that regardless of storage interval, rootstocks not affected acidity of 'Anna' apples in both seasons.

With respect to storage intervals, data showed that fruit juice acidity was gradually decreased as storage intervals were advanced. So, the highest values of fruit acidity were recorded for 0 day interval (0.53 & 0.58), and lowest values were for 120 days interval (0.42 & 0.37) in the two seasons, but differences reached significance in the second season only. Other intervals of storage recorded insignificant intermediate values.

Concerning the interaction between rootstocks and storage intervals, data showed that MM.106 rootstock had the highest significant fruit acidity as gave 0.61 at 0 day interval while gave lowest value (0.35) at 120 days interval, in the second season only. On the other hand, both rootstocks with other intervals of storage period recorded insignificant intermediate values.

Fruit shelf life :

Data of 'Anna' apples shelf life was tabulated in Table 7. Data revealed that fruit shelf life was increased when grown on Malus rootstock in a sandy soil significantly, and in a non significant manner in a clay one. On the other hand, Malus rootstock insignificantly reduced fruit shelf life in calcareous soil compared with MM.106 rootstock. Generally, it was clear that 'Anna' apples shelf life was decreased rapidly as intervals of storage period were advanced.

Sandy soil:

Response of shelf life of 'Anna' apples to rootstocks is shown in Table (7). Data showed that regardless of storage interval, Malus improved significantly shelf life as recorded 11.6 and 14.00 days against with 10.0 and 11.4 of MM.106 rootstock, in 2003 and 2004 seasons.

Concerning of storage intervals, data illustrated that 'Anna' apples shelf life was decreased as intervals of storage period were advanced. Although, 0 day storage interval recorded the longest values as gave (19.5 & 20.0), while at the end of storage period (120 days interval), recorded the lowest values (5.0 & 7.0) in both seasons, respectively. Other intervals of storage period

recorded intermediate values and differences among them were significant in most casses.

Data of interaction between rootstocks and storage intervals showed that apples grown on both rootstocks recorded the longest shelf life (20 days) at 0 day storage interval. On the other hand, fruits grown on MM.106 rootstock recorded the shortest life (4 days) at 120 days interval, while those grown on Malus recorded the lowest number of days (7) at 90 days interval, in first season.

Clay soil:

Regardless of storage intervals, data showed that apple fruits grown on Malus rootstock had the longest shelf life compared with those grown on MM.106, without significant differences in both seasons.

Concerning storage intervals, data in Table (7) showed that shelf life of 'Anna' apple fruits was decreased as intervals of storage period were advanced. So, data illustrated that 0 day storage interval recorded the longest shelf life as gave 17.0 and 17.5 days, while 120 days interval recorded the lowest ones (7.5 & 10.0 days) in both seasons. Other intervals of storage period recorded intermediate number of days and differences among them were significant in most cases.

With respect to interaction between rootstocks and storage intervals, data showed that both rootstocks recorded the longest shelf life (18 days) at 0 day storage interval, while lowest number of days recorded by Malus (7 days) and by MM.106 (8 days) at 120 days interval, in first season.

Calcareous soil:

Data in Table 7 concerned with rootstock influences on fruit shelf life illustrated that rootstocks did not show a significant effect. Fruits grown on MM.106 rootstock had the longest life as gave 10.2 days, while those grown on Malus gave the shortest ones as get 9.6 in both seasons.

With respect to storage intervals, data showed that fruit shelf life was significantly decreased as storage period advanced. It was clear that shelf life records were gradually decreased from storage start (15.5 & 16) up to 120 days interval (7.0 & 5.5), while other stipulated intervals gave intermediate records with significant differences among them.

Referring to interaction between rootstocks and storage intervals, data in Table (7) showed that both rootstocks at picking date had the longest significant fruit shelf life compared with shortest life at end of storage period (120 day interval), in both seasons.

Table (7): Effect of soil type and rootstock on shelf life (days) of 'Anna' apple fruits during cold storage at 0° C.

Treats. #	Storage intervals per days										Mean	
	0		30		60		90		120			
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
SM	20	20	15	15	9	14	7	13	7	8	11.6	14.0
SMM	19	20	14	15	7	9	6	7	4	6	10.0	11.4
Mean	19.5	20.0	14.5	15.0	8.0	11.5	6.5	10.0	5.5	7.0	10.8	12.7
L.S.D at 5% ##			A			B			A x B			
1st Season			1. 82			1. 49			2.04			
2nd Season			1. 74			1. 31			1.89			
CLM	18	17	13	16	11	14	9	13	7	11	11.6	14.2
CLMM	16	18	13	16	11	14	9	10	8	9	11.4	13.4
Mean	17.0	17.5	13.0	16.0	11.0	14.0	9.0	11.5	7.5	10.0	11.5	13.8
L.S.D at 5% ##			A			B			A x B			
1st Season			1.54			1.19			1.69			
2nd Season			1.43			1.27			1.78			
CAM	15	15	11	10	8	10	7	8	7	5	9.6	9.6
CAMM	16	17	12	12	9	9	7	7	7	6	10.2	10.2
Mean	15.5	16.0	11.5	11.0	8.5	9.5	7.0	7.5	7.0	5.5	9.9	9.9
L.S.D at 5% ##			A			B			A x B			
1st Season			1.61			1.17			1.79			
2nd Season			1.42			1.11			1.86			

#: S: Sandy soil – CL: Clay soil – CA: Calcareous soil – M: Malus rootstock – MM: MM.106 rootstock.
##: A: Rootstocks. B: Storage intervals A x B: Rootstocks and Storage intervals interaction.

DISCUSSION

The present results coincide with findings of El-Ansary *et al*. (1992), Turk (1993), Mahajan and Chopra (1998) and Elshemy and Elmorsy (2001) that apple fruit firmness and acidity were decreased as storage period was increased. In apple fruits a decrease in titratable acidity during ripening and storage may be attributed to an increase in malate decarboxylation system (Rhodes *et al*., 1968). Apple fruit cells have been reported to use organic

acids, principally malic acid as a respiratory substrates during ripening and storage (Ulrich, 1974).

The obtained data are also in agreement with Bartley and Knee (1982) on apple and Fatma Abd El-Wahab *et al*. (1983 a & b) and Elshemy and Mikhael (2006) on persimmon who reported that an increase in water soluble pectin and a decrease in insoluble pectin are characteristic of softening during storage in many fruits. This is due chiefly to the presence of pectinesterase activiy (Doesburg, 1965).

Results are in harmony with those of Turk (1993) on persimmon and Mahajan and Chopra (1998) and Elshemy and Elmorsy (2001) on apple that weight loss percentage were increased as storage was advanced. They added that soluble solids content were increased as storage period was increased while Chéour *et al*. (1991) in strawberry, reported that SSC was varied on its response and trend according to cultivar. On the other side, Mahajan and Chopra (1998) exhibted that TSS of fruits increased as the storage period advanced up to 150 days and declined thereafter towards the end of stipulated 210 days storage period, no influence was observed in our investigation. The increase in TSS may possibly be due to the numerous anabolic and catabolic processes taking place in the fruit, preparing it for senescence (Mahajan and Chopra, 1998). Hydrolysis of starch yielding mono and disccharides could be one of the reasons for the increase in TSS / sugars ratio, as on complete hydrolysis of starch, no further increase occurs and subsequently a decline in these parameter is predictable as they are the primary substrates for respiration (Wills *et al*.,1980).

Highest SSC records of fruits grown in a sandy soil againset those grown in a clay or calcareous ones may be attributed to its earlier maturation. So, it was predicted that differences among fruit sources at harvest were generally reflected in the storage levels.

Best firmness retention in 'Anna' apples was achieved of MM.106 rootstock. It may be a result of a good Ca ions absorption of MM.106 root which in turn increased its tissues content of calcium (Gabr *et al.*, 2006). Sharples and Jhonson (1977) reported that examples taken from studies on the storage quality of apples indicate that the rate of senescence often depends on the calcium statius of the tissue and that by increasing calcium levels, a number of senescence processes can be partly delayed. It is convenient to divide the evidence into two main groups, one concerned with the effects of calcium on fruit condition and storage disorders and the other dealing with its influence on the normal ageing of apple tissue.

REFERENCES

A. O. A. C. (1990). Official methods of analysis. Association of official analytical Chemists (15th ed.). Washington, DC, USA.

Bartley, I. and M. Knee (1982). The chemistry of textural changes in fruit during storage. Food Chem. 9:47-58.

Carré, M. H. and D. Haynes (1922). The estimation of pectin as calcium pectate and the application of this method to the determination of soluble pectin in apples. Biochem. J. 16:60.

Chéour, F., C. Willemot, J. Arul, J. Makhlouf and Y. Desjardins (1991). Postharvest response of two strawberry cultivars to foliar applicatyion of $CaCl_2$. HortScience 26 (9):1186-1188.

Doesburg, J. J. (1965). Pectic substances in fresh and preserved fruits and vegetables. IBVT Communication No. 25.

El-Ansary, M. M., H. M. Ayaad and F. El-Morshed (1992). The effect of spraying and post-harvest treatment with calcium chloride on the fruit quality changes of "Anna" apple during cold storage at 4°C. Acta Agronomica Hungarica 41(3-4):209-213.

Elshemy, M. A. and A. A. Elmorsy (2001). Quality of Anna apple fruits during cold storage as affected by hand thinning, $CaCl_2$ and hot water dipping treatments. J. Agric. Sci. Tanta Univ. 27 (2): 334 – 347.

Elshemy, M. A. and G. B. Mikhael (2006). Physiological changes of japanese persimmon fruits during storage as related to alternate bearing. J. Agric. Sci. Mansoura Univ. 31(2): 915 – 925.

Fallahi, E., D. G. Richardson and M. Westwood (1985). Influence of rootstocks and fertilizers on ethylene in apple fruit during maturation and storage. J. Amer. Soc. Hort. Sci. 110 (2): 149-153.

Fatma, K. Abd El-Wahab, F. A. El-Latif, A. B. Abou Aziz and M. A. Maksoud (1983 a). Artificial ripening of "Costata" persimmon fruits. Annals Agric. Sci., Fac. Agric. Ain Shams Univ. 26(1):273-286.

Fatma, K. Abd El-Wahab, A. B. Abou Aziz, F. A. El-Latif and M. A. Maksoud (1983 b). Behaviour of persimmon fruits under cold storage. Annals Agric. Sci., Fac. Agric. Ain Shams Univ. 26(1):287-299.

Gabr, M. A., Mervat A. Elshimy, G. B. Mikhael and Somaia A. Elsayed (2006). Evaluation of soil type and rootstock influences on: a) vegetative growth, nutritional status, yield and fruit quality of 'Anna' apple trees. Minufiya. J. Agric. Res., 31 (5):1239-1251.

Irristat (1999). Version 4.0.2.0 International Rice Research Institute (I. R. R. I.). Biometric Unit. Manila, Philippines.

Joshua, D. Klein; Susan Lurie and Ruth Ben-Arie (1990). Quality and cell wall components of 'Anna' and 'Granny Smith' apples treated with heat, calcium and ethylene J. Amer. Soc. Hort. Sci. 115:954-958.

Mahajan, B. V. C. And S. K. Chopra (1998). Effect of preharvest of ethylene inihibtors on the ethylene evolution, and quality of apple during cold storage. Indian J. Hort. 55(2):113-119.

Marini, R. P., J. A. Barden, J. A., Cline, R. L. Perry and Terence Robinson (2002). Effect of apple rootstocks on average 'Gala' fruit weight at four locations after adjusting for crop load. J. Amer. Soc. Hort. Sci. 127(5):749-753.

Rhodes, M. J. C., L. S. C. Wooltorton, T. Gallard and A. C. Hulme (1968). Metabolic changes in excised fruit tissue. I. Factors affecting the development of malate decarboxylation system during the ageing of disc of pre-climacteric apples. Phytochem. 7:439.

Rouchaud, J., C. Moons and J. A. Meyer (1985). Cultivar differences in the influence of harvest date and cold storage on the free sugars and acids contents, and on the eating quality of apples. J. Hort. Sci. 60(3):291-296.

Saeid, I. A. and M. A. Khalil (1992). Evaluation of some cultivars compared with Anna cultivar on two rootstocks. J. Agric. Sci. Mansoura Univ. 17 (12): 3900 – 3905.

Sharples, R. O. and D. S. Jhonson (1977). The influence of calcium on senescence changes in apple. Ann. Appl. Biol. 85: 450-453.

Thomas Fernandez, R., R. L. Perry and J. A. Flore (1997). Drought response of young apple trees on three rootstocks: Growth and development . J. Amer. Soc. Hort. Sci. 122(1):14-19.

Turk, R. (1993). The cold storage of persimmon (*Diospyros kaki* cv. *Fuyo*) harvested ah different maturities and the effect of different CO_2 applications on fruit ripening. Acta Horticulturae 343:190-194.

Ulrich, R. (1974). Biochemistry of fruits and their products. Academic Press. New York. pp.89-118.

Wills, R. B. H., P. A. Bembridge and K. J. Scott (1980). Use of flesh firmness and other objective tests to determine the consumer acceptability of Delicious apple. Aust. J. Exp. Agri. Anim. Husb. 20:252-256.

تقييم تأثير نوع التربة و الأصل على
: ب) الجودة والقدرة التخزينية لثمار التفاح "آنا"

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الملخص العربي

أجري هذا البحث بغرض دراسة تأثير نوع التربة و الأصل على مواصفات الجودة و القدرة التخزينية لثمار التفاح صنف "آنا" خلال عامي ٢٠٠٣ – ٢٠٠٤ ، بمحافظة البحيرة في منطقة البستان حيث التربة رملية أو جيرية و بمحافظة الغربية في قرية شبرا النملة حيث التربة الطينية , و تم إجراء البحث على أشجار التفاح "آنا" عمر سبع سنوات ، المطعومة على أصلي المالص و م م. ١٠٦ ، و قد تم جمع الثمار عند وصولها للنضج الفسيولوجي وتم التخزين عند درجة صفر ° م و رطوبة نسبية ٨٥ – ٩٠% و لفترات تخزينية ٣٠ – ٦٠ – ٩٠ – ١٢٠ يوم

ازدادت النسبة المئوية للفقد في الوزن كما ازداد محتوى الثمرة من البكتين الذائب كلما ازدادت الفترة التخزينية في حين انخفض عمر الرف وصلابة القشرة وصلابة لب الثمرة ، كما لوحظ انخفاض حموضة العصير ولكن بدون فرق معنوي بين الفترات التخزينية ما عدا الفرق بين تاريخ جمع الثمار (فترة صفر تخزين) و عند ١٢٠ يوم تخزين فقد كان معنويا ، بينما لم يتأثر محتوى العصير من المواد الصلبة بأي من الأصول أو الفترات التخزينية. و كانت ثمار الأشجار النامية في تربة رملية ذات محتوى أعلى معنويا من المواد الصلبة عن تلك النامية في تربة طينية بينما النامية في تربة جيرية فقد أعطت قيم متوسطة.

لم تؤدي زراعة الأشجار على أي من الأصلين إلي زيادة معنوية في حموضة العصير في كل أنواع الترب التي تم دراستها ، في حين أدت زراعة الأشجار على أصل المالص إلى زيادة عمر الرف للثمرة معنويا في التربة الرملية وبدون معنوية في التربة الطينية في حين كان الانخفاض معنوي في التربة الجيرية مقارنة بأصل م م.١٠٦. كما أدت زراعة الأشجار على أصل المالص في التربة الرملية إلي زيادة النسبة المئوية للفقد في وزن الثمرة مقارنة بالأشجار النامية على أصل م م. ١٠٦. أما بالنسبة للصلابة فبالرغم من عدم تأثرها معنويا فقد أظهرت ثمار الأشجار النامية في التربة الرملية أو الطينية على أصل م م. ١٠٦ قيم أعلى لصلابة لب الثمرة من تاريخ جمع الثمار (فترة صفر تخزين) و استمرت ١٢٠ يوم حتى نهاية فترة التخزين ، كذلك ثمار الأشجار النامية على أصل م م.١٠٦ في التربة الجيرية فقد أعطت قيم أعلى لصلابة قشرة و لب الثمرة من تلك النامية على أصل المالص.

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