Journal of Plant Production

Journal homepage: www.jpp.mans.edu.eg
Available online at: www.jpp.journals.ekb.eg

Study the Losses in Sugar Beet Roots After Harvesting and Reducing it by using Different Storage Methods, Covering and Spraying Treatments during Storage Periods

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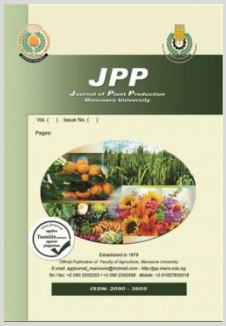

ABSTRACT

A research experiment was conducted after sugar beet harvesting season of 2018/2019 to study the losses in sugar beet roots and reducing it by using different storage methods (shadow and sun light), covering (without, rice straw, sugar beet foliages and net) and spraying treatments (without, tap water and Mepiquat chloride at 0.5, 1.0 and 1.5 cm/L) during storage periods (one, two, three and four weeks) under environmental conditions of Dakahlia Governorate, Egypt. The experiment was carried out in factorial experiment in randomized complete blocks design with three replicates. The highest values of root fresh weight/plant, root length and diameter and infestation percentage and lowest root weight loss percentage were recorded when stored under shading. The highest values of root fresh weight/plant, root length and diameter and lowest root weight loss percentages were recorded when covering root piles with sugar beet foliages, followed by covering with rice straw. The highest values of root fresh weight/plant, root length and diameter and lowest root weight loss percentages and infestation percentages of sugar beet roots were recorded when spraying piles of sugar beet roots with Mepiquat chloride at 1.0 cm/L. It can be concluded that stored sugar beet roots after harvesting directly in piles under shading and covering with beet foliages and spraying piles with Mepiquat chloride at 1.0 cm/L to reduce losses in sugar beet roots after harvesting and during storage and achieve high apparent characters of roots under the environmental conditions of Dakahlia Governorate, Egypt

Keywords: Sugar beet, losses in roots, storage methods, covering treatment, spraying with Mepiquat chloride.

INTRODUCTION

Sugar beet is a specially type of *Beta vulgaris* L. (*Beta valgaris* var. *saccharifera* L.) grown for sugar production and is considered the most important sugar crop in Egypt and in many countries all over the world besides sugar cane (*Sacchurum officinarum* L.). Recently, sugar beet crop has an important position in Egyptian crop rotation as winter crop not only in the fertile soils, but also in poor, saline alkaline and calcareous soils. Sugar beet being, often, the most important cash crop in the rotation, it leaves the soil in good conditions for the benefit of the following cereal crops. By-products of sugar production, such as pulp, molasses and lime, flow bath into agriculture to increase livestock production and improve soil fertility as well as provide various middle products as alcohol, forage and other many products.

Most of sugar beet crop is planted in the winter and harvested in the spring and summer in Egypt. Sugar beet crop is a crop that has a rapid deterioration in its chemical and technological properties after harvest, so this crop cannot be stored in sun light. Nevertheless, sugar beet roots must be removed from the ground at maturity and sugar factories must be run for several months to process the crop economically. Because of these factors, the harvest period usually is compressed into a short period of time, and large quantities of sugar beet roots are stored for some days prior to processing.

Storage conditions are important factors affecting the losses of technological value of sugar beet roots (Al-Abdalla *et al.*, 2010). Besides crop management and environmental conditions during the growing season also affect subsequent storage losses (Wiltshire and Cobb, 2000). Al-Jaridi (2009) found that the weight loss of topped and untapped roots increased at the end of storing period, where elevated percentages were showed by the topped roots stored under sunlight 47.61% and the untapped roots stored in shade 40.04%. Lafta and Fugate (2009) reported that storage sucrose loss increased by as much as 50% in roots that lost 9% of their weight due to desiccation and sucrose losses increased linearly with further water-related weight loss. Al-Abdallah *et al.* (2010) revealed that after harvest, most of the beets is stored in piles, which respiration, rotting, and physical deterioration decrease extractable sucrose. Alfaig *et al.* (2011) stated that the obtained results showed marked differences among the storage methods (storage at room, outdoors and underground temperature) and periods (24 h, 48 h, 72 h, one week, two weeks and one month). Underground storage scored the best results, which were comparable with the control (fresh). Al-Zubi *et al.* (2015) found that weight and weight loss percent were significantly reduced throughout storage periods. Karim (2015) showed that the moisture content in the roots of beets was decreased

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DOI: 10.21608/jpp.2021.178931

during the storage period by a large percentage and was observed at the beginning of storage at 79% and reached the end of storage to 61.9% at day 12. Hoffmann and Schnepel (2016) concluded that root tip breakage contributes considerably to storage losses of sugar beet. For long-term storage it is therefore of particular importance to avoid damage during the harvest operations and furthermore, to have genotypes with high storability and low susceptibility to damage. Abd El-Rahman *et al.* (2019) concluded that the storage of sugar beet roots in sun light without top (but covered with its top) or without top (without covering) was better in case of sugar recovery, followed by in room storage.

Changes in root characteristics are closely related to the loss of tissue turgor. Also, loss of moisture and thus turgor drop and increase of the degree of wilting, changes processing properties of the crop as well as the strength parameters of the root (Trzebinski, 1984). Abou-Shady (1994) revealed that sugar beet roots stored and covering by tops had the lowest deterioration rate in recoverable sugar. Ferweez and El-Dengawy (2004) stated that sugar beet roots could be held under covering by tops. It is not advisable to leave harvested roots under sun even for one day, as its lost significant weight. Karim (2015) showed that the rate of moisture decrease was lower in the roots stored by covering with beet throne in an open atmosphere. Mohamed *et al.* (2017) indicated that the moisture content of the sugar beet roots was decreased accompanied by an increase in the daily weight loss rate, where the best results in the roots covering with beet throne.

Sugar loss represents a substantial decrease in revenue for the sugar industry, and even small reductions in storage losses can have significant economic impact, when multiplied over the volume of roots processed and the time in storage. Mohamed (2002) revealed that sugar beet roots stored by spraying with milk of lime had the lowest deterioration rate in recoverable sugar yield/fed. Ferweez and El-Dengawy (2004) stated that sugar beet roots could be held under spraying by $Ca(OH)_2$ 20% in store room. It is not advisable to leave harvested roots under sun even for one day, as its lost significant weight. Al-Zubi *et al.* (2015) found that chemical treatments *i.e.* three lime concentrations of 5, 10 and 15 %, 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) had significant effect on root weight and weight loss percentage, and the best treatment was with calcium chloride 6%.

Therefore, this study was established to determine the effect of storage methods, covering and spraying treatments of sugar beet roots during storage periods on losses of roots after harvesting and apparent characters of roots under the environmental conditions of Dakahlia Governorate, Egypt.

MATERIALS AND METHODS

A research experiment was conducted at Kafr Allam Village, Miniat El-Nasr Center, Dakahlia Governorate, Egypt, after the sugar beet harvesting season of 2018/2019 to study the losses in sugar beet roots after harvesting and reducing it by using different storage methods, covering and spraying treatments of sugar beet roots during storage periods.

The experiment was carried out in factorial experiment in randomized complete blocks design (RCBD) with three replicates. The first factor included two storage methods of roots after harvesting *i.e.* storage sugar beet roots in shadow and in sun light. After harvesting sugar beet immediately, roots were storage in piles under shading net that used in greenhouses or under sun light conditions as shown in Fig. 1.

The second factor incorporated with the four covering treatments of sugar beet roots *i.e.* without covering (control treatment), covering with rice straw, sugar beet foliages and net. Under shadow or sun light conditions, piles of sugar beet roots were covered with suitable amount of rice straw or sugar beet foliages or net, which does not allow light to penetrate the roots besides control treatment (without covering) as shown in Fig. 2.

The third factor integrated with five spraying treatments of sugar beet roots with different rates of growth retardant such as Mepiquat chloride *i.e.* without spraying (control treatment), spraying with tap water and spraying with Mepiquat chloride at the rates of 0.5, 1.0 and 1.5 cm/L. Under different storage methods and covering treatments, piles of sugar beet roots were sprayed with about 6 liters of tap water or solution of mepiquat chloride at the rates of 0.5, 1.0 or 1.5 cm/L, that is enough to wet all the sugar beet roots in the pile, in addition control treatment (without spraying) as shown in Fig. 3. Mepiquat chloride (N, N-dimethylpiperidinium chloride) 25 %, well known as PIX, is a potential systemic plant growth regulator used as the active ingredient for controlling excessive vegetative growth of various crops. Mepiquat chloride used in this study was manufactured by Suzhou Eagro Limited, China and obtained from Agrocomp Company for Trade and Distribution, Nasr City, Cairo.

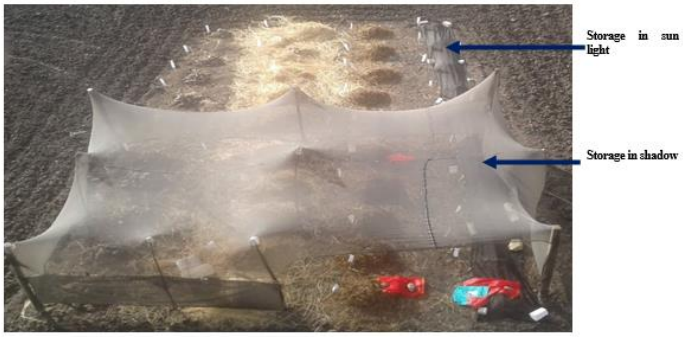

Fig. 1. Storage methods of sugar beet roots after harvesting.

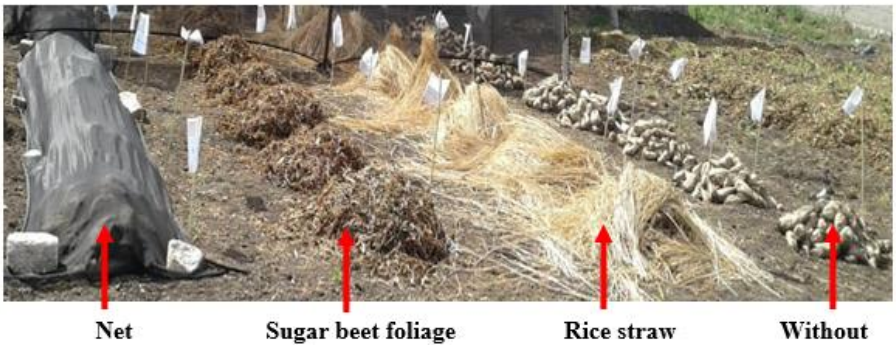

Fig. 2. Covering treatments of sugar beet roots during storage.

Fig. 3. Spraying treatments of sugar beet roots before storage.

Sugar beet field was planted on 2nd September, 2018 and harvested on 6th April, 2019 and the this study was started on 16th April, 2019 by storage sugar beet root for a four weeks.

The sugar beet cultivar that used in this study was Hossam, which is one of multigerm sugar beet cultivars, and annually imported from Holland by Sugar Crop Research Institute, Agricultural Research Center, Giza, Egypt.

Under field conditions of the study site, all studied storage methods, covering and spraying treatments were done as previously described.

In all studied treatments, about 70 kg of sugar beet root were put in pile in each replicate and then stored, covered and sprayed before beginning the study as formerly mentioned.

Before beginning the study and after storage periods (one, two, three and four weeks from beginning the study), ten sugar beet root were randomly taken from harvested sugar beet roots and each sugar beet piles (forty piles in each replicate) to determine the following apparent characters:

1. Root fresh weight (kg/plant). It was measured as averages weight of ten sugar beet roots.
2. Root weight loss percentage (%). It was estimated by calculating the percentage of root weight difference between the first to the second week, the second to the third week and the third to the fourth week.
3. Root length (cm). It was measured as the means of length of ten sugar beet roots.
4. Root diameter (cm). It was measured by using a varnier caliper as the means of ten sugar beet roots.
5. Infestation percentage of sugar beet roots (%). Ten sugar beet roots were randomly taken manually from different depths form each pile. Roots which having any manifestation of fungal infection were considered as infested. The infestation level was expressed as number and percentage of infested roots.

$$\text{Infestation roots (\%)} = \frac{\text{Number of infested roots}}{\text{Number of total roots in heap}} \times 100$$

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for factorial experiment in randomized complete blocks design (RCBD) to each storage period (one, two, three and four weeks from beginning the study), then combined analysis was done between storage periods as published by Gomez and Gomez (1984) by using means of "MSTAT-C" computer software package. Least significant difference (LSD) method was used to test the differences among treatment means at 5 % level of probability as described by Snedcor and Cochran (1980).

RESULTS AND DISCUSSION

1. Effect of storage methods:

Regarding the effect of studied storage methods for sugar beet roots (stored sugar beet roots under shading net that used in greenhouses and in stored sugar beet roots sun light "as control method") on apparent characters (root fresh weight/plant, root weight loss percentage, root length, root diameter and infestation percentage of sugar beet roots), it was significant after one, two, three and four weeks from beginning the study and combined over storage periods as shown in Tables 1 and 2.

It is clearly seen that, the highest values of root fresh weight/plant, infestation percentage, root length and root diameter of sugar beet roots were recorded when stored sugar beet roots under shading net after one, two, three and four weeks from beginning the study and combined over storage periods as shown in Tables 1 and 2. Whereas, the

lowest values of root fresh weight/plant, root length, root diameter and infestation percentage of sugar beet roots were recorded when stored sugar beet roots in sun light as control method after one, two, three and four weeks from beginning the study and combined over storage periods.

However, stored sugar beet roots in piles under shading net conditions indexed the lowest root weight loss percentages (from first to second week, second to third week and third to fourth week as well as combined over storage periods) as shown in Table 1. Despite the fact that, stored sugar beet roots in sun light conditions (control method) outcomed the highest root weight loss percentages (from first to second week, second to third week and third to fourth week as well as combined over storage periods).

The reason that caused enhancement sugar beet apparent characters due to stored under shading net may be due to prevent deterioration caused by physical, chemical and biological factors, where the moisture content of the sugar beet roots was decreased by increasing storage period and storage on sun light conditions which accompanied with increase in the daily weight loss rate, where the best results in the roots that stored in the shade (Mohamed *et al*., 2017). Comparable results were stated by Al-Zubi *et al.* (2015).

2. Effect of covering treatments:

With reference to the effect of studied covering treatments of sugar beet roots *i.e.* without covering (control treatment), covering sugar beet roots with rice straw, sugar beet foliages and net on apparent characters (root fresh weight/plant, infestation percentage, root length and root diameter of sugar beet roots), it is apparent from obtained results that studied covering treatments of sugar beet roots significantly affected apparent characters of sugar beet roots after one, two, three and four weeks from beginning the study and combined over storage periods as shown in Tables 1 and 2.

The highest values of root fresh weight/plant, root length and root diameter were recorded when covering root piles with sugar beet foliages, followed by covering piles of sugar beet roots with rice straw, and then covering piles of sugar beet roots with net after one, two, three and four weeks from beginning the study and combined over storage periods as shown in Tables 1 and 2. However, the lowest values of root fresh weight/plant, root length and root diameter were produced from the piles of sugar beet roots left without covering (control treatment) after one, two, three and four weeks from beginning the study and combined over storage periods.

On the other hand, the lowest root weight loss percentages (from first to second week, second to third week and third to fourth week as well as combined over storage periods) were obtained by covering sugar beet piles after harvesting with sugar beet foliages, followed covering sugar beet piles after harvesting with rice straw, and then covering sugar beet piles after harvesting with net as shown in Table 1. While, control treatment (without covering sugar beet piles after harvesting) produced in the highest root weight loss percentages (from first to second week, second to third week and third to fourth week as well as combined over storage periods).

Table 1. Root fresh weight/plant, root weight loss and infestation percentages of sugar beet as affected by storage methods, covering and spraying treatments of sugar beet roots as well as their interactions during storage periods and its combined.

Storage periods Treatments	Root fresh weight (kg/plant)					Root weight loss (%)				Infestation (%)				
	1st week	2nd week	3rd week	4th week	Com.	1st to 2nd week	2nd to 3rd week	3rd to 4th week	Com.	1st week	2nd week	3rd week	4th week	Com.
A- Storage methods:														
Shadow	1.619	1.435	1.037	0.783	1.218	10.99	28.07	24.17	21.08	16.69	11.54	5.31	3.84	9.35
Sun light	1.549	1.295	0.898	0.613	1.089	16.19	30.47	30.50	25.72	8.68	5.80	3.14	2.59	5.05
F. test	*	*	*	*	*	*	*	*	*	*	*	*	*	*
B- Covering treatments:														
Without	1.440	1.223	0.841	0.609	1.028	14.87	31.30	31.16	25.78	10.23	5.23	0.00	0.00	3.86
Rice straw	1.592	1.368	0.992	0.723	1.169	13.41	27.76	26.71	22.63	16.57	13.69	8.47	6.89	11.41
Foliages	1.821	1.569	1.087	0.820	1.324	12.04	26.95	24.37	21.12	12.57	10.05	8.45	5.97	8.96
Net	1.482	1.299	0.949	0.639	1.093	14.04	31.06	27.09	24.06	11.36	5.71	0.00	0.00	4.57
F. test	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LSD (0.05)	0.046	0.041	0.047	0.036	0.034	1.60	1.80	1.57	1.45	0.13	0.14	0.06	0.05	0.05
C- Spraying treatments:														
Without	1.374	1.190	0.770	0.567	0.975	15.16	34.98	31.18	27.11	19.12	13.29	6.34	4.64	10.85
Water	1.464	1.277	0.851	0.628	1.055	13.26	33.39	28.99	25.21	15.46	9.91	5.08	3.74	8.55
MC 0.5 cm/L	1.605	1.385	0.988	0.689	1.167	13.51	28.28	26.14	22.64	10.84	6.98	3.33	2.64	5.95
MC 1.0 cm/L	1.778	1.508	1.104	0.832	1.305	12.51	23.07	24.41	20.00	8.36	5.98	3.12	2.34	4.95
MC 1.5 cm/L	1.699	1.466	1.125	0.773	1.266	13.51	26.63	25.96	22.03	9.63	7.19	3.29	2.70	5.70
F. test	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LSD (0.05)	0.043	0.046	0.044	0.040	0.037	1.54	1.37	1.42	1.55	0.15	0.15	0.08	0.07	0.06
D- Interactions (F. test):														
A × B	*	*	*	*	*	*	*	NS	*	*	*	*	*	*
A × C	NS	*	*	*	*	*	NS	*	*	*	*	*	*	*
B × C	*	*	*	NS	*	NS	*	*	*	*	*	*	*	*
A × B × C	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Com. = Combined, Foliages= Sugar beet foliages, MC = Mepiquat chloride

Table 2. Root length and diameter of sugar beet as affected by storage methods, covering and spraying treatments of sugar beet roots as well as their interactions during storage periods and its combined.

Storage periods	Root length (cm)					Root diameter (cm)				
Treatments	1st week	2nd week	3rd week	4th week	Com.	1st week	2nd week	3rd week	4th week	Com.
A- Storage methods:										
Shadow	25.08	22.25	19.85	18.56	21.43	10.26	9.36	8.20	7.95	8.94
Sun light	23.54	20.94	18.68	17.80	20.24	10.09	9.09	7.95	7.78	8.73
F. test	*	*	*	*	*	*	*	*	*	*
B- Covering treatments:										
Without	23.95	21.18	18.69	17.76	20.39	10.06	8.94	7.70	7.49	8.55
Rice straw	24.39	21.77	19.43	18.21	20.95	10.18	9.37	8.21	8.02	8.94
Foliages	24.96	22.06	19.88	18.73	21.41	10.30	9.54	8.32	8.13	9.07
Net	23.93	21.37	19.06	18.02	20.59	10.15	9.06	8.07	7.82	8.78
F. test	*	*	*	*	*	*	*	*	*	*
LSD (0.05)	0.38	0.36	0.35	0.26	0.18	0.09	0.23	0.20	0.21	0.09
C- Spraying treatments:										
Without	23.16	20.24	18.29	17.19	19.72	10.00	8.90	7.58	7.45	8.48
Water	23.63	20.95	18.77	17.62	20.24	10.10	9.13	7.86	7.66	8.69
MC 0.5 cm/L	24.11	21.60	19.11	18.14	20.74	10.18	9.21	8.11	7.85	8.84
MC 1.0 cm/L	25.73	23.03	20.59	19.29	22.16	10.34	9.53	8.53	8.27	9.16
MC 1.5 cm/L	24.91	22.15	19.56	18.66	21.32	10.26	9.36	8.31	8.10	9.01
F. test	*	*	*	*	*	*	*	*	*	*
LSD (0.05)	0.42	0.40	0.40	0.29	0.21	0.10	0.25	0.22	0.23	0.11
D- Interactions (F. test):										
A × B	*	*	*	*	*	*	*	*	*	*
A × C	*	NS	NS	*	*	NS	*	NS	*	*
B × C	NS	*	*	NS	NS	*	NS	*	NS	NS
A × B × C	*	*	*	*	*	*	*	*	*	*

Com. = Combined, Foliages= Sugar beet foliages, MC = Mepiquat chloride

The highest infestation percentages of sugar beet roots after harvesting were obtained by covering sugar beet piles after harvesting with rice straw, followed covering sugar beet piles after harvesting with sugar beet foliages straw, and then covering sugar beet piles after harvesting with net after one, two, three and four weeks from beginning the study and combined over storage periods as shown in Table 1. While, control treatment (without covering sugar beet piles after harvesting) produced in the lowest infestation percentages of sugar beet roots after harvesting after one, two, three and four weeks from beginning the study and combined over storage periods.

The increases in improvement sugar beet apparent characters by covering root piles with sugar beet foliages or rice straw may be ascribed to maintain the moisture content of the sugar beet roots in addition decreasing the daily weight loss rate and lowest enzyme activity (Mohamed *et al.*, 2017).

3. Effect of spraying treatments:

Studied spraying treatments of sugar beet roots (without spraying "control treatment", spraying with tap water, Mepiquat chloride at the rates of 0.5, 1.0 and 1.5 cm/L) had significant effects on apparent characters (root fresh weight/plant, root weight loss percentage, root length, root diameter and infestation percentage of sugar beet roots) after one, two, three and four weeks from beginning the study and combined over storage periods as shown in Tables 1 and 2.

The highest values of root fresh weight/plant, root length and root diameter were recorded when spraying piles of sugar beet roots with Mepiquat chloride as growth retardant at the rate of 1.0 cm/L, followed by spraying piles of sugar beet roots with Mepiquat chloride at the rate of 1.5 cm/L, then spraying piles of sugar beet roots with Mepiquat chloride at the rate of 0.5 cm/L and spraying piles of sugar beet roots with tap water after one, two, three and four weeks from beginning the study and combined over storage periods as shown in Tables 1 and 2. Whereas, the lowest values of root fresh weight/plant, root length and root diameter after one, two, three and four weeks from beginning the study and combined over storage periods.

The lowest root weight loss percentages (from first to second week, second to third week and third to fourth week as well as combined over storage periods) and infestation percentages of sugar beet roots after one, two, three and four weeks from beginning the study and combined over storage periods were resulted when spraying sugar beet roots piles before storage with Mepiquat chloride at the rate of 1.0 cm/L, followed by spraying sugar beet roots piles before storage with Mepiquat chloride at the rate of 1.5 cm/L, then spraying sugar beet roots piles before storage with Mepiquat chloride at the rate of 0.5 cm/L and spraying sugar beet roots piles before storage with tap water as shown in Table 1. Even as, control treatment (without spraying sugar beet roots piles before storage with any treatment) produced in the highest root weight loss percentages (from first to second week, second to third week and third to fourth week as well as combined over storage periods) and infestation percentages of sugar beet roots after one, two, three and four weeks from beginning the study and combined over storage periods.

Chemical treatments is a good solution to reduce the loss in sugar content and root loss throughout spraying beet roots with calcium hydroxide or a mixture of calcium hydroxide and calcium chloride. These chemicals increased root hardness, and reflects sunlight because of its white color, so thus reduces the temperature (Youssif and Abou El-Magd, 2004). The reason that caused enhancement sugar beet apparent characters due to spraying piles of sugar beet roots with Mepiquat chloride as growth retardant at the rate

of 1.0 cm/L may be due to the role of Mepiquate chloride (pix) that has been widely used to reduce deterioration rate of root tissues and the daily weight loss rate (Mohamed, 2002). These results are in agreement with those stated by Ferweez and El-Dengawy (2004) and Al-Zubi *et al.* (2015).

4. Effect of interactions:

Sugar beet root fresh weight/plant, root weight loss percentage, root length, root diameter and infestation percentage of sugar beet roots were significantly affected by the interaction among the studied factors *i.e.* storage methods, covering and spraying treatments of sugar beet roots after one, two, three and four weeks from beginning the study and combined over storage periods as shown in Tables 1 and 2.

The highest values of root fresh weight/plant, root length and root diameter and the lowest root weight loss percentages were recorded when stored sugar beet roots in piles under shading net and covering with sugar beet foliages in addition spraying piles roots with Mepiquat chloride as growth retardant at the rate of 1.0 cm/L after one, two, three and four weeks from beginning the study and combined over storage periods as shown in Tables 3 and 4.

While, the lowest values of root fresh weight/plant, root length and root diameter and the highest root weight loss percentages were recorded when stored sugar beet roots in piles under sun light conditions without covering and spraying with Mepiquat chloride after one, two, three and four weeks from beginning the study and combined over storage periods.

Table 3. Root fresh weight/plant, root weight loss and infestation percentages of sugar beet as affected by the interaction among storage methods, covering and spraying treatments of sugar beet roots during storage periods and its combined.

Characters / Storage periods / Treatments			Root fresh weight (kg/plant)					Root weight loss (%)				Infestation percentage (%)				
			1st week	2nd week	3rd week	4th week	Com.	1st to 2nd week	2nd to 3rd week	3rd to 4th week	Com.	1st week	2nd week	3rd week	4th week	Com.
Shadow	Without	Without	1.320	1.133	0.688	0.503	0.911	13.67	38.63	31.32	27.87	18.67	8.63	0.00	0.00	6.82
		Water	1.413	1.230	0.792	0.543	0.995	13.07	36.34	25.97	25.13	15.63	5.43	0.00	0.00	5.26
		MC 0.5 cm/L	1.507	1.347	0.852	0.638	1.086	12.57	35.74	25.05	24.45	11.33	5.16	0.00	0.00	4.12
		MC 1.0 cm/L	1.616	1.410	1.023	0.880	1.232	10.27	24.62	13.25	16.05	8.23	4.54	0.00	0.00	3.19
		MC 1.5 cm/L	1.558	1.383	1.043	0.817	1.200	11.08	27.35	20.45	19.63	8.37	4.75	0.00	0.00	3.28
	Rice straw	Without	1.500	1.293	0.785	0.608	1.047	13.65	39.06	29.82	27.51	40.36	33.83	17.99	14.38	26.64
		Water	1.516	1.337	0.901	0.769	1.131	11.81	32.40	26.94	23.72	37.13	27.26	16.76	13.18	23.58
		MC 0.5 cm/L	1.581	1.402	1.143	0.834	1.240	11.41	18.02	25.91	18.45	14.87	13.25	5.53	4.40	9.51
		MC 1.0 cm/L	1.704	1.527	1.303	0.963	1.374	6.53	24.05	16.56	15.71	12.32	11.89	5.50	3.71	8.35
		MC 1.5 cm/L	1.640	1.481	1.280	0.897	1.324	9.98	14.57	22.34	15.63	13.62	13.17	6.00	5.51	9.58
	Foliages	Without	1.483	1.387	0.926	0.770	1.142	15.70	33.12	27.06	25.29	25.76	23.58	16.76	9.40	18.87
		Water	1.683	1.488	1.063	0.817	1.263	15.35	29.01	23.39	22.58	14.99	13.92	13.38	7.67	12.49
		MC 0.5 cm/L	2.037	1.753	1.243	0.907	1.485	13.84	28.36	22.24	21.48	9.40	9.04	8.67	6.65	8.44
		MC 1.0 cm/L	2.243	1.891	1.437	1.177	1.687	9.71	13.21	14.73	12.55	8.22	8.02	7.32	5.89	7.36
		MC 1.5 cm/L	2.143	1.814	1.360	1.053	1.593	10.68	24.79	17.91	17.79	10.55	9.32	8.42	6.04	8.58
	Net	Without	1.290	1.197	0.764	0.565	0.954	9.20	36.06	33.54	26.27	30.23	10.20	0.00	0.00	10.10
		Water	1.383	1.267	0.843	0.673	1.041	8.65	33.47	33.27	25.13	20.48	7.23	0.00	0.00	6.92
		MC 0.5 cm/L	1.480	1.343	1.007	0.716	1.136	8.25	24.90	27.99	20.38	15.33	6.95	0.00	0.00	5.57
		MC 1.0 cm/L	1.683	1.537	1.163	0.772	1.289	7.17	23.59	19.83	16.86	8.59	6.44	0.00	0.00	3.75
		MC 1.5 cm/L	1.595	1.480	1.129	0.754	1.239	7.18	24.18	25.88	19.08	9.70	8.32	0.00	0.00	4.50
Sun light	Without	Without	1.270	1.027	0.663	0.463	0.856	24.51	39.18	38.35	34.01	9.08	6.17	0.00	0.00	3.81
		Water	1.290	1.156	0.704	0.508	0.914	19.09	35.31	34.30	29.57	8.03	5.81	0.00	0.00	3.46
		MC 0.5 cm/L	1.372	1.109	0.861	0.550	0.973	18.06	28.09	30.01	25.39	7.89	4.44	0.00	0.00	3.08
		MC 1.0 cm/L	1.543	1.167	0.832	0.617	1.040	10.32	23.14	25.27	19.58	6.62	2.73	0.00	0.00	2.33
		MC 1.5 cm/L	1.510	1.267	0.957	0.569	1.076	16.10	24.64	26.95	22.56	8.50	4.72	0.00	0.00	3.30
	Rice straw	Without	1.490	1.183	0.730	0.524	0.982	20.44	38.08	35.20	31.24	10.47	9.17	8.21	7.23	8.77
		Water	1.513	1.243	0.857	0.556	1.042	17.52	37.80	34.77	30.03	9.48	7.76	6.62	5.76	7.40
		MC 0.5 cm/L	1.593	1.343	0.832	0.609	1.094	16.57	32.71	27.76	25.68	9.78	7.25	6.59	5.50	7.28
		MC 1.0 cm/L	1.753	1.510	1.017	0.776	1.264	13.74	20.86	23.24	19.28	8.36	6.35	6.07	4.38	6.29
		MC 1.5 cm/L	1.633	1.363	1.077	0.697	1.193	15.58	30.93	26.41	24.31	9.30	7.02	5.50	4.89	6.67
	Foliages	Without	1.417	1.238	0.804	0.601	1.015	17.10	38.42	35.18	30.23	10.82	9.19	7.76	6.15	8.48
		Water	1.546	1.370	0.843	0.630	1.097	16.85	35.91	28.27	27.01	8.60	7.64	3.89	3.38	5.87
		MC 0.5 cm/L	1.807	1.553	0.990	0.707	1.264	14.05	35.14	24.84	24.68	9.19	6.41	5.86	4.57	6.50
		MC 1.0 cm/L	1.940	1.613	1.053	0.797	1.351	11.48	27.31	23.84	20.88	7.22	5.42	6.07	4.75	5.86
		MC 1.5 cm/L	1.910	1.583	1.150	0.745	1.347	12.48	34.51	24.46	23.82	8.84	7.99	6.41	5.22	7.11
	Net	Without	1.221	1.058	0.798	0.503	0.895	19.27	28.63	35.91	27.94	7.62	5.55	0.00	0.00	3.29
		Water	1.367	1.127	0.803	0.528	0.956	16.94	27.60	34.93	26.49	9.36	4.26	0.00	0.00	3.40
		MC 0.5 cm/L	1.462	1.227	0.975	0.550	1.053	15.65	25.54	34.31	25.17	8.96	3.39	0.00	0.00	3.08
		MC 1.0 cm/L	1.743	1.407	1.005	0.673	1.207	13.05	21.11	32.31	22.16	7.33	2.50	0.00	0.00	2.45
		MC 1.5 cm/L	1.600	1.353	1.009	0.653	1.154	15.01	24.41	33.64	24.35	8.16	2.25	0.00	0.00	2.60
LSD (0.05)			0.085	0.082	0.075	0.074	0.076	2.17	2.15	2.25	2.31	0.42	0.43	0.20	0.18	0.16

Com. = Combined, Foliages= Sugar beet foliages, MC = Mepiquat chloride

Table 4. Root length and diameter of sugar beet of sugar beet as affected by the interaction among storage methods, covering and spraying treatments of sugar beet roots during storage periods and its combined.

Characters			Root length (cm)					Root diameter (cm)				
Storage periods		Treatments	1st week	2nd week	3rd week	4th week	Com.	1st week	2nd week	3rd week	4th week	Com.
Shadow	Without	Without	23.50	21.58	18.33	17.18	20.15	10.19	9.01	7.38	7.17	8.44
		Water	24.00	21.66	18.66	17.69	20.50	10.22	9.08	7.80	7.21	8.58
		MC 0.5 cm/L	24.33	21.89	18.55	17.99	20.69	10.23	9.16	8.13	7.46	8.74
		MC 1.0 cm/L	26.78	23.08	20.00	19.22	22.27	10.24	9.50	8.50	7.52	8.94
		MC 1.5 cm/L	26.11	22.00	19.33	18.44	21.47	10.25	9.40	8.44	7.47	8.89
	Rice straw	Without	24.55	20.33	18.89	17.33	20.27	10.00	9.17	8.01	7.78	8.74
		Water	25.04	21.66	19.67	17.61	20.99	10.17	9.22	8.21	8.05	8.91
		MC 0.5 cm/L	25.11	22.74	20.23	18.66	21.68	10.30	9.35	8.31	8.19	9.04
		MC 1.0 cm/L	26.37	23.55	21.44	19.44	22.70	10.40	9.53	8.53	8.53	9.25
		MC 1.5 cm/L	25.66	23.00	20.41	19.33	22.10	10.36	9.44	8.39	8.33	9.13
	Foliages	Without	24.33	20.66	19.66	18.33	20.75	10.16	9.15	7.95	7.69	8.74
		Water	24.66	22.30	20.33	18.99	21.57	10.22	9.47	8.19	8.13	9.00
		MC 0.5 cm/L	25.56	22.77	20.55	19.22	22.03	10.33	9.76	8.22	8.31	9.15
		MC 1.0 cm/L	26.51	23.45	22.55	20.33	23.21	10.51	9.85	8.98	8.85	9.55
		MC 1.5 cm/L	25.89	23.38	20.89	19.88	22.51	10.44	9.80	8.31	8.48	9.25
	Net	Without	23.89	20.77	18.56	17.85	20.27	10.09	8.88	7.83	7.58	8.59
		Water	24.29	21.22	19.00	18.03	20.63	10.17	9.06	8.02	7.64	8.72
		MC 0.5 cm/L	24.55	22.22	19.44	17.89	21.02	10.25	9.30	8.13	7.88	8.89
		MC 1.0 cm/L	25.66	24.00	20.78	19.33	22.44	10.37	9.63	8.40	8.37	9.19
		MC 1.5 cm/L	24.77	22.77	19.79	18.40	21.43	10.32	9.51	8.38	8.31	9.13
Sun light	Without	Without	21.22	19.31	17.29	16.59	18.60	9.57	8.28	7.04	7.26	8.04
		Water	22.33	19.85	17.78	17.00	19.24	9.81	8.35	7.13	7.47	8.19
		MC 0.5 cm/L	22.77	20.00	18.21	17.22	19.55	9.85	8.76	7.27	7.52	8.35
		MC 1.0 cm/L	24.77	21.83	19.77	18.63	21.25	10.16	8.97	7.92	7.94	8.75
		MC 1.5 cm/L	23.66	20.66	19.00	17.62	20.23	10.08	8.85	7.42	7.88	8.56
	Rice straw	Without	21.89	19.66	18.00	16.62	19.04	9.96	9.26	7.37	7.37	8.49
		Water	22.22	20.66	18.22	17.02	19.53	10.08	9.33	7.89	7.76	8.76
		MC 0.5 cm/L	23.33	21.33	18.44	18.26	20.34	10.14	9.34	8.30	7.98	8.94
		MC 1.0 cm/L	25.55	22.77	19.66	19.22	21.80	10.27	9.55	8.59	8.09	9.12
		MC 1.5 cm/L	24.22	22.00	19.33	18.66	21.05	10.16	9.51	8.50	8.11	9.07
	Foliages	Without	23.66	20.33	17.77	17.07	19.71	10.05	9.18	7.54	7.41	8.54
		Water	23.78	20.74	18.22	17.24	19.99	10.15	9.24	7.85	7.59	8.71
		MC 0.5 cm/L	24.11	21.22	18.88	18.11	20.58	10.23	9.47	8.55	8.06	9.08
		MC 1.0 cm/L	26.00	23.42	20.89	19.44	22.43	10.54	9.80	8.86	8.56	9.44
		MC 1.5 cm/L	25.11	22.33	19.11	18.66	21.30	10.33	9.65	8.79	8.23	9.25
	Net	Without	22.22	19.31	17.84	16.59	18.99	9.94	8.26	7.53	7.32	8.26
		Water	22.74	19.52	18.33	17.37	19.49	9.95	9.33	7.79	7.46	8.63
		MC 0.5 cm/L	23.11	20.66	18.55	17.75	20.02	10.11	8.59	7.99	7.38	8.51
		MC 1.0 cm/L	24.22	22.11	19.66	18.74	21.18	10.19	9.39	8.44	8.30	9.08
		MC 1.5 cm/L	23.84	21.11	18.66	18.30	20.47	10.16	8.70	8.23	8.00	8.77
LSD (0.05)			0.45	0.48	0.49	0.51	0.53	0.18	0.20	0.21	0.25	0.28

Com. = Combined, Foliages= Sugar beet foliages, MC = Mepiquat chloride

The highest infestation percentages of sugar beet roots after harvesting were obtained when stored sugar beet in piles under shading net and covering that piles with rice straw without spraying roots piles before storage with any treatment, followed by stored sugar beet in piles under shading net and covering that piles with rice straw as well spraying roots piles before storage with tap water after one, two, three and four weeks from beginning the study and combined over storage periods as shown in Table 3. Whilst, stored sugar beet in piles under sun light conditions without covering with any treatment and spraying sugar beet roots piles before storage with Mepiquat chloride at the rate of 1.0 cm/L produced the lowest infestation percentages of sugar beet roots after harvesting after one, two, three and four weeks from beginning the study and combined over storage periods.

CONCLUSION

From obtained results of this study, it can be concluded that stored sugar beet roots after harvesting directly in piles until supplying to the sugar factory under shading net and covering with sugar beet foliages in addition spraying piles roots with Mepiquat chloride at the rate of 1.0 cm/L to reduce losses in sugar beet roots after harvesting and during storage and achieve high apparent characters of sugar beet roots under the environmental conditions of Dakahlia Governorate, Egypt.

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دراسة الفقد في جذور بنجر السكر بعد الحصاد وتقليله باستخدام طرق التخزين المختلفة ومعاملات تغطية ورش جذور بنجر السكر خلال فترات التخزين

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أقيمت تجربة تخزين بحثية في قرية كفر علام، مركز منية النصر، محافظة الدقهلية بعد موسم حصاد 2019/2018 لبنجر السكر لدراسة الفقد في جذور بنجر السكر بعد الحصاد وتقليله باستخدام طرق التخزين المختلفة ومعاملات تغطية ورش جذور بنجر السكر خلال فترات التخزين. نفذت التجربة فى تجربة عاملية فى تصميم القطاعات كاملة العشوائية فى ثلاثة مكررات. شمل العامل الأول طريقتين لتخزين الجذور بعد الحصاد (تخزين جذور بنجر السكر في الظل وتخزين جذور بنجر السكر في الهواء الطلق). أما العامل الثاني فقد اشتمل على أربعة معاملات لتغطية جذور بنجر السكر قبل التخزين (بدون تغطية "معاملة المقارنة"، التغطية بقش الأرز، بعرش بنجر السكر والشبكة). أما العامل الثالث فقد تضمن خمسة معاملات لرش جذور بنجر السكر بمعدلات مختلفة من مثبطات النمو مثل موبيكوات كلوريد (بدون رش "معاملة المقارنة"، الرش بماء الصنبور والرش بموبيكوات كلوريد بمعدل 5.0 ، 1.0 و 1.5 سم / لتر. ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى؛ تم تسجيل أعلى القيم للوزن الطازج للجذر (كجم / نبات)، طول الجذر (سم)، قطر الجذر (سم)، نسبة الإصابة بالجذور (٪) عند تخزين جذور بنجر السكر تحت شبكة التظليل بعد أسبوع، أسبوعين، ثلاثة وأربعة أسابيع من بداية الدراسة والتحليل التجميعى لفترات التخزين. فى حين أدى تخزين جذور بنجر السكر في أكوام تحت ظروف شبكة التظليل إلى الحصول على أدنى القيم لنسبة فقدان وزن الجذر (من الأسبوع الأول إلى الأسبوع الثاني ، من الأسبوع الثاني إلى الأسبوع الثالث ومن الأسبوع الثالث إلى الرابع وكذلك التحليل التجميعى لفترات التخزين). تشير النتائج المتحصل عليها أنه تم تسجيل أعلى القيم للوزن الطازج للجذر (كجم / نبات)، طول الجذر (سم)، قطر الجذر (سم) عند تغطية أكوام الجذور بعرش بنجر السكر، يليها تغطية أكوام جذور بنجر السكر بقش الأرز ، ثم تغطية أكوام جذور بنجر السكر بالشبكة بعد أسبوع، أسبوعين، ثلاثة وأربعة أسابيع من بداية الدراسة والتحليل التجميعى لفترات التخزين. من ناحية أخرى ، فإن أقل نسب مئوية لفقدان وزن الجذر (من الأسبوع الأول إلى الأسبوع الثاني ، من الأسبوع الثاني إلى الأسبوع الثالث ومن الأسبوع الثالث إلى الرابع وكذلك التحليل التجميعى لفترات التخزين). تم تسجيل أعلى القيم للوزن الطازج للجذر (كجم / نبات)، طول الجذر (سم)، قطر الجذر (سم) عند رش أكوام من جذور بنجر السكر بموبيكوات كلوريد كمثبط للنمو بمعدل 1.0 سم / لتر، متبوعًا برش أكوام جذور بنجر السكر بموبيكوات كلوريد بمعدل 1.5 سم / لتر ، ثم رش أكوام جذور بنجر السكر بموبيكوات كلوريد بمعدل 0.5 سم / لتر بعد أسبوع، أسبوعين، ثلاثة وأربعة أسابيع من بداية الدراسة والتحليل التجميعى لفترات التخزين. بينما نتجت أقل نسب مئوية لفقدان وزن الجذر (من الأسبوع الأول إلى الأسبوع الثاني ، من الأسبوع الثاني إلى الأسبوع الثالث ومن الأسبوع الثالث إلى الرابع وكذلك التحليل التجميعى لفترات التخزين) بعد أسبوع، أسبوعين، ثلاثة وأربعة أسابيع من بداية الدراسة والتحليل التجميعى لفترات التخزين من رش أكوام جذور بنجر السكر قبل التخزين بموبيكوات كلوريد بمعدل 1.0 سم / لتر. من النتائج التي تم الحصول عليها من هذه الدراسة توصي الدراسة بتخزين جذور بنجر السكر بعد الحصاد مباشرة في أكوام حتى التوريد لمصنع السكر تحت شبكة التظليل مع تغطيتها بعرش بنجر السكر بالإضافة إلى رش كومات الجذور بموبيكوات كلوريد بمعدل 1.0 سم / لتر لتقليل الفقد في جذور بنجر السكر بعد الحصاد وأثناء التخزين مع تحسين الصفات الظاهرية لجذور بنجر السكر تحت الظروف البيئية لمحافظة الدقهلية، مصر