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EFFECT OF SOME SODIUM SALTS ON THE GROWTH,MINERAL COMPOSITION AND ORGANIC CONTENT OF SOME GRAPE ROOTSTOCKS:
II. THE MINERAL COMPOSITION

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ABSTRACT

The present investigation was carried out during 2000 and 2001 growing seasons in order to study the effect of sodium chloride and sodium carbonate treatments on leaf and root mineral composition of four grapevine cultivars (commonly used as rootstocks) namely, Harmony, 1103 Paulsen, Dogridge and Thompson seedless.

The main results can be summarized in the following points:

A. **Effect of salinity treatments**

1- The two sodium carbonate treatments significantly decreased root nitrogen content than the control.
2- Sodium chloride treatments, in both seasons, significantly increased leaf phosphorus content than sodium carbonate ones.
3- Salinity treatments significantly decreased root potassium as compared with the control .
4- Leaf and root chloride significantly increased, in both seasons, with the two sodium chloride treatments as compared with the other treatments.
5- In both seasons, leaf and root sodium content significantly increased with different sodium chloride and sodium carbonate treatments as compared with the control.
6- Root calcium content significantly decreased with salinity treatments, except 1500 ppm sodium chloride as compared with the control.
7- In the first season, leaf magnesium content significantly decreased with salinity treatments, whereas in the second one, the differences among treatments were not significant. Sodium chloride at 1500 ppm significantly increased root magnesium content than the control, however.
8- Root iron content significantly decreased with salinity treatments.
9- Both 3000 ppm sodium chloride and 750 ppm sodium carbonate treatments significantly increased leaf / root Na ratio than the other treatments.
10- Sodium carbonate at 1500 ppm significantly increased leaf / root Cl ratio than the other treatments.

B. **Effect of rootstocks**

1- Thompson seedless had higher leaf phosphorus and calcium contents and lower leaf manganese and zinc contents, in both seasons. In the meantime, its roots had significantly higher nitrogen, magnesium, manganese and K/Na values and lower iron and Na/Ca values.
2- In both seasons, Harmony leaves contained lower phosphorus and calcium contents,whereas its roots contained higher Na/Ca ratio and lower phosphorus and manganese contents.
3- In both seasons, the leaves of 1103 Paulsen contained significantly low nitrogen, chloride, sodium and leaf / root sodium values, whereas their roots contained high phosphorus, and low zinc and manganese levels.

Finally,it could be concluded that 1103 Paulsen is more salinity tolerant than the other rootstocks.

INTRODUCTION

Grape is ranking superiour among the important fruit crops in Egypt. The total area of grapevines in Egypt reached 148406 feddans producing about 1078912 tons of fruits according to the statistics of the Ministry of Agriculture and Land Reclamation, Cairo, 2001. A large part of new lands area suffers from increasing salinity. Rootstock variations considered as an important factor affecting that salt tolerance of fruit crops. *Vitis vinifera* varieties are moderately tolerant to salinity (i.e. high total salts). However, injury may result from excessive intake of chloride. Certain rootstocks reduce the accumulation of chloride in the scion variety (Sauer, 1968 and Bernstein *et al.*, 1969). It is evident that high salt concentrations in the soil cause growth inhibition in most plants, but saline conditions affect plant growth in a variety of ways. Salinity can cause: (1) a decrease in water uptake in the plants,(2) the accumulation of ions to toxic levels, and (3) reduces nutrient availability (Flowers *et al.*, 1977).

Importance of carbonate and bicarbonate in irrigation water is due to precipitation of calcium and magnesium, if they were in higher concentrations than these cations. Therefore, sodium carbonate is formed causing black alkaline soils. Absorbing high concentrations of chloride and sodium ions by plants causes crumbling of the new growing leaves, chlorosis, leaf burn, defoliation, shoot dieback and finally plant death. Salt tolerance can be expressed by relative growth at certain levels of soluble salts. With a 0.7-0.8% water- soluble salt content in the soil, the plants were unthrifty with thin shoots, short internodes and small leaves (Martynenko *et al.*,1973).

The objective of the present investigation was to study the response of four grapevine rootstocks namely, Harmony, Dogridge, 1103 Paulsen and Thompson seedless to different sodium chloride and sodium carbonate treatments in the irrigation water.

MATERIALS AND METHODS

This study was conducted during the growing seasons of 2000 and 2001 in a greenhouse at the Agricultural Experiment Station of Alexandria University. The present investigation aimed to study the influence of sodium salts, i.e sodium chloride and sodium carbonate on leaf and root mineral composition of four grapevine rootstocks namely, Harmony (*Vitis champini* x 1613), 1103 Paulsen (*Vitis berlandieri* x *Vitis rupestris)*, Dogridge (*Vitis champini*) and Thompson seedless (*Vitis vinifera*). The experimental plants of the four cultivars were one - year- old and planted in mid February in clay pots filled with sand, previously leached for salt removal. One plant was planted in each pot. All plants were irrigated with tap water every two days before starting irrigation with solutions of the different salt treatments in July 2000 and May 2001 until October of both seasons.

The sodium (Na) was applied through irrigation water as sodium chloride (NaCl) and sodium carbonate (Na_2CO_3). From each salt, two salinity concentrations were tested against the control (tap water without adding salts) namely, 1500, 3000 ppm for NaCl and 750, 1500 ppm for Na_2CO_3.

Each treatment was replicated four times with three plants in each replicate. The plants were irrigated with salt solutions every two days and the pots were leached with tap water three times monthly to avoid salt accumulation in the root zone. One litre of 1000 ppm Crystalone solution was added to each pot weekly as a source of nutritive mineral salts from starting treatments until the end of each season.

Roots and leaves of each plant were washed several times with tap water, rinsed three times with distilled water and separately oven – dried at 70 C° to a constant weight.The dried leaf and root materials were then ground and digested by sulphuric acid and hydrogen peroxide according to Evenhuis and DeWaard (1980).Suitable aliquots were then taken for the determination of nitrogen, phosphorus, potassium, calcium, magnesium, sodium, iron, zinc and manganese.Total nitrogen and phosphorus were colorimetrically determined according to Evenhuis (1976) and Murphy and Riley (1962), respectively. Potassium and sodium were measured against a standard using a flame photometer. Calcium and magnesium were determined by the versenate (EDTA) method according to Cheng and Bray (1951). For chloride determination, 0.1 gm from the ground leaf and root materials of each replicate was wetted with 6 percent calcium acetate solution, ignited to 500 °C four hours and then extracted with hot distilled water. Chloride in the extracts were determined by the silver nitrate method according to Chapman and Pratt (1961). Fe, Zn and Mn were determined by Perkin Elmer Atomic Absorption Spectrophotometer.The concentrations of nitrogen, phosphorus, potassium, calcium, magnesium, sodium and chloride were expressed as percent, while those of iron, manganese and zinc as parts per million on dry weight basis.

Soil and water samples were taken before planting, data of soil and water analysis are presented in Table (1). The data collected throughout this study were subjected to analysis using a factorial experiment in RCBD in 4 replicates. L.S.D at 0.05 compared the differences among means according to Snedecor and Cochran (1967).

Table (1): Chemical analysis of the used tap water and sand soil at planting.

Character	Tap water	Sand soil
pH	7.66	7.76
E.C. (mmhos/ cm)	0.39	0.98
Soluble ions (meq/ l)		
Ca^{++}	1.07	1.38
Mg^{++}	1.46	3.54
Na^{+}	1.46	4.70
K^{+}	0.11	0.21
HCO_3	1.57	2.48
Cl^{-}	1.48	3.99
SO_4^{-2}	1.04	3.36

RESULTS AND DISCUSSION

The data representing the effect of different sodium chloride and sodium carbonate treatments on leaf and root mineral composition of the experimental grape plants during 2000 and 2001 seasons, are listed in Tables (2 to 15).

1. Nitrogen

Concerning the effect of salinity treatments on leaf nitrogen content, irrespective the effect of rootstocks, the results in Table (2) indicated that, in the first season, plants treated with 3000 ppm sodium chloride had significantly higher leaf nitrogen content as compared with those treated with either 1500 ppm sodium chloride or 1500 ppm sodium carbonate.The differences among other treatments in the second season were not big enough to be statistically significant. These results are, generally, in accordance with those reported by Downton (1985); Abou – Rayya *et al.* (1988) and Stevens *et al.* (1996).They found that leaf nitrogen content in grapevines was not affected by rising salinity in the irrigation water.

As for the effect of rootstocks on leaf nitrogen content, regardless of the effect of salinity treatments, the data in Table (2) indicated that, in the first season, Dogridge plants had significantly higher leaf nitrogen content than the other cultivars. In the meantime, Harmony and Thompson seedless plants had significantly higher leaf nitrogen value than 1103 Paulsen. In the second season, Harmony plants had significantly higher leaf nitrogen level than the other cultivars. Significant difference was also found between Dogridge and 1103 Paulsen cultivars. Gaser (1992) reported that Thompson seedless followed by Couderc 1616 tended to accumulate higher amount of nitrogen in their leaves than st. George and Couderc 1202 grapevine rootstocks.

Regarding the effect of salinity treatments on root nitrogen content, irrespective the effect of rootstocks, the results in Table (2) indicated that, the experimental grape plants treated with 1500ppm sodium chloride and the control treatments had significantly higher root nitrogen content than those subjected to 750 and 1500 ppm sodium carbonate treatments. These results are supported by Salama *et al.*, (1992); Shehata *et al.*, (1996) and Youssif (1998). They reported that salinity caused a marked reduction in root nitrogen content in grapevines.

As for the effect of rootstocks on root nitrogen content, regardless of the effect of salinity treatments, the data in Table (2) indicated that, the studied rootstocks could be arranged in the following descending order with respect to root nitrogen content: Thompson seedless > Dogridge > 1103 Paulsen > Harmony. The differences among them were statistically significant, except between 1103 Paulsen and Harmony plants. Gaser (1992) reported that there were no significant differences between cultivars in root nitrogen content for seven of grapevine rootstocks.

Table (2): Effect of sodium chloride and sodium carbonate treatments on leaf and root nitrogen content (% D.W. basis) of grape rootstocks in 2000 and 2001seasons.

Rootstock \ Treatment	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	3000	750	1500		
Leaves 2000						
Harmony	1.59	1.89	1.50	1.68	2.29	1.79
Dogridge	2.42	2.53	2.64	2.05	2.08	2.34
1103 Paulsen	1.41	1.22	1.22	1.45	1.38	1.34
Thompson seedless	1.64	2.17	2.16	1.67	1.89	1.91
Average	1.77	1.95	1.88	1.71	1.91	
L.S.D 0.05	Rootst. 0.13		Treat. 0.15		Rootst. x Treat. 0.29	
Leaves 2001						
Harmony	2.40	2.36	2.63	2.44	2.42	2.45
Dogridge	1.88	2.18	2.00	1.88	1.95	1.98
1103 Paulsen	1.78	1.75	1.66	1.60	1.66	1.69
Thompson seedless	1.69	1.87	1.77	1.78	2.03	1.83
Average	1.94	2.04	2.02	1.93	2.02	
L.S.D 0.05	Rootst. 0.17		Treat. N.S		Rootst. x Treat. N.S	
Roots 2001						
Harmony	1.11	1.03	0.95	0.95	0.93	0.99
Dogridge	1.20	1.01	1.09	0.99	1.40	1.14
1103 Paulsen	1.15	1.21	0.91	0.87	1.06	1.04
Thompson seedless	1.36	1.39	1.39	1.24	1.48	1.37
Average	1.21	1.16	1.09	1.01	1.22	
L.S.D 0.05	Rootst. 0.09		Treat. 0.10		Rootst. x Treat. 0.20	

2. Phosphorus

Regarding the effect of salinity treatments on leaf phosphorus content, irrespective the effect of rootstocks, the results in Table (3) revealed that, in the first season, plants subjected to sodium chloride at 1500 or 3000 ppm had almost the same level of phosphorus in their leaves as that in the control plants. These treatments and the control caused significantly higher leaf phosphorus content than that of 750 and 1500 ppm sodium carbonate treatments. Significant difference was also found between 750 ppm and 1500 ppm sodium carbonate treatments. In the second season, irrigating plants with water containing either 1500 or 3000 ppm sodium chloride significantly increased leaf phosphorus content as compared with those treated with the two studied concentrations of sodium carbonate and the control. These findings agreed with those previously reported by El – Gazzar *et al.* (1979); Allam *et al.* (1988); and Garcia and Charbaji (1989). They found that leaf phosphorus content, generally, decreased with increasing irrigation water salinity in grapevines. However, Divate and Pandey (1981); Shehata (1983); and Shehata *et al.* (1996) reported that leaf phosphorus content increased under saline condition.

As for the effect of rootstocks on leaf phosphorus content, regardless of the effect of salinity treatments, the data in Table (3) indicated that, in the first season, Thompson seedless plants had significantly higher leaf phosphorus content than the other studied cultivars. Likewise, 1103 Paulsen cultivar contained significantly higher phosphorus in its leaves than that of Harmony one, and no significant difference was found between Harmony and Dogridge plants. In the second season, 1103 Paulsen cultivar had significantly higher leaf phosphorus content than the other cultivars, followed by Thompson seedless. The latter, i.e Thompson seedless had significantly higher leaf phosphorus content than Harmony and Dogridge cultivars. El – Azab and Minessy (1975) reported that the leaves of Roumi Red grape had more phosphorus content than the leaves of Thompson seedless in both years of the experiment.

Concerning the effect of salinity treatments on root phosphorus content, irrespective the effect of rootstocks, the results in Table (3) revealed that, the plants treated with 1500 ppm sodium chloride had significantly higher root phosphorus content as compared with those treated with either 3000 ppm sodium chloride or 1500 ppm sodium carbonate. These results are in agreement with Stevens *et al.*, (1996) who found that root phosphorus content in grapevine was not affected with saline irrigation water. However, Salama *et al.*, (1992); Mohamed (1996) and Youssif (1998) reported that root phosphorus content decreased due to increasing salinity in grapevines.

As for the effect of rootstocks on root phosphorus content, regardless of the effect of salinity treatments, the data in Table (3) indicated that, 1103 Paulsen plants had significantly higher root phosphorus content than those of Harmony and Dogridge. It was also found that Harmony cultivar had significantly lower root phosphorus content than the other cultivars. Gaser (1992) found that seven grapevine rootstocks under different salt treatments exhibited a trend similar in root phosphorus content.

3. Potassium

Concerning the effect of salinity treatments on leaf potassium content, irrespective the effect of rootstocks, the data in Table (4) revealed that, in the first season, the plants treated with the high concentration of each studied salt had significantly higher leaf potassium content as compared with those subjected to the low concentrations and the control. In the second season, the plants treated with 1500 and 3000 ppm sodium chloride and those subjected to 750 ppm sodium carbonate had significantly higher leaf potassium content than those treated with 1500 ppm sodium carbonate and the control. These findings were in harmony with Al – Saidi (1980); Al – Saidi and Alawi (1984) and Essa (1988). They reported that leaf potassium content increased under saline conditions in grapevines.

As for the effect of rootstocks on leaf potassium content, regardless of the effect of salinity treatments, the results in Table (4) indicated that, in the first season, Dogridge plants had significantly higher leaf potassium content than the other studied cultivars. In the second season, Harmony had significantly higher leaf potassium content than 1103 Paulsen and Thompson seedless. In the meantime, 1103 Paulsen cultivar had significantly the lowest leaf potassium content. El – Azab and Minessy (1975) reported that the Roumi Red grape variety had more leaf potassium content than the Thompson seedless grape variety in both years of the experiment.

Table (3): Effect of sodium chloride and sodium carbonate treatments on leaf and root phosphorus content (% D.W. basis)of grape rootstocks in 2000 and 2001 seasons.

Treatment / Rootstock	Na Cl (ppm) 1500	Na Cl (ppm) 3000	Na_2CO_3 (ppm) 750	Na_2CO_3 (ppm) 1500	Control	Average
Leaves 2000						
Harmony	0.43	0.32	0.35	0.34	0.38	0.36
Dogridge	0.43	0.37	0.35	0.32	0.44	0.38
1103 Paulsen	0.40	0.46	0.37	0.36	0.43	0.40
Thompson seedless	0.55	0.56	0.43	0.30	0.46	0.46
Average	0.45	0.43	0.38	0.33	0.43	
L.S.D 0.05	Rootst. 0.04		Treat. 0.04		Rootst. x Treat. 0.08	
Leaves 2001						
Harmony	0.40	0.41	0.34	0.32	0.35	0.36
Dogridge	0.41	0.41	0.37	0.37	0.35	0.38
1103 Paulsen	0.50	0.47	0.39	0.32	0.37	0.41
Thompson seedless	0.51	0.51	0.39	0.43	0.46	0.46
Average	0.46	0.45	0.37	0.36	0.38	
L.S.D 0.05	Rootst. 0.03		Treat. 0.03		Rootst. x Treat. 0.06	
Roots 2001						
Harmony	0.50	0.41	0.40	0.34	0.39	0.41
Dogridge	0.46	0.47	0.46	0.46	0.51	0.47
1103 Paulsen	0.52	0.49	0.50	0.48	0.53	0.50
Thompson seedless	0.48	0.49	0.50	0.46	0.50	0.49
Average	0.49	0.46	0.47	0.44	0.48	
L.S.D 0.05	Rootst. 0.03		Treat. 0.03		Rootst. x Treat. 0.06	

Regarding the effect of salinity treatments on root potassium content, irrespective the effect of rootstocks, the results in Table (4) indicated that, the control plants had significantly higher root potassium content than the other treatments. Likewise, increasing the concentration of each studied salt significantly decreased root potassium content. These findings are supported by Hooda *et al.* (1990); Garcia and Charbaji (1993); Stevens and Harvey (1995); Mohamed (1996); Stevens *et al.* (1996); Youssif (1998) and Viana *et al.* (2001a). They found that root potassium content decreased with saline irrigation water in grapevines.

Concerning the effect of studied rootstocks on root potassium content, regardless of the effect of salinity treatments, the data in Table (4) indicated that, Thompson seedless had significantly higher root potassium content than the other cultivars. In the meantime, Dogridge roots contained significantly higher potassium content than both Harmony and 1103 Paulsen ones. Gaser (1992) concluded that the relatively salt tolerant rootstocks

(Couderc 1616, ARG1 and Thompson seedless) tended to absorb more amount of potassium content than the most sensitive ones (st. George, Couderc 1202 and couderc 1613).

Table (4): Effect of sodium chloride and sodium carbonate treatments on leaf and root potassium content (% D.W. basis) of grape rootstocks in 2000 and 2001 seasons.

Treatment / Rootstock	Na Cl (ppm) 1500	Na Cl (ppm) 3000	Na_2CO_3 (ppm) 750	Na_2CO_3 (ppm) 1500	Control	Average
Leaves 2000						
Harmony	0.77	0.92	0.82	0.96	0.87	0.87
Dogridge	1.15	1.16	1.21	1.04	0.86	1.08
1103 Paulsen	0.93	1.07	0.88	0.81	0.77	0.89
Thompson seedless	0.65	0.76	0.71	1.27	1.10	0.90
Average	0.88	0.98	0.91	1.02	0.90	
L.S.D 0.05	Rootst. 0.06		Treat. 0.06		Rootst. x Treat. 0.13	
Leaves 2001						
Harmony	1.13	1.20	1.18	1.01	0.85	1.07
Dogridge	1.20	1.22	0.97	1.09	0.82	1.06
1103 Paulsen	0.74	0.61	0.72	0.55	0.70	0.66
Thompson seedless	0.96	1.05	1.09	0.82	0.92	0.97
Average	1.01	1.02	0.99	0.87	0.82	
L.S.D 0.05	Rootst. 0.10		Treat. 0.11		Rootst. x Treat. 0.21	
Roots 2001						
Harmony	0.44	0.33	0.40	0.38	0.50	0.41
Dogridge	0.52	0.44	0.52	0.42	0.66	0.51
1103 Paulsen	0.46	0.39	0.41	0.38	0.61	0.45
Thompson seedless	0.78	0.81	0.62	0.48	1.14	0.77
Average	0.55	0.49	0.49	0.42	0.73	
L.S.D 0.05	Rootst. 0.05		Treat. 0.06		Rootst. x Treat. 0.11	

4. Chloride

Regarding the effect of salinity treatments on leaf chloride content, irrespective the effect of rootstocks, the results in Table (5) revealed that, in both seasons, the plants treated with sodium chloride, either at 1500 or 3000 ppm, had significantly higher leaf chloride content as compared with those treated with 750 or 1500 ppm sodium carbonate and those of the control. Significant differences were also found between 1500 and 3000 ppm sodium chloride treatments, and also between the control and those subjected to the two sodium carbonate concentrations, in the second season. These results were in accordance with Divate and Pandey (1981); Shehata (1983) and Essa (1988). They found that rising salinity levels caused a marked increase in leaf chloride content in grapevines.

As for the effect of rootstocks on leaf chloride content, regardless of the effect of salinity treatments, the data in Table (5) indicated that, in both seasons, 1103 Paulsen had significantly lower leaf chloride content than the other studied cultivars which did not significantly differ in their leaf chloride content. Bernstein *et al.*, (1969) reported that scions on Thompson seedless, Dogridge, 1613 – 3 and Salt Creek roots consistently accumulated only one

– half, one – third, one tenth and one – sixteenth as much chloride, respectively.

Regarding the effect of salinity treatments on root chloride content, irrespective the effect of rootstocks, the results in Table (5) showed that, irrigating plants with water containing sodium chloride salt significantly increased root chloride content than those treated with sodium carbonate (750 or 1500 ppm) and the control. Sodium carbonate treatments markedly decreased root chloride content as compared with the control plants. Significant difference was also found between 1500 and 3000 ppm sodium chloride treatments. These findings are supported by Al – Saidi and Alawi (1984); Gaser (1992); Mohamed (1996) and Youssif (1998). They reported that root chloride content increased due to increasing salinity.

As for the effect of rootstocks on root chloride content, regardless of the effect of salinity treatments, the data in Table (5) indicated that, there were no significant differences among them. Gaser (1992) found that Couderc 1616 followed by Thompson seedless and ARGI, were prone to accumulate lower amounts of chloride than the other rootstocks, while st. George and Couderc 1202 accumulated higher chloride content. However, chloride content of Dogridge and Couderc 1613 seemed to be intermediate.

Table (5): Effect of sodium chloride and sodium carbonate treatments on leaf and root chloride content (% D.W. basis) of grape rootstocks in 2000 and 2001 seasons.

Treatment / Rootstock	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	3000	750	1500		
Leaves 2000						
Harmony	1.36	1.36	0.80	0.79	0.76	1.01
Dogridge	1.35	1.51	0.90	0.88	0.95	1.12
1103 Paulsen	0.70	0.71	0.39	0.42	0.40	0.52
Thompson seedless	1.27	1.69	0.89	0.82	0.78	1.09
Average	1.17	1.32	0.75	0.73	0.72	
L.S.D 0.05	Rootst. 0.18		Treat. 0.21		Rootst. x Treat. N.S	
Leaves 2001						
Harmony	1.09	1.63	0.74	0.64	0.48	0.92
Dogridge	0.83	1.37	0.75	0.75	0.57	0.85
1103 Paulsen	0.43	0.55	0.31	0.28	0.16	0.35
Thompson seedless	1.11	1.14	0.76	0.82	0.52	0.87
Average	0.87	1.17	0.64	0.62	0.43	
L.S.D 0.05	Rootst. 0.13		Treat. 0.14		Rootst. x Treat. 0.29	
Roots 2001						
Harmony	0.87	1.03	0.47	0.37	0.47	0.64
Dogridge	0.85	1.21	0.44	0.57	0.60	0.73
1103 Paulsen	0.76	0.88	0.42	0.44	0.69	0.64
Thompson seedless	0.80	1.13	0.32	0.27	0.62	0.63
Average	0.82	1.06	0.41	0.41	0.60	
L.S.D 0.05	Rootst. N.S		Treat. 0.10		Rootst. x Treat. 0.21	

5. Sodium

Concerning the effect of salinity treatments on leaf sodium content, irrespective the effect of rootstocks, the data in Table (6) indicated that, in both seasons, salinity treatments caused a significant increase in leaf sodium content as compared with the untreated plants. The results also indicated that, in the first season, treating the plants with 1500 ppm sodium carbonate significantly increased leaf sodium content than the other treatments. Likewise, plants irrigated with water containing 3000 ppm sodium chloride or 750 ppm sodium carbonate had significantly higher leaf sodium than those subjected to 1500 ppm sodium chloride. In the second season, significant difference was found between 1500 ppm and 3000 ppm sodium chloride treatments. These results agreed with those obtained by Al – Saidi (1980); Divate and Pandey (1981); and Allam *et al.*, (1988). They found that leaf sodium content in grapevines markedly increased with rising salinity in irrigation water. However, Youssif (1998) reported that 2500 ppm sodium chloride did not significantly affect the leaf sodium content in grapevines.

As for the effect of rootstocks on leaf sodium content, regardless of the effect of salinity treatments, the results in Table (6) indicated that, in the first season, Thompson seedless had significantly higher leaf sodium content than the other cultivars. In the meantime, Dogridge had significantly higher leaf sodium content as compared with Harmony and 1103 Paulsen. In the second season, Harmony leaves contained significantly higher sodium content than 1103 Paulsen and Thompson seedless, whereas1103 Paulsen plants had significantly the lowest leaf sodium content. El – Azab and Minessy (1975) found that the level of sodium in Thompson seedless plants in the first season, as an average of all salt treatments, was significantly higher than that found in the Roumi Red grape variety. In the second season, an opposite trend was observed.

Regarding the effect of salinity treatments on root sodium content, irrespective the effect of rootstocks, the data inTable (6) revealed that all salinity treatments significantly increased root sodium content as compared with the control. No significant differences were found among the other studied treatments. These findings are, generally, in line with those previously reported by Hooda *et al.*, (1990); Mohamed (1996); Shehata *et al.*, (1996); Sivritepe and Eris (1998) and Viana *et al.*, (2001b). They reported that root sodium content increased with rising salinity in water used for grapevines irrigation.

As for the effect of rootstocks on root sodium content, regardless of the effect of salinity treatments, the results in Table (6) indicated that, there were no significant differences among the studied cultivars with respect to root sodium content.

Table (6): Effect of sodium chloride and sodium carbonate treatments on leaf and root sodium content (% D.W. basis) of grape rootstocks in 2000 and 2001 seasons.

Treatment / Rootstock	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	3000	750	1500		
Leaves 2000						
Harmony	0.43	0.43	0.42	0.42	0.24	0.39
Dogridge	0.51	0.51	0.52	0.57	0.39	0.50
1103 Paulsen	0.41	0.48	0.38	0.42	0.35	0.41
Thompson seedless	0.39	0.59	0.65	0.96	0.33	0.58
Average	0.44	0.50	0.49	0.59	0.33	
L.S.D 0.05	Rootst. 0.03		Treat. 0.03		Rootst. x Treat. 0.06	
Leaves 2001						
Harmony	0.92	0.98	0.97	0.93	0.79	0.92
Dogridge	0.94	1.07	0.88	0.94	0.69	0.90
1103 Paulsen	0.68	0.68	0.68	0.66	0.62	0.66
Thompson seedless	0.78	0.92	0.93	0.93	0.74	0.86
Average	0.83	0.91	0.87	0.87	0.71	
L.S.D 0.05	Rootst. 0.05		Treat. 0.05		Rootst. x Treat. 0.10	
Roots 2001						
Harmony	0.78	0.70	0.74	0.79	0.79	0.76
Dogridge	0.72	0.73	0.76	0.77	0.63	0.72
1103 Paulsen	0.71	0.75	0.75	0.82	0.68	0.74
Thompson seedless	0.78	0.83	0.75	0.75	0.67	0.76
Average	0.75	0.75	0.75	0.78	0.69	
L.S.D 0.05	Rootst. N.S		Treat. 0.05		Rootst. x Treat. N.S	

6. Calcium

Regarding the effect of salinity treatments on leaf calcium content, irrespective the effect of rootstocks, the data in Table (7) indicated that, in the first season, the plants treated with salinity had significantly lower leaf calcium content as compared with the control. In the second season, the plants subjected to 1500 or 3000 ppm sodium chloride contained significantly higher leaf calcium content than those of the other treatments. Al - Saidi and Alawi (1984); Allam *et al.*, (1988) and Shehata *et al.*, (1996) found that leaf calcium content increased with rising salinity in grapevines. Conversely, Divate and Pandey (1981); Garcia and Charbaji (1989) and Hooda *et al.*, (1990) reported that increasing salinity led to a decrease in leaf calcium content of grapevines.

As for the effect of rootstocks on leaf calcium content, regardless of the effect of salinity treatments, the results in Table (7) indicated that, in the first season, Dogridge and Thompson seedless had significantly higher leaf calcium content than that in Harmony and 1103 Paulsen cultivars. In the second season, Thompson seedless plants contained significantly higher calcium value in the leaves as compared with the other cultivars. Significant difference was also found between Harmony and 1103 Paulsen. Gaser (1992) reported that Couderc 1616 and ARG1 followed by Dogridge and Thompson seedless tended to contain higher amount of such element, while the lowest accumulation of calcium was found in st. George and Couderc 1202 plants.

Concerning the effect of salinity treatments on root calcium content, irrespective the effect of rootstocks, the data in Table (7) revealed that, control plants had significantly higher root calcium content as compared with those of the other treatments, except those treated with 1500 ppm sodium chloirde. No other significant differences were observed. These results are supported by Garcia and Charbaji (1993); Mohamed (1996); Youssif (1998) and Viana *et al.*, (2001b). They reported that root calcium content reduced with rising salinity in grapevines irrigation water. However, Downton (1985) reported that root calcium content was not affected with salinity.

As for the effect of rootstocks on root calcium content, regardless of the effect of salinity treatments, the results in Table (7) indicated that the differences among the studied cultivars were not big enough to be statistically significant in respect to their root calcium content. Salama *et al.*, (1992) found that salinity had no effect on root calcium content.

Table (7): Effect of sodium chloride and sodium carbonate treatments on leaf and root calcium content (% D.W. basis) of grape rootstocks in 2000 and 2001 seasons.

Treatment / Rootstock	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	3000	750	1500		
Leaves 2000						
Harmony	1.00	1.11	1.03	1.05	1.36	1.11
Dogridge	1.34	1.31	1.33	1.12	1.34	1.29
1103 Paulsen	1.04	1.09	1.08	1.21	1.25	1.13
Thompson seedless	1.27	1.33	1.32	1.24	1.45	1.32
Average	1.16	1.21	1.19	1.16	1.35	
L.S.D 0.05	Rootst. 0.13		Treat. 0.14		Rootst. x Treat. N.S	
Leaves 2001						
Harmony	1.38	1.29	1.08	0.98	0.94	1.13
Dogridge	1.12	1.28	1.23	1.14	1.27	1.21
1103 Paulsen	1.31	1.37	1.20	1.31	1.26	1.29
Thompson seedless	1.87	1.71	1.48	1.45	1.45	1.59
Average	1.42	1.41	1.25	1.22	1.23	
L.S.D 0.05	Rootst. 0.12		Treat. 0.14		Rootst. x Treat. N.S	
Roots 2001						
Harmony	1.03	1.17	1.02	1.10	1.22	1.11
Dogridge	1.28	1.12	1.11	1.02	1.13	1.13
1103 Paulsen	1.07	1.01	1.21	1.20	1.25	1.15
Thompson seedless	1.64	1.08	1.05	1.05	1.60	1.28
Average	1.26	1.10	1.10	1.09	1.30	
L.S.D 0.05	Rootst. N.S		Treat. 0.19		Rootst. x Treat. N.S	

7. Magnesium

Concerning the effect of salinity treatments on leaf magnesium content, irrespective the effect of rootstocks, the data in Table (8) indicated that, in the first season, the plants irrigated with water containing the different salinity treatments had significantly lower leaf magnesium content than the control. Significant difference was also found between 3000 ppm sodium chloride and 1500 ppm sodium carbonate treatments. In the second season, no significant differences were found among the studied treatments. Stevens *et al.*, (1996) found that leaf magnesium content was not affected with using saline water in grapevines irrigation. However, Haggag *et al.*, (1988); Salama *et al.*, (1992); Garcia and Charbaji (1993) and Mohamed (1996) reported that salinity decreased leaf magnesium content in grapevines.

As for the effect of rootstocks on leaf magnesium content, regardless of the effect of salinity treatments, the results in Table (8) indicated that, in the first season Thompson seedless plants had significantly higher leaf magnesium content than the other cultivars, and significant difference was also found between Harmony and Dogridge. In the second season, the differences among the studied cultivars were not significant, however. Mohamed (1996) found that magnesium content in the shoots differed between cultivars from one season to another.

Regarding the effect of salinity treatments on root magnesium content, irrespective the effect of rootstocks, the data inTable (8) revealed that its content was significantly higher in the roots of plants treated with 1500 ppm sodium chloride than those of the other treatments, except 3000 ppm sodium chloride. On the other hand, plants treated with 1500 ppm sodium carbonate had significantly lower root magnesium content than those treated with 3000 ppm sodium chloride and 750 ppm sodium carbonate. Stevens *et al.*, (1996) reported that salinity had no effect on grapevines magnesium content. On the other hand, Downton (1985) determined magnesium under saline condition, and found that this element increased with salinity.

Concerning the effect of rootstocks on root magnesium content, regardless of the effect of salinity treatments, the data in Table (8) indicated that, Thompson seedless had significantly higher root magnesium content than Dogridge and 1103 Paulsen cultivars. Mohamed (1996) reported that there were an evident variance of studied rootstocks in their root magnesium content.

8. Iron

Regarding the effect of salinity treatments on leaf iron content, irrespective the effect of rootstocks, the results in Table (9) revealed that, in the first season, plants treated with 750 ppm sodium carbonate had significantly higher leaf iron content than those treated with 1500 ppm from either sodium chloride or sodium carbonate. In the second season, the differences among the studied treatments were not significant, however. These results are supported by Youssif (1998) on fig plants. Who found that the concentration of iron in leaf was unaffected by salinity.

As for the effect of rootstocks on leaf iron content, regardless of the effect of salinity treatments, the data in Table (9) indicated that, in the first season, Dogridge and 1103 Paulsen plants had significantly higher leaf iron content as compared with Harmony and Thompson seedless, which also significantly differed. In the second season, 1103 Paulsen plants had significantly higher leaf iron content than the other cultivars. El – Azab and

Minessy (1975) reported that the iron in the leaves of Roumi Red grape, in both years, was significantly higher when compared with the Thompson seedless at 1500,3000 ppm NaCl: $CaCl_2$ (1:1 w/w).

Table (8): Effect of sodium chloride and sodium carbonate treatments on leaf and root magnesium content (% D.W. basis) of grape rootstocks in 2000 and 2001 seasons.

Treatment / Rootstock	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	3000	750	1500		
Leaves 2000						
Harmony	0.51	0.63	0.68	0.78	1.40	0.80
Dogridge	0.97	0.86	0.98	0.82	1.12	0.95
1103 Paulsen	0.83	0.91	0.85	0.84	0.90	0.87
Thompson seedless	1.28	1.53	1.24	1.01	1.55	1.32
Average	0.90	0.98	0.94	0.86	1.24	
L.S.D 0.05	Rootst. 0.09		Treat. 0.10		Rootst. x Treat. 0.20	
Leaves 2001						
Harmony	0.71	0.58	0.64	0.64	0.79	0.67
Dogridge	0.80	0.89	0.83	0.86	0.76	0.83
1103 Paulsen	0.77	0.91	0.88	0.77	0.69	0.80
Thompson seedless	0.77	0.71	0.69	0.83	0.90	0.78
Average	0.76	0.77	0.76	0.78	0.79	
L.S.D 0.05	Rootst. N.S		Treat. N.S		Rootst. x Treat. N.S	
Roots 2001						
Harmony	0.70	0.58	0.54	0.72	0.66	0.64
Dogridge	0.82	0.64	0.54	0.40	0.43	0.57
1103 Paulsen	0.63	0.57	0.47	0.39	0.62	0.54
Thompson seedless	0.63	0.71	0.89	0.58	0.59	0.68
Average	0.70	0.63	0.61	0.52	0.58	
L.S.D 0.05	Rootst. 0.08		Treat. 0.09		Rootst. x Treat. 0.18	

Concerning the effect of salinity treatments on root iron content, irrespective the effect of rootstocks, the results in Table (9) showed that all salinity treatments significantly decreased root iron content than the control. Significant difference was also found between 3000 ppm sodium chloride and 1500 ppm sodium carbonate treatments. These results agreed with Sharaf *et al.*, (1985) on grapevines. They found that saline potentiality of the irrigation water led to a significant decrease in root iron content.

As for the effect of rootstocks on root iron content, regardless of the effect of salinity treatments, the data in Table (9) indicated that, Harmony and Dogridge had significantly higher root iron content than Thompson seedless. Mohamed (1996) found that Thompson seedless plants had the higher values of iron in their roots, compared with the others cultivars.

Table (9): Effect of sodium chloride and sodium carbonate treatments on leaf and root iron content (ppm D.W. basis)of grape rootstocks in 2000 and 2001 seasons.

Treatment / Rootstock	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	3000	750	1500		
Leaves 2000						
Harmony	373.88	362.77	326.66	384.44	392.77	368.10
Dogridge	512.78	619.44	912.22	440.00	643.88	625.66
1103 Paulsen	559.44	643.33	640.55	413.88	641.66	579.77
Thompson seedless	480.55	484.44	406.17	380.00	577.27	465.69
Average	481.66	527.50	571.40	404.58	563.90	
L.S.D 0.05	Rootst. 89.14		Treat. 99.66		Rootst. x Treat. N.S	
Leaves 2001						
Harmony	363.33	317.22	251.66	373.89	327.22	326.66
Dogridge	286.11	394.44	205.55	280.55	188.88	271.11
1103 Paulsen	390.00	344.16	571.11	745.00	962.78	602.61
Thompson seedless	268.90	458.33	396.66	240.00	257.78	324.33
Average	327.09	378.54	356.25	409.86	434.17	
L.S.D 0.05	Rootst. 86.47		Treat. N.S		Rootst. x Treat. 193.35	
Roots 2001						
Harmony	616.66	714.99	701.66	536.66	986.11	711.22
Dogridge	473.33	677.78	851.11	632.77	1035.00	734.00
1103 Paulsen	532.22	672.22	358.89	493.89	846.11	580.67
Thompson seedless	728.32	589.44	563.89	288.33	496.66	533.33
Average	587.63	663.61	618.89	487.91	840.97	
L.S.D 0.05	Rootst. 140.45		Treat. 157.02		Rootst. x Treat. N.S	

9. Manganese

Concerning the effect of salinity treatments on leaf manganese content, irrespective the effect of rootstocks, the data in Table (10) indicated that, in the first season, salinity treatments did not significantly differ than the control, except 1500 ppm sodium carbonate. The latter concentration gave significantly lower leaf manganese content than the untreated plants. In the second season, the data showed that sodium chloride treatments gave significantly higher leaf manganese content than the other treatments. Stevens *et al*. (1996) and Youssif (1998) found that leaf manganese content decreased with rising salinity.

As for the effect of rootstocks on leaf manganese content, regardless of the effect of salinity treatments, the results in Table (10) indicated that, in the first season, the studied cultivars could be arranged in the following descending order with respect to leaf manganese content 1103 Paulsen > Dogridge > Harmony > Thompson seedless. In the second season, Harmony had significantly higher leaf manganese content than Dogridge and 1103 Paulsen.The latter cultivars had significantly higher value than Thompson seedless. El - Azab and Minessy (1975) reported that the leaf manganese content was significantly higher in Roumi Red than in Thompson seedless in the first season but not in the second one.

Regarding the effect of salinity treatments on root manganese content, irrespective the effect of rootstocks, the results in Table (10) indicated that, sodium chloride treatments gave significantly higher root manganese content than 1500 ppm sodium carbonate and control treatments.

As for the effect of rootstocks on root manganese content, regardless of the effect of salinity treatments, the data in Table (10) indicated that, Dogridge and Thompson seedless had significantly higher root manganese content than Harmony and 1103 Paulsen. Gaser (1992) showed that Couderc 1616 and Thompson seedless tended to accumulate higher amounts of manganese while st. George; Couderc 1202 and Couderc 1613 accumulated the lowest values. However, ARG1 and Dogridge contained an intermediate level of manganese.

Table (10): Effect of sodium chloride and sodium carbonate treatments on leaf and root manganese content (ppm D.W. basis) of grape rootstocks in 2000 and 2001 seasons.

Treatment / Rootstock	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	3000	750	1500		
Leaves 2000						
Harmony	83.00	52.94	89.55	75.83	134.27	87.12
Dogridge	120.58	109.33	111.55	81.72	84.00	101.44
1103 Paulsen	107.50	149.33	142.94	103.77	107.44	122.20
Thompson seedless	83.77	78.89	79.44	70.16	62.55	74.96
Average	98.71	97.62	105.87	82.87	97.07	
L.S.D 0.05	Rootst. 10.78		Treat. 12.05		Rootst. x Treat. 24.11	
Leaves 2001						
Harmony	108.22	101.27	80.66	90.50	79.00	91.93
Dogridge	72.66	75.39	67.91	64.38	76.72	71.41
1103 Paulsen	81.41	75.83	64.00	78.05	62.83	72.42
Thompson seedless	68.94	68.11	29.33	31.44	43.00	48.16
Average	82.81	80.15	60.48	66.09	65.39	
L.S.D 0.05	Rootst. 7.62		Treat. 8.52		Rootst. x Treat. 17.03	
Roots 2001						
Harmony	46.33	71.00	49.77	57.78	50.78	55.13
Dogridge	62.28	55.44	69.27	53.39	73.66	62.81
1103 Paulsen	55.28	75.33	55.66	39.77	39.08	53.02
Thompson seedless	97.39	67.33	67.61	37.08	57.16	65.31
Average	65.32	67.28	60.58	47.01	55. 17	
L.S.D 0.05	Rootst. 7.53		Treat. 8.42		Rootst. x Treat. 16.83	

10. Zinc

Regarding the effect of salinity treatments on leaf zinc content, irrespective the effect of rootstocks, the results in Table (11) indicated that, in both seasons, different sodium chloride and sodium carbonate treatments did not significantly differ than the control in leaf zinc content. These findings are in accordance with those of Stevens *et al.*, (1996) who found that saline irrigation did not affect the leaf concentration of zinc in four grapevine cultivars on their own roots and on Ramsey rootstock.

As for the effect of rootstocks on leaf zinc content, regardless of the effect of salinity treatments, the data in Table (11) indicated that, in the first season, the studied rootstocks could be arranged in the following descending order with respect to leaf zinc content Dogridge > 1103 Paulsen > Harmony > Thompson seedless. In the second season, Harmony had significantly higher leaf zinc content than Dogridge, which did not significantly differ than 1103 Paulsen. The latter did not significantly vary than Thompson seedless. Gaser (1992) reported that the most sensitive rootstocks st. George and Couderc 1202 tended to absorb and accumulate zinc in lower rates than the other grapevine rootstocks.

Regarding the effect of salinity treatments on root zinc content, irrespective the effect of rootstocks, the data in Table (11) indicated that, root zinc content was not significantly affected with different sodium chloride and sodium carbonate treatments.

As for the effect of rootstocks on root zinc content, regardless of the effect of salinity treatments, the results in Table (11) indicated that, 1103 Paulsen had significantly lower root zinc content than the other rootstocks. Mohamed (1996) reported that Thompson seedless transplants exhibited the higher value of Zn content in their roots, whereas in the second season, Early Superior was the higher in root zinc content.

Table (11): Effect of sodium chloride and sodium carbonate treatments on leaf and root zinc content (ppm D.W. basis) of grape rootstocks in 2000 and 2001 seasons.

Treatment / Rootstock	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	3000	750	1500		
Leaves 2000						
Harmony	18.33	25.33	21.10	18.05	36.44	23.85
Dogridge	40.00	37.50	44.99	36.66	29.44	37.72
1103 Paulsen	23.89	25.55	28.33	44.16	28.33	30.05
Thompson seedless	17.77	16.66	12.22	10.00	11.67	13.66
Average	25.00	26.26	26.66	27.22	26.47	
L.S.D 0.05	Rootst. 2.93		Treat. N.S		Rootst. x Treat. 6.56	
Leaves 2001						
Harmony	32.22	28.88	29.44	34.44	36.11	32.22
Dogridge	24.99	28.33	24.44	26.66	21.11	25.11
1103 Paulsen	24.44	23.33	22.22	21.11	23.88	23.00
Thompson seedless	23.88	24.99	22.77	21.11	15.55	21.66
Average	26.38	26.38	24.72	25.83	24.16	
L.S.D 0.05	Rootst. 3.28		Treat. N.S		Rootst. x Treat. N.S	
Roots 2001						
Harmony	28.88	16.12	25.55	21.67	22.22	22.89
Dogridge	20.00	20.55	20.00	23.33	22.77	21.33
1103 Paulsen	18.33	16.11	13.89	16.66	17.77	16.55
Thompson seedless	23.33	23.33	27.77	16.11	16.66	21.44
Average	22.64	19.03	21.80	19.44	19.86	
L.S.D 0.05	Rootst. 2.77		Treat. N.S		Rootst. x Treat. 6.20	

11. K / Na ratio

Regarding the effect of salinity treatments on leaf K/Na ratio, irrespective the effect of rootstocks, the data in Table (12) indicated that, in the first season, different sodium chloride and sodium carbonate treatments gave significantly lower leaf K / Na ratio than the untreated plants. In the second season, it was found that the untreated plants did not significantly differ than those subjected to the other salinity treatments, except 1500 ppm sodium carbonate, which had significantly, lower value than the untreated plants. Al – Saidi and Alawi (1984) and Al – Saidi *et al.* (1987) found that leaf K / Na ratio decreased under saline conditions.

As for the effect of rootstocks on leaf K/Na ratio, regardless of the effect of salinity treatments, the results in Table (12) revealed that, in the first season, Harmony and Dogridge had significantly higher leaf K / Na ratio than 1103 Paulsen. The latter had significantly higher value than Thompson seedless. In the second season, Dogridge had significantly higher leaf K / Na ratio than Harmony and Thompson seedless. The latter cultivars had significantly higher level than 1103 Paulsen.

Concerning the effect of salinity treatments on root K/Na ratio, irrespective the effect of rootstocks, the data in Table (12) indicated that, the untreated plants had significantly higher values than salinity treated ones. Al – Saidi *et al.* (1985) and Sivritepe and Eris (1998) found that salinity reduced root K / Na ratio in grapevines.

Table (12): Effect of sodium chloride and sodium carbonate treatments on leaf and root K/Na ratio content of grape rootstocks in 2000 and 2001 seasons.

Rootstock \ Treatment	Na Cl (ppm) 1500	Na Cl (ppm) 3000	Na_2CO_3 (ppm) 750	Na_2CO_3 (ppm) 1500	Control	Average
Leaves 2000						
Harmony	1.81	2.14	1.96	2.27	3.56	2.35
Dogridge	2.26	2.28	3.30	1.81	2.17	2.36
1103 Paulsen	2.25	2.22	2.31	1.92	2.20	2.18
Thompson seedless	1.68	1.28	1.09	1.32	3.29	1.73
Average	2.00	1.98	2.17	1.83	2.81	
L.S.D 0.05	Rootst. 0.07		Treat. 0.07		Rootst. x Treat. 0.15	
Leaves 2001						
Harmony	1.23	1.22	1.20	1.08	1.08	1.16
Dogridge	1.27	1.37	1.10	1.16	1.18	1.22
1103 Paulsen	1.07	0.90	1.05	0.83	1.12	0.99
Thompson seedless	1.21	1.13	1.16	0.87	1.23	1.12
Average	1.20	1.16	1.13	0.99	1.15	
L.S.D 0.05	Rootst. 0.06		Treat. 0.06		Rootst. x Treat. 0.13	
Roots 2001						
Harmony	0.56	0.28	0.54	0.48	0.83	0.54
Dogridge	0.71	0.60	0.68	0.55	1.22	0.75
1103 Paulsen	0.59	0.42	0.54	0.46	1.00	0.60
Thompson seedless	1.00	0.96	0.82	0.64	1.81	1.05
Average	0.72	0.57	0.65	0.53	1.22	
L.S.D 0.05	Rootst. 0.05		Treat. 0.06		Rootst. x Treat. 0.12	

As for the effect of rootstocks on root K/Na ratio, regardless of the effect of salinity treatments, the results in Table (12) revealed that, the studied cultivars could be arranged in the following descending order with respect to root K / Na ratio Thompson seedless > Dogridge > 1103 Paulsen > Harmony.

12. Na / Ca ratio

Regarding the effect of salinity treatments on leaf Na/Ca ratio, irrespective the effect of rootstocks, the results in Table (13) indicated that, in both seasons, Na / Ca ratio in salinity treated plant leaves was significantly higher than that of untreated ones, except those treated with 1500 ppm sodium chloride in the second season. This trend was supported by Sivritepe and Eris (1998) on grapevines. They found that salinity led to an increase in leaf Na / Ca ratio.

As for the effect of rootstocks on leaf Na/Ca ratio, regardless of the effect of salinity treatments, the data in Table (13) indicated that, in the first season, Thompson seedless had significantly higher leaf Na / Ca ratio than Dogridge which had significantly higher value than Harmony and 1103 Paulsen. In the second season, the studied cultivars could be arranged in the following descending order with respect to leaf Na / Ca ratio Harmony > Dogridge > Thompson seedless > 1103 Paulsen.

Concerning the effect of salinity treatments on root Na/Ca ratio, irrespective the effect of rootstocks, the data in Table (13) indicated that, the different sodium chloride and sodium carbonate treatments had significantly higher values than control. This note was supported by Sivritepe and Eris (1998).

As for the effect of rootstocks on root Na/Ca ratio, regardless of the effect of salinity treatments, the results in Table (13) indicated that, Harmony had significantly higher Na / Ca ratio in root than 1103 Paulsen which had significantly higher ratio than Dogridge and Thompson seedless.

13. Leaf / root Na ratio

Concerning the effect of salinity treatments on leaf / root Na ratio, irrespective the effect of rootstocks, the results in Table (14) indicated that, both 3000 ppm sodium chloride and 750 ppm sodium carbonate treatments had significantly higher leaf / root Na ratio than the other treatments.

As for the effect of rootstocks on leaf / root Na ratio, regardless of the effect of salinity treatments, the data in Table (14) indicated that, Harmony and Dogridge had significantly higher leaf / root Na ratio than Thompson seedless which had significantly higher value than 1103 paulsen.

Table (13): Effect of sodium chloride and sodium carbonate treatments on leaf and root Na / Ca ratio content of grape rootstocks in 2000 and 2001 seasons.

Treatment / Rootstock	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	3000	750	1500		
Leaves 2000						
Harmony	0.42	0.38	0.42	0.41	0.18	0.36
Dogridge	0.37	0.38	0.40	0.52	0.29	0.39
1103 Paulsen	0.40	0.44	0.35	0.35	0.27	0.36
Thompson seedless	0.30	0.44	0.49	0.77	0.23	0.45
Average	0.37	0.41	0.42	0.51	0.24	
L.S.D 0.05	Rootst. 0.03		Treat. 0.04		Rootst. x Treat. 0.07	
Leaves 2001						
Harmony	0.67	0.76	0.90	0.96	0.83	0.82
Dogridge	0.84	0.83	0.71	0.82	0.54	0.75
1103 Paulsen	0.52	0.49	0.57	0.51	0.48	0.51
Thompson seedless	0.42	0.54	0.62	0.64	0.51	0.54
Average	0.61	0.66	0.70	0.73	0.59	
L.S.D 0.05	Rootst. 0.03		Treat. 0.04		Rootst. x Treat. 0.07	
Roots 2001						
Harmony	0.77	0.98	0.72	0.72	0.48	0.73
Dogridge	0.56	0.66	0.68	0.74	0.47	0.62
1103 Paulsen	0.73	0.93	0.63	0.69	0.48	0.69
Thompson seedless	0.47	0.77	0.71	0.71	0.39	0.61
Average	0.63	0.84	0.69	0.72	0.46	
L.S.D 0.05	Rootst. 0.03		Treat. 0.04		Rootst. x Treat. 0.07	

Table (14): Effect of sodium chloride and sodium carbonate treatments on leaf/ root Na ratio content of grape rootstocks at the end of the experiment.

Treatment / Rootstock	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	3000	750	1500		
Harmony	1.17	1.40	1.31	1.17	1.32	1.27
Dogridge	1.30	1.46	1.15	1.22	1.09	1.24
1103 Paulsen	0.97	0.89	1.10	0.80	0.92	0.94
Thompson seedless	1.00	1.10	1.24	1.24	1.11	1.14
Average	1.11	1.21	1.20	1.11	1.11	
L.S.D 0.05	Rootst. 0.05		Treat. 0.05		Rootst. x Treat. 0.10	

14. Leaf / root Cl ratio

Regarding the effect of salinity treatments on leaf / root Cl ratio, irrespective the effect of rootstocks, the results in Table (15) revealed that, 1500 ppm sodium carbonate had significantly higher leaf / root Cl ratio than the other treatments, followed by 750 ppm sodium carbonate, which had significantly higher leaf / root Cl ratio than 1500 and 3000 ppm sodium chloride treatments and the control. Untreated plants (control) had significantly the lowest value.

As for the effect of rootstocks on leaf / root Cl ratio, regardless of the effect of salinity treatments, the data in Table (15) indicated that, the studied cultivars could be arranged in the following descending order with respect to leaf / root Cl ratio: Thompson seedless > Harmony > Dogridge > 1103 Paulsen. The differences among them were significant.

Table (15): Effect of sodium chloride and sodium carbonate treatments on leaf / root Cl ratio content of grape rootstocks at the end of the experiment.

Treatment / Rootstock	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	3000	750	1500		
Harmony	1.24	1.58	1.64	1.89	1.07	1.48
Dogridge	0.96	1.13	1.49	1.30	0.97	1.17
1103 Paulsen	0.62	0.61	0.77	0.63	0.22	0.57
Thompson seedless	1.40	1.00	2.42	3.10	0.87	1.76
Average	1.06	1.08	1.58	1.73	0.78	
L.S.D 0.05	Rootst. 0.13		Treat. 0.15		Rootst.x Treat. 0.30	

Finally, it could be concluded that 1103 Paulsen is more salinity tolerant than the other rootstocks. This tolerance is based on the least contents of sodium and chloride in the leaves.

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تأثير بعض أملاح الصوديوم على النمو والتركيب المعدني والمحتوي العضوي لبعض أصول العنب:

٢- التركيب المعدنى

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أجرى هذا البحث خلال موسمي ٢٠٠٠ ، ٢٠٠١ بغرض دراسة تاثير ملحي كلوريد الصوديوم وكربونات الصوديوم على التركيب المعدنى لأوراق وجذور أربعة اصناف عنب هي هارموني ، ١١٠٣ بولسن ودوج ريدج وطومسون سيدلس والمستخدمة كأصول.

ويمكن تلخيص النتائج الرئيسية لهذه الدراسة فى النقاط التالية:

أ. تأثير المعاملات الملحية

١- ادت معاملتى كربونات الصوديوم الي خفض نتيروجين الجذر معنويا مقارنة بالكنترول.

٢- ادت معاملتى كلوريد الصوديوم في كلا الموسمين الي زيادة فوسفور الورقة معنويا مقارنة بمعاملتى كربونات الصوديوم.

٣- ادت المعاملات الملحية الى خفض بوتاسيوم الجذر معنويا مقارنة بالكنترول.

٤- إزداد كلوريد الورقة والجذر معنويا في كلا الموسمين بمعاملتى كلوريد الصوديوم مقارنة بباقي المعاملات الاخري.

٥- في كلا الموسمين إزداد صوديوم الورقة والجذر معنويا بمعاملات كلوريد الصوديوم وكربونات الصوديوم المختلفة مقارنة بالكنترول.

٦- انخفض كالسيوم الجذر معنويا بالمعاملات الملحية ما عدا ١٥٠٠ جزء في المليون كلوريد صوديوم مقارنة بالكنترول.

٧- في الموسم الاول انخفض ماغنسيوم الورقة معنويا بالمعاملات الملحية بينما في الموسم الثاني كانت الاختلافات بين المعاملات غير معنوية . ادي كلوريد الصوديوم عند تركيز ١٥٠٠ جزء في المليون الي زيادة ماغنسيوم الجذر معنويا مقارنة بالكنترول.

٨- انخفض حديد الجذر معنويا بالمعاملات الملحية .

٩- ادت المعاملتين ٣٠٠٠ جزء في المليون كلوريد صوديوم ، ٧٥٠ جزء في المليون كربونات صوديوم الى زيادة نسبة صوديوم الورقة الى صوديوم الجذر معنويا مقارنة بباقي المعاملات الاخرى.

١٠- أدى استخدام كربونات الصوديوم عند تركيز ١٥٠٠ جزء في المليون إلى زيادة نسبة كلوريد الورقة إلى كلوريد الجذر مقارنة بباقي المعاملات الأخرى.

ب. تاثير الأصول

١- كان الأصل طومسون سيدلس اعلى في فوسفور وكالسيوم الورقة واقل فى منجنيز وزنك الورقة وذلك في كلا الموسمين. وفي نفس الوقت احتوت جذوره على قيم اعلى معنويا في النيتروجين والماغنسيوم والمنجنيز ونسبة البوتاسيوم للصوديوم واقل في الحديد ونسبة الصوديوم الى الكالسيوم.

٢- في كلا الموسمين احتوت اوراق الأصل الهارمونى على اقل فوسفور وكالسيوم بينما احتوت جذوره على اعلى نسبة للصوديوم / الكالسيوم واقل فوسفور ومنجنيز .

٣- في كلا الموسمين احتوت اوراق الأصل ١١٠٣ بولسن على اقل نيتروجين وكلوريد وصوديوم ونسبة صوديوم الورقة الي صوديوم الجذر بينما احتوت جذوره على اعلى فوسفور واقل زنك ومنجنيز .

وأخيرا يمكن استنتاج أن الأصل ١١٠٣ بولسن اكثر تحملا للملوحة عن باقي الأصول الأخرى.