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IMPACT OF SOME CHEMICAL TREATMENTS AND LENGTH OF STORAGE ON THE STORABILITY OF S UGAR BEET

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Abstract

An experiment was conducted at the Agricultural Research Center of Al Ghab, General Commission for Scientific Agricultural Research (GCSAR), Syria, to evaluate the effect of some chemical application on the sugar losses reduction, and some quality traits in 2014/2015 season. Three slaked lime concentrations of 5, 10 and 15 percent, and three concentrations of calcium chloride of 2, 4, and 6%, and a mix of 5% slaked lime with 2% calcium chloride, beside the check (no treatment) (factor C). The second factor (D) was the storage durations of 6 days, and tow varieties (Factor V) were arranged as factorial experiment in RCBD with four replications. The varieties one of them was monogerm (Vico), while the other was multigerm (Reda), they were drilled in mid November, and storage roots were harvested late August. Weight percent loss and quality of beet samples such as sugar content, total soluble solids (TSS %), and purity% were determined throughout storage period. The results of analysis of variance ANOVA showed that effect of varieties was significant for TSS (brix %), sucrose%, root weight loss ($P<0.05$). All the studied traits were affected significantly ($P<0.05$) by storage duration. Chemical treatments had significant effect on all the studied traits ($P<0.05$), and the best treatment was with calcium chloride 6%. The percentage of variance confirmed that the most effective factor for the all studied traits was the storage period, followed by the varieties, and finally in a very low percent was the chemical treatments, because of that it is very urgent to send the harvested roots immediately to the factories to be processed within 24 hours, or treated with calcium chloride of 6% to preserve the sugar content as possible till manufacturing. Also the study concluded that the mutigerm variety Reda deteriorated less that the monogerm variety Vico, so Reda is recommended to be stored if necessary.

Key words: Slaked lime, Chloride calcium, Sugar losses, Storage duration, Sugar beet.

Introduction

Sugar beet (*Beta vulgaris* L.) is the second important sugar crop after sugar cane; produce about 30 % of total world production and have readily adaptable to different environmental factors including climate (El Hag Mohammad *et al*., 2015). Sugar beet is the main and only source of sugar in Syria (AL Jbawi et al., 2015a). Al Ghab is the main area for growing sugar beet in Syria (Al Jbawi et al., 2011). Sugar beet is sown from mid October onwards mid November, and from mid January to mid February, and the operation is normally completed by September. The harvesting period, takes place between late June and late September, when the amount of sugar in the beet is at its highest. As late season growth declines, the pace of harvesting quickens to ensure the crop is safely gathered in before the onset of damaging summer high temperatures.

During storage, respiration, rotting, and physical deterioration decrease extractable sucrose in beet roots (Campbell and Klotz, 2006; Campbell et al., 2008; Al Jbawi et al., 2015b). Beet quality is affected by storage conditions (Miyamoto et al., 1989; Bzowska-Bakalarz, 1991; Al Jbawi et al., 2015b). The reduction in sucrose percentage leads to a substantial decrease in revenue for the sugar industry, and can have significant economic impact, when multiplied over the volume of roots processed and the time in storage. Because of that the ultimate goal of the sugar industry is to store sugar beets with a minimum of weight and sugar loss (Jaggard et al., 1997; Kenterand and Hoffmann, 2006; Kenter et al., 2006).

Many studies confirmed that chemical treatments is a good solution to reduce the loss in sugar content and root loss throughout spraying beet roots with calcium hydroxide Ca(OH)2 (5%) (Gibriel et al., 2003), or a mixture of calcium hydroxide (5%) and calcium chloride (2%) (Yousif and Abou El-Magd, 2004). These chemicals increased root hardness, and reflects sunlight because of its white color, so thus reduces the temperature.

Learning about the effect of those factors shall enable to define the optimum conditions for harvesting and storage of the tested varieties. The aim of the present study was to quantify changes in the quality of beet roots during storage outdoors in piles, in order to investigate whether the chemical treatment is an appropriate to prolong the processing campaign, and to improve the storability of sugar beet roots.

Materials and Methods

The experiment was carried out at Agricultural Research Center, (GCSAR), Al Ghab, Syria, during 2014/2015 season. The study included two varieties, the source of those genotypes were clarified in Table (1). Three slaked lime concentrations of 5, 10 and 15 percent, and three concentrations of calcium chloride of 2, 4, and 6%, and a mix of 5% slaked lime with 2% calcium chloride, beside the check (no treatment), and storage durations of 6 days.

Table 1: The source of sugar beet varieties

Genotype	Germity	Source
Vico	monogerm	Belgium
Reda	multigerm	Belgium

Source: Sugar Beet Department (GCSAR)

The trail was planted in a density of 100 000 plant.ha^{-1} (50 X 20) (Al Jbawi *et al.*, 2009), on 15 November. Plots were eight rows wide, (50-cm row spacing), and 20 cm within plants in each row. The plot size was 32 m^2, and 8 m long. The soil classifies as sandy clayed, low content of organic matters, high nitrogen and phosphorous contents, and good content of potassium, because of that no nitrogen, potassium, and phosphorous fertilizers addition. The previous crop was wheat. The crop was harvested after 240 days after sowing. The temperatures during September at harvest reached 41°C (Table 2).

Table 2: Temperatures during 2014/2015 storage period

Season	**2014/2015**	
Date	**Max. Temperature °C**	**Min. Temperature °C**
1/9/2015	38.5	22.6
2/9/2015	39.0	21.0
3/9/2015	40.0	19.5
5/9/2015	39.0	24.0
6/9/2015	37.0	20.5
7/9/2015	41.0	20.5
8/9/2015	33.0	24.5

Source: Meteorology Station in Al Ghab

During the 2014/2015 storage period, temperatures began 38.5°C and attained after 7 days in storage 33°C (Table 2). The temperature remained above 37°C for the remainder of the storage period.

Root samples:

The center six rows were manually harvested on 1 September and topped. Six beet sugar samples per plot were collected for sugar analysis during harvest. At the same time, a sample per plot for each chemical treatment was collected and placed in a nylon mesh onion bag in natural conditions, at the average temperature of 33^{o}C (Table 2). However, temperature changes in the piles are not predictable and vary considerably at different depths of the pile (Jaggard et al. 1997). The storage period from harvest to the final measurement was 10 days.

Studied traits

Sucrose was determined polarimetrically (McGinnis, 1982). Juice purity was calculated using the procedures described by Dexter *et al*., (1967). Sucrose concentrations for the samples obtained were expressed on a fresh weight basis. Subsample of brie 50 g dried in a vacuum oven at 85°C to constant weight to calculate water content. Prior to placing the storage samples in the pile, each sample was weighed. The samples were reweighed when retrieved from the storage pile. These weights were used to determine reduction in root weight.

Experiment design and statistical analysis

Factorial Experiment in Randomized Completely Block Design (RCBD) was used with four replicates, to analyze the source of variations (ANOVA), and the interaction. The statistical program GenStat. V. 12 was used. Least significant difference was used at 5% level of probability.

Results and discussion

The effect of chemical treatments and postharvest on the Total Soluble Solids % (Brix%):

The differences between varieties in terms of this trait (Table 3) were significant ($P \leq 0.05$), Reda variety gave the highest brix% value (28.2), compared to Vico (27.7) over all studied factors (D and C). So thus the monogerm variety was deteriorated less compared to multigerm variety according to this trait, it gave less value. The statistical analysis shows that prolonging postharvest period of beet roots in the fields leads to an increase in brix% significantly; this result is accompany with Kenter and Hoffmann, (2008) who stated that storage conditions in piles had negative consequences of accumulation of non sucrose substances. The highest values were achieved in the last days of storage 31.5%, and 31.7% for the fifth and sixth days, respectively (Table, 4). The loss percentage was 31.0%, the results are in a link with Smith and Ruppel, 1971; Bugbee, 1993; Wiltshire and Cobb, 2000, who concluded that the environment affect subsequent storage losses. Regarding the differences between chemical treatments, they have almost the same effect on this trait (Tables 3 and 4).

Table 3. Analysis of variance (ANOVA) of TSS (Brix)%

Source of variance	df	MS	Variance%	P
Replications	**3**	16.91	3.3	-
Chemical treatment (C)	**7**	17.71	3.4	0.002
Storage period (D)	**5**	786.92	151.4	<.001
Varieties (V)	**1**	28.79	5.5	0.019
C * D	**15**	6.40	1.2	0.182
C * V	**3**	6.92	1.3	0.235
D * V	**5**	2.16	0.4	0.838
C * D * V	**35**	5.88	1.1	0.288

DF : Degree of Freedom = n – 1, MS : Mean Square = SS / DF, SS : Sum of Squares

Variance % = (MS Factor / MS Total) * 100, P : Probability 0.05

Table 4. The effect of chemical treatments and postharvest on brix% of two sugar beet varieties during 2014/2015 season

Day D	Variety V	Chemical treatment C								
		Check (not treated)	$Ca(OH)_2$ 5%	$Ca(OH)_2$ 10%	$Ca(OH)_2$ 15%	Ca Cl_2 2%	Ca Cl_2 4%	Ca Cl_2 6%	$Ca(OH)_2$ 5% + Ca Cl_2 2%	Mean
1	Vico	23.1	23.1	24.1	24.4	23.4	23.8	24.9	25.0	**24.0**
	Reda	24.4	24.6	25.0	26.7	22.8	23.7	24.4	23.9	**24.4**
Mean		**23.7**	**23.9**	**24.5**	**25.5**	**23.1**	**23.8**	**24.6**	**24.4**	**24.2[d]**
2	Vico	24.4	23.8	24.2	23.3	23.4	25.8	24.4	24.4	**24.2**
	Reda	24.3	24.7	24.9	24.6	23.4	25.0	25.1	25.3	**24.7**
Mean		**24.4**	**24.2**	**24.5**	**24.0**	**23.4**	**25.4**	**24.7**	**24.8**	**24.4[d]**
3	Vico	25.7	25.9	26.1	25.2	25.6	26.4	26.4	26.4	**26.0**
	Reda	27.6	24.9	25.5	26.1	26.5	26.7	25.5	24.2	**25.9**
Mean		**26.7**	**25.4**	**25.8**	**25.6**	**26.0**	**26.6**	**25.9**	**25.3**	**25.9[c]**
4	Vico	29.5	29.7	29.6	29.7	27.8	31.3	28.9	30.2	**29.6**
	Reda	30.8	30.2	29.9	30.7	31.1	30.5	30.1	30.6	**30.5**
Mean		**30.2**	**29.9**	**29.7**	**30.2**	**29.4**	**30.9**	**29.5**	**30.4**	**30.0 [b]**
5	Vico	30.1	30.4	29.9	31.7	31.4	32.7	32.8	29.8	**31.1**
	Reda	33.8	32.3	31.7	28.0	31.3	33.3	31.8	33.2	**31.9**
Mean		**32.0**	**31.3**	**30.8**	**29.9**	**31.4**	**33.0**	**32.3**	**31.5**	**31.5 [a]**
6	Vico	30.6	30.1	28.9	32.2	29.7	39.1	30.4	29.6	**31.3**
	Reda	31.4	31.2	32.1	32.8	30.9	33.5	32.3	31.9	**32.0**
Mean		**31.0**	**30.7**	**30.5**	**32.5**	**30.3**	**36.3**	**31.3**	**30.7**	**31.7 [a]**
General mean		**28.0[b]**	**27.6 [b]**	**27.6 [b]**	**28.0 [b]**	**27.3 [b]**	**29.3 [a]**	**28.1 [b]**	**27.9 [b]**	**28.0**
Varieties mean		**Vico**					**Reda**			
		27.7[b]					**28.2[a]**			
LSD 0.05		**C=0.92*, V=0.46*, D=0.79*, CxV=1.30, CxD=2.24, VxD=1.12, CxVxD=3.17**								
CV%		**8.2**								

The effect of chemical treatments and postharvest on sucrose %:

The results in Table (5) shows a significant effect of all studied factors on sucrose%, Reda variety (20.5%) surpassed Vico (19.2), according to sucrose%, The chemical treatment with calcium chloride 6% had a significant effect, compared with the other treatments, and attained the highest sucrose value (20.4%) (Table 6).

Prolonging postharvest period of beet roots leads to an increase in sucrose% significantly ($P \leq 0.05$); the highest value was achieved in the fifth day of storage 22.3%. The increment percentage was 11.0%, this increase in sucrose% because of the reduction in water content as a result of high temperature during storage period (Table 2). Because of that, this increment is not a good indicator, this reduction in water content of the roots make them lose their refreshment and affect negatively sugar extraction during manufacturing in sugar factories. During storage sugar concentration is reported to decline by around 0.02% per day (Jaggard et al., 1997). The increment in clamp temperature improve the respiratory losses thereby root damage (Wiltshire and Cobb, 2000). The high temperatures hydrolyses sucrose to give the reducing sugars, glucose and fructose, which are then used in respiration (Wiltshire and Cobb, 2000). Respiration rate is highly and predictably correlated with sucrose loss (Youssif and Abou El-Magd, 2004; Kenter and Hoffmann, 2008).

Table 5.Analysis of variance (ANOVA) of sucrose%

Source of variance	df	MS	Variance%	P
Replications	**3**	0.74	0.7	-
Chemical treatment (C)	**7**	10.58	9.6	<.001
Storage period (D)	**5**	180.07	162.7	<.001
Varieties (V)	**1**	14.90	13.5	<.001
C * D	**15**	2.94	2.7	<.001
C * V	**3**	6.11	5.5	<.001
D * V	**5**	1.02	0.9	0.470
C * D * V	**35**	2.80	2.5	<.001

DF : Degree of Freedom = n – 1, MS : Mean Square = SS / DF, SS : Sum of Squares
Variance % = (MS Factor / MS Total) * 100, P : Probability 0.05

Table 6: The effect of chemical treatments and postharvest on sucrose% of two sugar beet varieties during 2014/2015 season

Day D	Variety V	Chemical treatment C								
		Check (not treated)	$Ca(OH)_2$ 5%	$Ca(OH)_2$ 10%	$Ca(OH)_2$ 15%	$CaCl_2$ 2%	$CaCl_2$ 4%	$CaCl_2$ 6%	$Ca(OH)_2$ 5% + $CaCl_2$ 2%	Mean
1	Vico	16.6	16.9	17.5	18.7	17.5	17.6	20.0	19.0	**18.0**
	Reda	17.4	18.3	18.6	18.6	17.2	19.0	18.2	18.3	**18.2**
Mean		**17.0**	**17.6**	**18.0**	**18.6**	**17.3**	**18.3**	**19.1**	**18.6**	**18.1^{f}**
2	Vico	17.7	17.6	18.9	19.2	18.0	18.3	20.3	17.9	**18.5**
	Reda	17.7	19.4	18.8	19.2	18.2	18.4	19.1	18.7	**18.7**
Mean		**17.7**	**18.5**	**18.8**	**19.2**	**18.1**	**18.4**	**19.7**	**18.3**	**18.6^{e}**
3	Vico	19.6	18.4	18.4	19.6	19.4	19.6	20.7	21.2	**19.6**
	Reda	21.4	19.7	20.2	19.5	19.2	20.6	19.9	18.9	**19.9**
Mean		**20.5**	**19.0**	**19.3**	**19.6**	**19.3**	**20.1**	**20.3**	**20.1**	**19.8^{d}**
4	Vico	21.3	21.7	20.4	21.1	20.8	22.0	22.1	23.1	**21.6**
	Reda	23.2	21.2	20.9	21.1	21.1	21.3	23.9	21.8	**21.8**
Mean		**22.2**	**21.5**	**20.6**	**21.1**	**20.9**	**21.7**	**23.0**	**22.5**	**21.7^{b}**
5	Vico	20.4	24.2	20.8	20.7	21.2	22.4	22.5	24.0	**22.0**
	Reda	23.4	23.5	21.1	22.1	22.3	24.3	23.2	21.4	**22.7**
Mean		**21.9**	**23.9**	**20.9**	**21.4**	**21.7**	**23.4**	**22.8**	**22.7**	**22.3^{a}**
6	Vico	19.3	20.5	19.2	18.9	19.3	19.7	21.0	20.2	**19.8**
	Reda	20.1	19.5	20.2	22.5	20.6	20.1	21.0	20.4	**20.5**
Mean		**19.7**	**20.0**	**19.7**	**20.7**	**19.9**	**19.9**	**21.0**	**20.3**	**20.1^{c}**
General mean		**19.8^{cd}**	**20.1^{bc}**	**19.6^{d}**	**20.1^{bc}**	**19.5^{d}**	**20.3^{bc}**	**21.0^{a}**	**20.4^{b}**	**20.1**

Varieties mean	Vico	Reda
	19.2^{b}	20.5^{a}
LSD $_{0.05}$	C=0.43*, V=0.21*, D=0.37*, CxV=0.60*, CxD=1.04*, VxD=0.52, CxVxD=1.46*	
CV%	5.2	

The effect of chemical treatments and postharvest on purity %:

The differences between varieties according to purity% were not significant (Table 7). The statistical analysis shows that prolonging postharvest period of beet roots leads to reduction in purity% significantly (P≤0.05). The reduction percentage was 12.0% (Table 8). This decrease in purity% because of the increase in brix%, because the correlation between those two traits is negative (Al Jbawi et al., 2015b). Spraying roots with calcium chloride 6% attained the highest purity percentage (83.7%), but the difference was not significant compared to the check (82.8%) (Table 8). The percentage of variance in Table (7) explains that the period storage had the highest effect on purity% (41.69%), followed by the chemical treatments (3.19%), and finally the varieties (0.39%). The second level of interaction (C*D*V) had a significant influence on this trait, but the first level of interactions had no substantial impact.

Table 7.Analysis of variance (ANOVA) of purity%

Source of variance	df	MS	Variance%	P
Replications	**3**	143.01	4.18	-
Chemical treatment (C)	**7**	108.97	3.19	0.003
Storage period (D)	**5**	1424.71	41.69	<.001
Varieties (V)	**1**	13.23	0.39	0.534
C * D	**15**	45.50	1.33	0.108
C * V	**3**	49.11	1.44	0.190
D * V	**5**	6.36	0.19	0.968
C * D * V	**35**	62.12	1.82	0.005

DF : Degree of Freedom = n – 1, MS : Mean Square = SS / DF, SS : Sum of Squares
Variance % = (MS Factor / MS Total) * 100, P : Probability 0.05

Table 8: The effect of chemical treatments and postharvest on purity% of two sugar beet varieties during 2014/2015 season

Day D	Variety V	Chemical treatment C								Mean
		Check (not treated)	$Ca(OH)_2$ 5%	$Ca(OH)_2$ 10%	$Ca(OH)_2$ 15%	$Ca\,Cl_2$ 2%	$Ca\,Cl_2$ 4%	$Ca\,Cl_2$ 6%	$Ca(OH)_2$ 5% + $Ca\,Cl_2$ 2%	
1	**Vico**	81.6	80.2	85.4	84.4	82.5	83.7	83.6	84.6	**83.2**
	Reda	84.7	81.0	82.0	78.8	79.6	87.7	84.4	86.3	**83.1**
Mean		**83.2**	**80.6**	**83.7**	**81.6**	**81.1**	**85.7**	**84.0**	**85.4**	**83.2^{bc}**
2	**Vico**	82.2	81.9	89.5	85.9	83.8	83.1	88.1	84.9	**84.9**
	Reda	86.6	87.7	84.7	86.5	80.2	85.7	84.8	83.1	**84.9**
Mean		**84.4**	**84.8**	**87.1**	**86.2**	**82.0**	**84.4**	**86.4**	**84.0**	**84.9^{ab}**
3	**Vico**	86.8	85.3	83.1	82.9	89.0	84.7	85.7	89.5	**85.9**
	Reda	85.9	90.6	87.3	83.8	85.8	85.7	91.2	89.0	**87.4**

Mean		**86.3**	**87.9**	**85.2**	**83.3**	**87.4**	**85.2**	**88.5**	**89.2**	**86.6^{a}**
4	**Vico**	78.9	81.4	78.4	77.5	81.5	76.2	83.2	84.1	**80.2**
	Reda	81.8	78.8	83.0	78.5	76.4	78.8	85.2	79.0	**80.2**
Mean		**80.3**	**80.1**	**80.7**	**78.0**	**79.0**	**77.5**	**84.2**	**81.6**	**80.2^{d}**
5	**Vico**	84.9	86.9	83.7	74.7	76.9	78.1	78.1	89.4	**81.6**
	Reda	86.7	85.0	71.2	90.4	83.1	73.5	87.9	80.1	**82.3**
Mean		**85.8**	**86.0**	**77.5**	**82.5**	**80.0**	**75.8**	**83.0**	**84.7**	**81.9^{cd}**
6	**Vico**	77.5	76.4	76.4	72.2	74.8	59.6	78.8	69.2	**73.1**
	Reda	76.3	72.3	71.9	70.4	76.0	72.1	73.6	73.9	**73.3**
Mean		**76.9**	**74.4**	**74.2**	**71.3**	**75.4**	**65.9**	**76.2**	**71.6**	**73.2^{e}**
General mean		**82.8^{ab}**	**82.3^{ab}**	**81.4^{abc}**	**80.5^{bc}**	**80.8^{bc}**	**79.1^{c}**	**83.7^{a}**	**82.8^{ab}**	**81.7**
Varieties mean		**Vico**				**Reda**				
		81.5^{a}				**81.9^{a}**				
LSD $_{0.05}$		**C=2.35*, V=1.17, D=2.03*, CxV=3.32, CxD=5.75, VxD=2.88, CxVxD=8.14***								
CV%		**7.2**								

The effect of chemical treatments and postharvest on root weight loss:

Storing beet after harvest causes loss in moisture, which increases the degree of wilting and changes processing properties (Vukov, 1977; Trzebinski, 1984). The results in Table (9) shows that the differences between varieties were significant ($P \leq 0.05$), Vico variety (13.3%) surpassed, the variety Reda (11.6%), this means that the monogerm varieties deteriorated more than the multigerm, this result disagrees with Al Jbawi et al. (2015b), who stated that the deterioration in muligerm varieties is higher compared to monogerm varieties. The chemical treatments affected this trait significantly ($P < 0.05$). The weight loss of the check attained the highest value (15.2%), while the roots which treated with slaked lime 15%, calcium chloride 2, and 6%, and the mix treatment gave the lowest loss in root weight, 11.7, 11.6, 11.6, and 11.6, respectively.

The statistical analysis shows that postponing postharvest period of beet roots leads to reduction in root weight loss significantly ($P \leq 0.05$). The reduction percentage was 114.2% (Table 10), this decrease in root weight loss% because of high temperature during storage period (Table 2). Kenter and Hoffmann (2008) and Al Jbawi et al. (2015b) confirmed that the storage duration and temperature have large significant on the changes of beet quality and water content.

Table 9. Analysis of Variance (ANOVA) of root weight loss%

Source of variance	df	MS	Variance%	P
Replications	**3**	11.29	5.3	-
Chemical treatment (C)	**7**	79.14	37.3	<.001
Storage period (D)	**5**	811.12	381.8	<.001
Varieties (V)	**1**	275.74	129.8	<.001
C * D	**15**	4.15	2.0	0.002
C * V	**3**	32.25	15.2	<.001
D * V	**5**	4.40	2.1	0.069
C * D * V	**35**	2.82	1.3	0.109

DF : Degree of Freedom = n – 1, MS : Mean Square = SS / DF, SS : Sum of Squares
Variance % = (MS Factor / MS Total) * 100, P : Probability 0.05

Table 10: The effect of chemical treatments and postharvest on root weight loss % of two sugar beet varieties during 2014/2015 season

Day D	Variety V	Chemical treatment C								
		Check (not treated)	$Ca(OH)_2$ 5%	$Ca(OH)_2$ 10%	$Ca(OH)_2$ 15%	$Ca\ Cl_2$ 2%	$Ca\ Cl_2$ 4%	$Ca\ Cl_2$ 6%	$Ca(OH)_2$ 5% + $Ca\ Cl_2$ 2%	Mean
1	**Vico**	12.7	9.6	9.7	7.8	10.6	6.9	9.0	5.6	**12.7**
	Reda	9.1	6.5	7.7	8.4	7.1	8.3	6.8	8.0	**9.1**
Mean		**10.9**	**8.0**	**8.7**	**8.1**	**8.9**	**7.6**	**7.9**	**6.8**	**8.4^{f}**
2	**Vico**	14.9	12.4	11.2	8.8	9.4	8.6	10.3	9.0	**10.6**
	Reda	10.4	8.4	8.5	9.4	8.1	10.4	7.7	9.9	**9.1**
Mean		**12.6**	**10.4**	**9.8**	**9.1**	**8.7**	**9.5**	**9.0**	**9.4**	**9.8^{e}**
3	**Vico**	14.6	13.5	12.1	10.2	10.7	9.9	10.4	10.8	**11.5**
	Reda	11.1	10.6	9.4	9.8	9.6	10.8	8.8	10.9	**10.1**
Mean		**12.9**	**12.1**	**10.7**	**10.0**	**10.1**	**10.4**	**9.6**	**10.8**	**10.8^{d}**
4	**Vico**	16.0	15.5	14.6	11.7	12.2	12.4	13.9	12.8	**13.6**
	Reda	12.2	14.1	11.2	13.0	11.8	13.2	10.7	12.1	**12.3**
Mean		**14.1**	**14.8**	**12.9**	**12.4**	**12.0**	**12.8**	**12.3**	**12.4**	**13.0^{c}**
5	**Vico**	20.7	17.6	16.8	14.2	13.4	15.5	15.5	14.2	**16.0**
	Reda	15.9	14.8	13.2	13.8	13.2	15.0	12.0	13.8	**13.9**
Mean		**18.3**	**16.2**	**15.0**	**14.0**	**13.3**	**15.3**	**13.8**	**14.0**	**15.0^{b}**
6	**Vico**	23.1	20.0	20.7	17.4	18.1	18.5	19.9	16.6	**19.3**
	Reda	22.1	18.1	16.7	15.3	14.9	16.6	14.4	15.3	**16.7**
Mean		**22.6**	**19.0**	**18.7**	**16.3**	**16.5**	**17.5**	**17.2**	**15.9**	**18.0^{a}**
General mean		**15.2^{a}**	**13.4^{b}**	**12.6^{c}**	**11.7^{d}**	**11.6^{d}**	**12.2^{cd}**	**11.6^{d}**	**11.6^{d}**	**12.5**
Varieties mean		**Vico**				**Reda**				
		13.3^{a}				**11.6^{b}**				
LSD $_{0.05}$		**C=0.59*, V=0.29*, D=0.51*, CxV=0.83*, CxD=1.43*, VxD=0.72, CxVxD=2.03**								
CV%		**11.7**								

Conclusion

- A gradual increment in the total soluble solids (brix %) (31.5%), low sugar percent, and juice purity % at the end of storage period as compared with the first day. Also the results clarified. The percent of decrement in root weight loss% was 114.2 % for the all varieties and all chemical treatments.
- The percentage of variance confirmed that the most effective factor for the all studied traits was the storage period, followed by the varieties, and finally in a very low percent was the chemical treatments, because of that it is very urgent to send the harvested roots immediately to the factories to be processed within 24 hours, or treated with calcium chloride of 6% to preserve the sugar content as possible till manufacturing.

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