J. Agric. Sci. Mansoura Univ., 28 (9): 6821 - 6839, 2003

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

Eissa, A. M.; M.N. Haggag; M.B. El-Sabrout and M.E. Abd El-Rahman
Department of Pomology, Faculty of Agriculture, Alexandria University, Alexandria, Egypt.

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 growth 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

Plant height, growth rate, number of leaves, leaf area, pruning wood weight and plant fresh and dry weight, in both seasons. Number and diameter of shoots, in the second season only, significantly decreased with the different sodium chloride and sodium carbonate treatments. On the other hand, shoot/ root ratio significantly increased with salinity treatments. Stem diameter was not significantly affected with salinity treatments, in both seasons, however.

B. Effect of rootstocks

In both seasons, Thompson seedless had significantly higher leaf area and dry weight, shoot diameter, root fresh and dry weight and lower leaves number. In the meantime, Dogridge had significantly higher average plant height in both seasons and shoot / root ratio, at the end of the experiment. Harmony had significantly lower shoots and roots fresh and dry weight, while 1103 Paulsen had significantly higher leaves number and lower leaf area, in both seasons.

INTRODUCTION

Grape is one of the most 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 research aimed to study the influence of sodium salts, i.e sodium chloride and sodium carbonate on growth 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. Vegetative growth parameters included plant height, the length of the lateral shoots, the number of shoots and leaves were recorded at zero time and at the end of each season. Besides, for leaf area determination, five leaves were taken from the middle of one shoot per plant, cleaned and drawn on paper. The area of each leaf was measured by planimeter and were expressed as cm^2. Stem diameter in millimeters was measured at 5 cm height above the ground and shoots diameters were also measured. Pruning wood weight was determinated in January 2001.
The growth rate of each plant was calculated using the following equation:

$$\text{Growth rate} = \frac{\text{Final length} - \text{initial length}}{\text{Initial length}}$$

The fresh and dry weights of 30 leaves, stems, shoots, roots and the whole plant were determinated. Besides, shoot/root ratio was determined at the end of the experiment. Leaf samples were taken in October 2000 and 2001. At the termination of the experiment in October 2001, all plants were carefully lifted from the pots and adhering soil particles were removed off the roots by washing them with tap water . Plant fresh and dry weights were measured. Soil and water samples were taken before planting, data of soil and water analysis are presented in Table (1).

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
$H\ CO_3$	1.57	2.48
Cl^{-}	1.48	3.99
SO_4^{-2}	1.04	3.36

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).

RESULTS AND DISCUSSION

Data representing the effect of different sodium chloride and sodium carbonate treatments on plant growth parameters of the studied grape rootstocks in 2000 and 2001 seasons are listed in Tables (2 to 18).

1. Plant height

Regarding the effect of different salinity treatments on plant height, irrespective the effect of rootstocks, the results in Table (2) indicated that, in both seasons, plant height markedly decreased with rising salinity as compared with the control. In the meantime, increasing concentration of the studied salts in the irrigation water significantly increased the depression effect of salinity on plant height. These results agreed with those previously reported by Essa (1988); Hooda *et al*., (1990); Gaser (1992) and Mohamed (1996) working on grapevines.

As for the effect of rootstocks on plant height, regardless of the effect of salinity treatments, the data in Table (2) indicated that, in the first season, Harmony and Dogridge had significantly higher plant height than Thompson seedless and 1103 Paulsen. In the second season, the studied cultivars could be arranged in the following descending order: Dogridge > Thompson seedless > Harmony > 1103 Paulsen and the differences among them were significant. Gaser (1992) found that Couderc 1616, Couderc 1613 and Thompson seedless grew well under salt stress as they developed the longest shoots, while st. George and Couderc 1202 produced the shortest growth. Moreover, Dogridge and ARG1 rated in between.

Table (2): Effect of sodium chloride and sodium carbonate treatments on plant height (cm) 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
2000						
Harmony	80.25	76.17	111.90	107.56	133.85	101.95
Dogridge	111.75	96.81	120.25	72.75	123.38	104.99
1103 Paulsen	67.56	59.71	71.31	61.50	93.42	70.70
Thompson seedless	104.46	63.63	57.52	58.15	84.08	73.57
Average	91.01	74.08	90.25	74.99	108.68	
L.S.D 0.05	Rootst. 4.93		Treat. 5.51		Rootst. x Treat. 11.03	
2001						
Harmony	104.06	91.33	129.42	131.16	218 .25	134.84
Dogridge	165.30	161.13	160.44	126.13	258.50	174.30
1103 Paulsen	105.08	100.41	116.75	95.18	127.16	108.92
Thompson seedless	153.31	130.83	156.69	112.15	198.75	150.35
Average	131.94	120.93	140.83	116.16	200.67	
L.S.D 0.05	Rootst. 9.71		Treat. 10.86		Rootst. x Treat. 21.72	

2- Number of shoots

Concerning the effect of salinity treatments on average number of shoots per plant, irrespecive the effect of rootstocks, the data in Table (3) indicated that, in the first season, the average number of shoots per plant was not significantly affected by salinity treatments. In the second season, however, control plants had significantly higher number of shoots as compared with the other treatments. Likewise, plants treated with 1500 ppm and 3000 ppm sodium chloride or 750 ppm sodium carbonate had significantly higher average number of shoots per plant than those treated with 1500 ppm sodium carbonate. Ahmed and Atalla (1984) and Prior *et al.,* (1992) reported that number of laterals was depressed by increasing salinity in irrigation water. However, Hooda *et al.* (1990) found that the number of shoots/vine remained unaffected by salinity.

As for the effect of rootstocks on number of shoots, regardless of the effect of salinity treatments, the results in Table (3) indicated that, in the first season, Harmony had the highest number of shoots as compared with the other cultivars, which didn't significantly vary. In the second season, the present results showed that 1103 Paulsen had significantly higher average number of shoots than the other cultivars . Moreover, Thompson seedless had significantly the lowest average. Mohamed (1996) reported that , in the first season , King's Ruby and Thompson seedless transplants exhibited the higher values of increasing number of shoots followed by Flame seedless and Early Superior, although these values were lacking insignificantly. However , in the second season, King's Ruby exhibited higher value followed by Thompson seedless and Flame seedless, whereas Early Superior was the least one with no significant differences between them.

Table (3): Effect of sodium chloride and sodium carbonate treatments on number of shoots per plant 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
2000						
Harmony	1.71	2.13	2.25	2.71	1.54	2.07
Dogridge	1.83	2.00	1.79	1.38	1.67	1.73
1103 Paulsen	2.19	1.46	2.00	1.54	1.98	1.83
Thompson seedless	1.50	1.79	1.58	1.73	1.67	1.65
Average	1.81	1.85	1.91	1.84	1.72	
L.S.D 0.05	Rootst. 0.22		Treat. N.S		Rootst. x Treat. 0.50	
2001						
Harmony	3.33	2.63	2.75	2.66	3.75	3.02
Dogridge	3.12	3.25	3.75	2.00	3.87	3.20
1103 Paulsen	4.21	3.75	3.37	3.39	5.50	4.04
Thompson seedless	2.31	2.62	2.66	2.06	3.29	2.59
Average	3.24	3.06	3.13	2.53	4.10	
L.S.D 0.05	Rootst. 0.34		Treat. 0.38		Rootst. x Treat. 0.77	

3- Leaf area

Regarding the effect of salinity treatments on average leaf area, irrespective the effect of rootstocks, the data in Table (4) revealed that, in both seasons, control plants had significantly higher average leaf area as compared with the other treatments. Plants treated with 1500 ppm sodium chloride had significantly lower average leaf area than those treated with the two studied sodium carbonate concentrations. In the second season, significant difference was found between the two concentrations of each studied salt . Joolka *et al*. (1976); Pandy and Divate (1976); Ahmed and Atalla (1984); Arbabzadeh and Dutt (1987); Gaser (1992); Walker *et al*. (1997) and Youssif (1998) found that leaf area decreased with rising salinity in grapevines.

As for the effect of rootstocks on average leaf area, regardless of the effect of salinity treatments, the results in Table (4) indicated that, the experimental cultivars, in both seasons could be arranged with respect to average leaf area in the following descending order: Thompson seedless> Dogridge > Harmony > 1103 Paulsen and the differences among them were statistically significant, except between Harmony and 1103 Paulsen in the first season. Gaser (1992) reported that the highest leaf area was recorded on Thompson seedless plants followed by Dogridge, Couderc 1613 and Couderc 1616. The lowest averages were obtained with st. George, ARG1 and Couderc 1202 . Mohamed (1996) reported that King's Ruby transplants exhibited the least value of reduction as compared with the other cultivars followed by Early Superior and Thompson seedless, whereas Flame seedless, was the least one in the first season. However, no significant differences were detected between Early Superior and Thompson seedless in the second season.

Table (4): Effect of sodium chloride and sodium carbonate treatments on leaf area (cm^2) of grape rootstocks in 2000 and 2001 seasons.

Treatment / Rootstock	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	3000	750	1500		
2000						
Harmony	12.86	20.91	24.12	33.78	22.32	22.80
Dogridge	41.13	19.04	51.45	27.70	43.90	36.64
1103 Paulsen	19.26	22.19	21.83	13.04	32.44	21.75
Thompson seedless	46.68	66.86	36.66	60.13	49.85	52.04
Average	29.98	32.25	33.52	33.66	37.13	
L.S.D 0.05	Rootst. 3.02		Treat. 3.38		Rootst. x Treat. 6.76	
2001						
Harmony	31.53	41.99	37.42	41.75	62.55	43.05
Dogridge	67.61	53.61	72.95	53.71	77.18	65.01
1103 Paulsen	32.31	25.31	47.62	35.00	50.35	38.12
Thompson seedless	73.90	97.66	80.31	88.45	135.95	95.25
Average	51.34	54.64	59.58	54.73	81.51	
L.S.D 0.05	Rootst. 2.37		Treat. 2.65		Rootst. x Treat. 5.29	

4- Number of leaves

Concerning the effect of salinity treatments on number of leaves, irrespective the effect of rootstocks, the data in Table (5) indicated that, in both seasons, the salinity treatments significantly decreased number of leaves as compared with the control. It was also found that increasing the concentration of the studied salts in the irrigation water significantly decreased average number of leaves per plant, except between 1500 and 3000 ppm sodium chloride treatments, in the first season only. These findings seem to be in agreement with those reported by many other investigators such as Joolka *et al*. (1976); Ahmed and Atalla (1984); Hooda *et al*. (1990); Gaser (1992); Mohamed (1996) and Shahin (1997) working on grapevines.

As for the effect of rootstocks on average number of leaves, regardless of the effect of salinity treatments, the results in Table (5) revealed that, in the first season, the experimental plants could be arranged with respect to the average number of leaves per plant in the following descending order: 1103 Paulsen > Harmony > Dogridge > Thompson seedless, whereas in 2001 it rearranged in the following descending order: 1103 Paulsen > Dogridge > Harmony > Thompson seedless. The differences among cultivars were statistically significant, in both seasons, except between Dogridge and Thompson seedless in the first season only. Gaser (1992) found that Couderc 1616 plants were prone to increase leaf number per plant regardless of salt treatments. This was true in both seasons. Otherwise, Couderc 1613 (in both seasons) as well as Couderc 1202 (in the 2nd season only) recorded the lowest averages of leaves number/plant, however, Dogridge, ARG1, st. George and Thompson seedless were intermediate.

Table (5): Effect of sodium chloride and sodium carbonate treatments on leaves number per plant of grape rootstocks in 2000 and 2001 seasons.

Treatment / Rootstock	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	3000	750	1500		
2000						
Harmony	41.63	29.94	109.44	60.29	183.81	85.02
Dogridge	54.79	42.50	66.58	22.13	75.13	52.23
1103 Paulsen	58.48	73.67	78.96	48.94	219.25	95.86
Thompson seedless	65.52	43.75	53.27	26.15	63.92	50.52
Average	55.10	47.46	77.06	39.37	135.52	
L.S.D 0.05	Rootst. 6.95		Treat. 7.77		Rootst. x Treat. 15.53	
2001						
Harmony	108.75	40.83	86.56	72.57	200.54	101.85
Dogridge	74.58	62.00	79.58	74.75	284.71	115.12
1103 Paulsen	126.12	110.16	124.00	96.87	230.16	137.46
Thompson seedless	44.62	38.79	64.75	25.25	95.43	53.77
Average	88.52	62.95	88.72	67.36	202.71	
L.S.D 0.05	Rootst. 7.59		Treat. 8.48		Rootst. x Treat. 16.97	

5. Growth rate

Regarding the effect of salinity treatments on growth rate, irrespective the effect of rootstocks, the results in Table (6) indicated that growth rate significantly decreased with rising salinity as compared with the untreated plants in both seasons. In the meantime, increasing the concentration of each studied salt significantly decreased average growth rate. These results agreed with those obtained by Kamel *et al*. (1977); Gaser (1992) and Youssif (1998) on grapevines.

As for the effect of rootstocks on growth rate, regardless of the effect of salinity treatments, the data in Table (6) indicated that, in the first season, Dogridge had significantly higher growth rate than the other cultivars. Likewise, Thompson seedless had significantly higher growth rate as compared with 1103 Paulsen. In the second season, Thompson seedless had significantly the highest growth rate than the other cultivars, which showed almost the same growth rate. Gaser (1992) found that Couderc 1616, Couderc 1613 and Thompson seedless grew well under salt stress as they developed the longest shoots, while st. George and Couderc 1202 produced the shortest growth. Moreover, Dogridge and ARG1 rated in between.

Table (6): Effect of sodium chloride and sodium carbonate treatments on growth rate of grape rootstocks in 2000 and 2001 seasons.

Treatment / Rootstock	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	3000	750	1500		
2000						
Harmony	0.19	0.13	0.21	0.15	0.58	0.25
Dogridge	0.65	0.57	0.64	0.22	0.85	0.59
1103 Paulsen	0.04	0.01	0.10	0.06	0.92	0.22
Thompson seedless	0.54	0.27	0.09	0.04	0.65	0.32
Average	0.36	0.25	0.26	0.12	0.75	
L.S.D 0.05	Rootst. 0.10		Treat. 0.11		Rootst. x Treat. 0.23	
2001						
Harmony	0.31	0.07	0.04	0.02	0.38	0.16
Dogridge	0.05	0.02	0.04	0.01	0.57	0.14
1103 Paulsen	0.16	0.08	0.15	0.04	0.28	0.14
Thompson seedless	0.78	0.71	1.23	0.69	1.29	0.94
Average	0.33	0.22	0.37	0.19	0.63	
L.S.D 0.05	Rootst. 0.07		Treat. 0.07		Rootst. x Treat. 0.15	

6 - Stem diameter

Concerning the effect of salinity treatments on stem diameter, irrespective the effect of rootstocks, the results in Table (7) indicated that, stem diameter didn't significantly differ with the studied salinity treatments, in both seasons. Abou- Rayya *et al*. (1988) found that diameter of the main shoot was not significantly affected by different salt concentrations up to 2000 ppm in Thompson seedless. However, Arbabzadeh and Dutt (1987) and Mohamed (1996) on grapevines, found that stem diameter significantly decreased with rising salinity in the irrigation water.

As for the effect of rootstocks on stem diameter, regardless of the effect of salinity treatments, the data in Table (7) indicated that, in the first season, Dogridge had significantly lower stem diameter than the other cultivars. In the second season, there were no significant differences among the studied cultivars. Mohamed (1996) reported that Flame seedless exhibited the highest values of increasing rate of stem diameter followed by King's Ruby and Early Superior, whereas Thompson seedless was the least one, although, no significant differences were detected between the values obtained by Thompson seedless, Early Superior or King's Ruby transplants.

Table (7): Effect of sodium chloride and sodium carbonate treatments on stem diameter (mm) of grape rootstocks in 2000 and 2001 seasons.

Treatment / Rootstock	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	3000	750	1500		
2000						
Harmony	8.34	8.55	8.80	8.69	9.22	8.72
Dogridge	8.39	8.56	8.69	6.79	7.61	8.01
1103 Paulsen	8.96	9.12	9.50	8.37	9.77	9.14
Thompson seedless	9.14	9.01	9.61	9.46	9.29	9.30
Average	8.71	8.81	9.15	8.33	8.97	
L.S.D 0.05	Rootst. 0.62		Treat. N.S		Rootst. x Treat. N.S	
2001						
Harmony	9.79	9.58	10.87	9.62	12.79	10.53
Dogridge	9.27	8.58	10.44	11.25	14.71	10.85
1103 Paulsen	8.95	10.41	11.33	10.90	9.83	10.28
Thompson seedless	12.41	11.79	11.96	10.58	14.20	12.19
Average	10.11	10.09	11.15	10.59	12.88	
L.S.D 0.05	Rootst. N.S		Treat. N.S		Rootst. x Treat. N.S	

7. Shoot diameter

Regarding the effect of salinity treatments on shoot diameter, irrespective the effect of rootstocks, the results in Table (8) indicated that, in the first season, the different sodium chloride and sodium carbonate treatments had insignificant effect on shoot diameter as compared with the control. However, in the second season it was found that shoot diameter significantly decreased under saline condition as compared with the untreated plants. Besides, 1500 ppm sodium carbonate caused the strongest reduction. Al-Saidi *et al*. (1987) reported that shoot diameter in Abassi and Kamali grape cultivars were decreased with rising salt percentage in the soil.

As for the effect of rootstocks on shoot diameter, regardless of the effect of salinity treatments, the data in Table (8) indicated that, in both seasons, Thompson seedless had significantly higher shoot diameter than the other cultivars, except Harmony rootstock, in the first season.

Table (8): Effect of sodium chloride and sodium carbonate treatments on shoot diameter (mm) 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
2000						
Harmony	4.86	5.27	5.21	4.28	5.31	4.99
Dogridge	4.83	4.08	4.83	3.72	4.12	4.32
1103 Paulsen	4.48	4.83	4.54	5.07	5.10	4.80
Thompson seedless	5.55	4.60	5.54	5.05	5.47	5.24
Average	4.93	4.70	5.03	4.53	5.00	
L.S.D 0.05	Rootst. 0.40		Treat. N.S		Rootst. x Treat. N.S	
2001						
Harmony	3.99	4.12	4.36	4.48	5.54	4.50
Dogridge	5.69	5.12	6.14	4.65	5.94	5.51
1103 Paulsen	3.86	4.31	4.73	3.92	4.22	4.21
Thompson seedless	6.90	6.50	5.98	5.33	7.79	6.50
Average	5.11	5.01	5.30	4.60	5.87	
L.S.D 0.05	Rootst. 0.40		Treat. 0.44		Rootst.. x Treat. 0.89	

8- Total fresh weight

Concerning the effect of salinity treatments on total fresh weight of the studied plants, irrespective the effect of rootstocks, the results in Table (9) indicated that, control plants had significantly higher total fresh weight as compared with the other treatments. The other treatments could be arranged as the following descending order with respect to total fresh weight 750 ppm sodium carbonate > 1500 ppm sodium chloride > 3000 ppm sodium chloride > 1500 ppm sodium carbonate, and the differences among them were statistically significant. The results of the present study are in agreement with those recorded by Ahmed and Attalla (1984); Haggag *et al*. (1988) and Shehata *et al*. (1996) on grapevines.

As for the effect of rootstocks on total fresh weight, regardless of the effect of salinity treatments, the data in Table (9) revealed that Thompson seedless plants had significantly the highest total fresh weight, whereas Harmony had the lowest one, and Dogridge and 1103 Paulsen were intermediate. Significant differences were observed among the studied cultivars.

Table (9): Effect of sodium chloride and sodium carbonate treatments on total fresh weight (g) 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	116.11	128.00	155.94	131.28	322.49	170.76
Dogridge	230.03	176.47	276.33	191.28	466.98	268.22
1103 Paulsen	217.81	272.54	316.68	175.41	319.38	260.36
Thompson seedless	418.30	323.76	281.19	208.90	515.87	349.60
Average	245.56	225.19	257.54	176.72	406.18	
L.S.D 0.05	Rootst. 6.88		Treat. 7.70		Rootst. x Treat. 15.39	

9- Total dry weight

Regarding the effect of salinity treatments on total dry weight of the studied plants, irrespecitve the effect of rootstocks, the results in Table (10) indicated that the control plants had significantly higher total dry weight as compared with the other treatments. In the meantime, experimental plants treated with 750 ppm sodium carbonate had significantly higher total dry weight than those subjected to the rest treatments. Sodium chloride at 3000 ppm and sodium carbonate at 1500 ppm treatments, which showed almost the same average caused a significant decrease in plant total dry weight as compared with those of 1500 ppm sodium chloride treatment. These findings are supported by Al- Saidi *et al*. (1987); Essa (1988); Prior *et al*. (1992); Shehata *et al.* (1996); Mohamed (1996); Jalili (1998) and Youssif (1998) on grapevines.

As for the effect of rootstocks on total dry weight, regardless of the effect of salinity treatments, the data in Table (10) revealed that the experimental cultivars could be arranged in the following descending order with respect to total dry weight Dogridge > 1103 Paulsen > Thompson seedless > Harmony and the differences among them were statistically significant. Gaser (1992) found that Couderc 1616 and Thompson seedless plants were prone to increase dry weight than other rootstocks, regardless of salt treatments. On the other side, st. George followed by Couderc 1613 and Couderc 1202 recorded the lowest values in this respect.

Table (10): Effect of sodium chloride and sodium carbonate treatments on total dry weight (g) 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	49.57	40.71	55.93	52.55	94.41	58.63
Dogridge	141.29	94.12	175.98	117.78	222.83	150.40
1103 Paulsen	106.33	98.87	158.66	102.02	166.68	126.51
Thompson seedless	111.89	98.18	105.94	70.44	168.49	110.99
Average	102.27	82.97	124.13	85.70	163.10	
L.S.D 0.05	Rootst. 5.67		Treat. 6.34		Rootst. x Treat. 12.68	

10 - Leaf fresh weight

Concerning the effect of salinity treatments on leaf fresh weight, irrespective the effect of rootstocks, the results in Table (11) indicated that, in both seasons, leaf fresh weight significantly decreased under salinity treatments, except 750 ppm sodium carbonate in the first season . Also, it was showed that increasing the concentration of studied salts, generally, decreased average leaf fresh weight. These findings are supported by Kamel *et al*. (1977); El- Gazzar *et al*. (1979) and Shehata (1983) on grapevines.

As for the effect of rootstocks on leaf fresh weight, regardless of the effect of salinity treatments, the data in Table (11) indicated that, in the first season, the studied cultivars could be arranged in the following descending order with respect to leaf fresh weight Thompson seedless > Dogridge >1103 Paulsen > Harmony. In the second season, this arrangement was as follows: 1103 Paulsen > Dogridge > Thompson seedless > Harmony. The differences among these cultivars, in both seasons, were statistically significant.

Table (11): Effect of sodium chloride and sodium carbonate treatments on leaf fresh weight (g) of grape rootstocks in 2000 and 2001 seasons.

Treatment / Rootstock	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	3000	750	1500		
2000						
Harmony	5.28	6.38	10.27	10.45	15.97	9.67
Dogridge	15.68	17.10	22.90	15.50	16.43	17.52
1103 Paulsen	12.63	10.17	14.83	11.97	14.80	12.88
Thompson seedless	37.30	32.20	32.45	35.48	37.95	35.08
Average	17.72	16.46	20.11	18.35	21.29	
L.S.D 0.05	Rootst. 1.24		Treat. 1.39		Rootst. x Treat. 2.78	
2001						
Harmony	10.77	10.67	9.92	14.80	23.07	13.85
Dogridge	26.72	17.65	26.58	22.17	35.58	25.74
1103 Paulsen	49.96	39.54	39.83	41.45	76.85	49.53
Thompson seedless	13.68	14.83	21.12	14.42	19.73	16.76
Average	25.28	20.67	24.36	23.21	38.81	
L.S.D 0.05	Rootst. 2.47		Treat. 2.77		Rootst. x Treat. 5.54	

11 - Leaf dry weight

Regarding the effect of salinity treatments on leaf dry weight, irrespective the effect of rootstocks, the data in Table (12) indicated that, leaf dry weight significantly decreased with different sodium chloride and sodium carbonate treatments in both seasons. The results, also showed that increasing the concentration of studied salts decreased average leaf dry weight in both seasons, except different sodium carbonate treatments in the first season. These results are supported by Essa (1988); Gaser (1992) and Youssif (1998) working on grapevines.

As for the effect of rootstocks on leaf dry weight, regardless of the effect of salinity treatments, the results in Table (12) indicated that, in the first season, Thompson seedless had significantly higher leaf dry weight than Dogridge, which was significantly higher than Harmony and 1103 Paulsen. In the second season, leaf dry weight in all tested stocks followed the descending order: Thompson seedless > Dogridge >1103 Paulsen > Harmony. Gaser (1992) found that Couderc 1616 and Thompson seedless plants were prone to increase leaf dry weight than the other rootstocks, regardless of salt treatments. On the other side, st. George followed by Couderc 1613 and Couderc 1202 recorded the lowest values in this respect.

Table (12): Effect of sodium chloride and sodium carbonate treatments on leaf dry weight (g) of grape rootstocks in 2000 and 2001 seasons.

Treatment / Rootstock	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	3000	750	1500		
2000						
Harmony	2.68	2.75	4.03	4.57	6.28	4.06
Dogridge	6.00	5.07	7.10	5.75	6.38	6.06
1103 Paulsen	3.95	3.13	4.12	3.90	4.38	3.90
Thompson seedless	10.60	9.05	8.97	9.52	10.75	9.78
Average	5.81	5.00	6.06	5.94	6.95	
L.S.D 0.05	Rootst. 0.32		Treat. 0.36		Rootst. x Treat. 0.72	
2001						
Harmony	3.00	1.96	2.62	3.02	4.63	3.05
Dogridge	5.51	3.99	6.59	4.55	7.42	5.61
1103 Paulsen	3.32	3.83	4.28	3.22	3.87	3.70
Thompson seedless	8.08	6.95	5.98	6.10	13.22	8.07
Average	4.98	4.18	4.87	4.22	7.29	
L.S.D 0.05	Rootst. 0.48		Treat. 0.54		Rootst. x Treat. 1.07	

12. Stems and shoots fresh weight

Concerning the effect of salinity treatments on stems and shoots fresh weight, irrespective the effect of rootstocks, the data in Table (13) indicated that stems and shoots fresh weight significantly decreased under different sodium chloride and sodium carbonate treatments as compared with the untreated plants at the end of the experiment. The results, also showed that increasing the concentration of sodium carbonate decreased stems and shoots fresh weight but there were no significant differences with increasing the concentration of sodium chloride. These results agreed with those found by Kamel *et al.* (1977); El-Gazzar *et al*. (1979) and Shehata (1983) on grapevines.

As for the effect of rootstocks on stems and shoots fresh weight, regardless of the effect of salinity treatments, the results in Table (13) indicated that, Thompson seedless had significantly higher stems and shoots fresh weight than 1103 Paulsen and Harmony. However, stems and shoots fresh weight of Thompson seedless did not differ significantly than those of Dogridge.

Table (13): Effect of sodium chloride and sodium carbonate treatments on stems and shoots fresh weight (g) 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	55.20	69.85	98.19	85.02	209.57	103.57
Dogridge	137.27	120.31	177.66	153.55	302.62	178.28
1103 Paulsen	131.89	176.61	216.74	117.37	199.85	168.49
Thompson seedless	239.05	168.88	159.53	118.43	263.92	189.96
Average	140.85	133.91	163.03	118.59	243.99	
L.S.D 0.05	Rootst. 11.98		Treat. 13.40		Rootst. x Treat. 26.79	

13. Stems and shoots dry weight

Regarding the effect of salinity treatments on stems and shoots dry weight, irrespective the effect of rootstocks, the data in Table (14) indicated that, stems and shoots dry weight significantly decreased with salinity treatments as compared with the untreated plants. The results also showed that increasing the concentration of studied salts, generally, decreased stems and shoots dry weight. These findings agreed with those found by Essa (1988); Gaser (1992) and Mohamed (1996) on grapevines.

As for the effect of rootstocks on stems and shoots dry weight, regardless of the effect of salinity treatments, the results in Table (14) indicated that, stems and shoots dry weight in all tested rootstocks followed the descending order: Dogridge >1103 Paulsen >Thompson seedless > Harmony. Mohamed (1996) reported that no significant differences were noticed in shoot dry weight between Flame seedless, King's Ruby and Thompson seedless transplants compared to Early Superior in the first season. However, Flame seedless, King's Ruby exhibited highest values compared with Thompson seedless and Early Superior in the second season.

Table (14): Effect of sodium chloride and sodium carbonate treatments on stems and shoots dry weight (g) 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	37.77	31.50	43.83	42.48	67.95	44.71
Dogridge	121.46	83.27	152.73	102.97	181.90	128.47
1103 Paulsen	84.17	75.88	133.50	87.50	137.32	103.67
Thompson seedless	85.47	72.73	75.50	53.50	125.92	82.62
Average	82.22	65.85	101.39	71.61	128.27	
L.S.D 0.05	Rootst. 9.19		Treat. 10.27		Rootst. x Treat. 20.54	

14. Root fresh weight

Concerning the effect of salinity treatments on root fresh weight, irrespective the effect of rootstocks, the results in Table (15) indicated that, at the end of the experiment, root fresh weight significantly decreased under different sodium chloride and sodium carbonate treatments as compared with the untreated plants. The results also indicated that increasing the concentration of the studied salts significantly decreased average root fresh weight. These findings are supported by Kamel *et al*., (1977); El- Gazzar *et al*., (1979) and Shehata (1983) on grapevines.

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

Table (15): Effect of sodium chloride and sodium carbonate treatments on root fresh weight (g) 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	50.15	47.49	47.84	31.46	89.86	53.36
Dogridge	66.05	38.51	75.08	15.56	128.78	64.80
1103 Paulsen	72.24	81.09	78.82	43.62	99.80	75.11
Thompson seedless	129.28	115.34	81.83	49.02	175.10	110.11
Average	79.43	70.61	70.89	34.92	123.39	
L.S.D 0.05	Rootst. 2.57		Treat. 2.87		Rootst. x Treat. 5.74	

15. Root dry weight

Regarding the effect of salinity treatments on root dry weight, irrespective the effect of rootstocks, the data in Table (16) indicated that, at the end of the experiment, root dry weight significantly decreased under different sodium chloride and sodium carbonate treatments as compared with the untreated plants. The results also indicated that increasing the concentration of sodium carbonate significantly decreased average root dry weight but there were no significant differences with increasing the concentration of sodium chloride. The data of the present study are in agreement with those recorded by Essa (1988); Gaser (1992); Mohamed (1996) and Youssif (1998) working on grapevines.

As for the effect of rootstocks on root dry weight, regardless of the effect of salinity treatments, the results in Table (16) indicated that, Thompson seedless and 1103 Paulsen had significantly higher root dry weight than Dogridge, which had significantly higher value than Harmony. Mohamed (1996) reported that Early Superior and Flame seedless exhibited the highest values of root dry weight compared by Thompson seedless and King's Ruby but no significant differences were noticed between them.

Table (16): Effect of sodium chloride and sodium carbonate treatments on root dry weight (g) 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	8.81	7.29	9.48	7.05	21.83	10.89
Dogridge	14.32	6.87	16.66	10.27	33.24	16.27
1103 Paulsen	18.84	19.15	20.89	11.30	25.50	19.14
Thompson seedless	18.34	18.50	24.46	10.84	29.35	20.30
Average	15.08	12.95	17.87	9.87	27.48	
L.S.D 0.05	Rootst. 2.03		Treat. 2.27		Rootst. x Treat. 4.54	

16. Pruning wood weight

Concerning the effect of salinity treatments on pruning wood weight, irrespective the effect of rootstocks, the data in Table (17) indicated that, pruning wood weight significantly decreased under different sodium chloride and sodium carbonate treatments as compared with the control. These results are supported by many previous investigators such as: Arbabazadeh and Dutt (1987); Prior *et al*. (1992) and Shehata *et al*. (1996) on grapevines.

As for the effect of rootstocks on pruning wood weight, regardless of the effect of salinity treatments, the results in Table (17) indicated that, Harmony and Thampson seedless had significantly higher pruning wood weight than Dogridge and 1103 Paulsen. Gaser (1992) found that Couderc 1616 and Thompson seedless plants were prone to increase shoot weight than the other rootstocks namely, st. George, Couderc 1613 and Couderc 1202.

Table (17): Effect of sodium chloride and sodium carbonate treatments on pruning wood weight (g) of grape rootstocks in January 2001.

Treatment / Rootstock	Na Cl (ppm)		Na_2CO_3 (ppm)		Control	Average
	1500	**3000**	**750**	**1500**		
Harmony	13.25	13.50	28.75	30.75	39.25	25.10
Dogridge	19.50	19.00	23.25	19.75	14.50	19.20
1103 Paulsen	15.00	13.00	19.25	14.50	22.00	16.75
Thompson seedless	30.00	26.25	17.25	14.75	27.50	23.15
Average	19.44	17.94	22.13	19.94	25.81	
L.S.D 0.05	Rootst. 2.70		Treat. 3.02		Rootst. x Treat. 6.03	

17. Shoot / root ratio

Regarding the effect of salinity treatments on shoot/root ratio, irrespective the effect of rootstocks, the data in Table (18) indicated that, 1500 ppm sodium carbonate treatments gave significantly higher shoot / root ratio than the other treatments. Ahmed and Attalla (1984) studied shoot/root ratio in Bez- El-Anza and Roumi Red. Results showed that shoot at lower concentrations of salts were affected more than root. However, at higher concentration the latter showed more effect. Youssif (1998) found that top to root dry weight ratio tended to increase with increasing the salinity level of the irrigation solution in grapevines.

As for the effect of rootstocks on shoot/root ratio, regardless of the effect of salinity treatments, the results in Table (18) indicated that, Dogridge had significantly higher shoot/root ratio than 1103 Paulsen which had significantly higher value than Harmony and Thompson seedless.

Table (18): Effect of sodium chloride and sodium carbonate treatments on shoot /root ratio 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	4.63	4.58	4.94	6.45	3.34	4.79
Dogridge	8.87	12.65	9.54	10.52	5.69	9.45
1103 Paulsen	4.62	4.15	6.59	8.04	5.53	5.79
Thompson seedless	5.18	4.31	3.33	5.56	4.73	4.62
Average	5.83	6.42	6.10	7.64	4.82	
L.S.D 0.05	Rootst. 0.42		Treat. 0.47		Rootst. x Treat. 0.93	

Finally, it could be concluded that 1103 Paulsen is more salinity tolerant than the other rootstocks. This tolerance is based on 1103 Paulsen had significantly higher number of shoots and leaves than the other rootstocks at the end of the experiment.

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تـأثير بعض أمـلاح الصـوديوم علـى النمـو والتركيـب المعدنى والمحتـوى العضـوى لبعض أصول العنب:
1- النمو

أحمد محمد عيسى ومحمد نظيف حجاج ومحمد بدر الصبروت ومحمد السيد عبد الرحمن
قسم الفاكهة – كلية الزراعة – جامعة الإسكندرية – الإسكندرية - مصر

اجرى هذا البحث خلال موسمى 2000 ، 2001 بغرض دراسة تـاثير ملحـي كلوريد الصـوديوم وكربونـات الصـوديوم علـى نمـو أربعـة اصـناف عنـب هـي هـارموني، 1103 بولسن ودوج ريدج وطومسون سيدلس والمستخدمة كأصول.

ويمكن تلخيص النتائج الرئيسية لهذه الدراسة فى النقاط التالية:

أ- تأثير المعاملات الملحية

انخفضت قيم ارتفاع النبات ومعدل النمو وعدد الاوراق والمساحة الورقيـة ووزن خشب التقليم والوزن الطـازج والجـاف للنباتـات فـي كـلا الموسـمين انخفاضـا معنويـا وعدد وقطـر الافـرخ فـي الموسـم الثـاني فقط بمعـاملات كلوريـد الصـوديوم وكربونـات الصـوديوم المختلفة. و من ناحية اخرى زادت معنويـا نسبة المجموع الخضـري / الجذري بالمعـاملات الملحية. ولم يتاثر معنويا قطر الساق بالمعاملات الملحية في كلا الموسمين.

ب- تاثير الأصول

في كلا الموسمين كان الأصل طومسون سيدلس اعلـى معنويـا فيمـا يتعلـق بـالوزن الجاف للاوراق ومساحتها وقطر الفرخ والوزن الطازج والجاف للجذر واقل معنويا في عدد الاوراق. وكـان الأصـل دوج ريـدج اعلـى معنويـا فـي متوسط ارتفـاع النبـات فـي الموسـمين ونسبة المجموع الخضري/ الجذري فـى نهايـة التجربـة. وكـان الأصـل هـارموني اقـل معنويـا في الوزن الطازج والجاف للافرخ والجذور فى حين كان الأصل 1103 بولسن اعلى معنويا في عدد الاوراق واقل معنويا في المساحة الورقية فى كلا الموسمين.