

Trials for Alleviating the Adverse Effects of Salinity on Some Grapevine Cvs

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Abstract: During 2013 and 2014 seasons, transplants of three grapevine cvs Flame seedless, Red Roomy and Superior were subjected to soil salinity at 1000 to 2000 ppm and three antioxidants namely citric acid at 1000 ppm, potassium silicate at 1000 ppm and salicylic acid at 50 ppm as an attempt for enhancing the tolerance of these grapevines cvs to soil salinity. Flame seedless grapevine cv showed a remarkable tolerance to soil salinity till 2000 ppm, especially when accompanied with using any one of the three antioxidants. The best antioxidant in controlling salinity was salicylic acid followed by potassium silicate. Based on the obtained results, Flame seedless grapevine could tolerate 2000 ppm salinity in the soil when subjected to spraying salicylic acid at 50 ppm. Both Red Roomy and Superior grapevine cvs could tolerate 1000 ppm soil salinity also when the transplants were subjected to spraying salicylic acid at 50 ppm.

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1. Introduction

Nowadays, many trials were established for enhancing the tolerance of some grapevine cvs to salinity. Using antioxidants are beneficial in this respect through their positive action on enhancing the tolerance of trees to biotic and abiotic stresses. Citric acid, silicon and salicylic acid were found by many authors to maintain plant water balance and structure of xylem vessels and layers under higher transpiration rates. (Rao *et al.*, 2000; Ding, *et al.*, 2001; Iwaski *et al.*, 2002; Hattori *et al.*, 2003 and Ding and Wang, 2003).

Salinity caused an obvious reduction on growth and nutrient uptake of grapevines (Singh *et al.*, 2000; Viana *et al.*, 2001; Fisarakis *et al.*, 2001; Abd El-Hady *et al.*, 2003 and Mohamed – Khani *et al.*, 2013).

Antioxidants were found by many authors to stimulate growth characters in different grapevine cvs (Uwakiem, 2011; Refaai, 2011; Al- Obeed, 2011; El- Hanafy, 2011; El- Kady- Hanaa, 2011; Osman, 2014 and Al- Wasfy, 2014).

The target of this study was examining the effect of some antioxidants on enhancing the tolerance of some grapevine cvs to soil salinity.

2. Material and Methods

This pot experiment was conducted during the two successive seasons of 2013 and 2014 on Nursery of El- Mataana Agricultural Experimental Station situated at Esna district,, Luxor Governorate in order to test the response and tolerance of the transplants of grapevine cvs Superior, Red Roomy and Flame

seedless to salinity in the soil. Uniform and healthy two hundred and seventy one year old own rooted transplants of each grapevine cv. were selected for achieving of this investigation.

The soil was washed several times with water, air dried and subjected to mechanical, physical, water holding properties and chemical analysis according to procedures outlined by Jackson, 1958 and Black *et al.* (1965). The obtained data of soil analysis are given in Table (1).

Table (1): Analysis of the tested soil

Particle size distribution:	
Sand %	:87.65
Silt %	:11.85
Clay	:0.50
Texture	: sandy
pH(1:2.5 extract)	:7.15
EC (1: 2.5 extract) (ds/ m ⁻¹)	:0.01
Total CaCO ₃ %	:0.50
Organic Matter %	:0.9
Total N %	:0.05
Available P (according to Olsen, ppm)	:30.3
Available K (Ammonium acetate, ppm)	:180
Water holding properties:-	
Field capacity %	:8.0
Wilting point %	:2.5
Available water %	:5.5

The experiment included twenty – seven treatments from two factors namely A & B. The first

factor (A) consisted from three grapevine cvs namely a₁) Superior, a₂) Red Roomy and a₃) Flame seedless. The second factor (B) included the following nine treatments:

- b₁) Control (untreated transplants).
- b₂) Soil salinity at 1000 ppm alone.
- b₃) Soil salinity at 1000 ppm + spraying citric acid at 1000 ppm.
- b₄) Soil salinity at 1000 ppm + potassium silicate at 1000 ppm.
- b₅) Soil salinity at 1000 ppm + spraying salicylic acid at 50 ppm.
- b₆) Soil salinity at 2000 ppm alone.
- b₇) Soil salinity at 2000 ppm + spraying citric acid at 1000 ppm.
- b₈) Soil salinity at 2000 ppm + potassium silicate at 1000 ppm.
- b₉) Soil salinity at 2000 ppm + spraying salicylic acid at 50 ppm.

Each treatment was replicated three times, ten seedling per each. Soil salinity was derived from mixing sodium chloride and sodium sulphate in an equal weight (1:1 by weight). Concentration of 0.05, 0.1, 0.2 and 0.4 % salinity were caused by mixing (1.5+ 1.5 g + 3+ 3g & 6 + 6g and 12 + 12g from sodium chloride + sodium sulphate/ bag, respectively.

All transplants were winter pruned to two eyes then planted in the last week of February in both seasons in 40 cm diameter and 50 cm height of black polyethylene bags as one transplant per each bag. Each bag was filled with 6 kg sandy soil. The bags were equipped with bottom holes to allow excess water drainage. The investigated salts at the named concentrations were added to the soil and mixed thoroughly to ensure the uniformity. Irrigation was done after the depletion of 35% of the available water of each treatment all over the season and the given amount of water was calculated by using the following equation which suggested by **Israelsen and Hanson (1962)**.

$$Q = A.W. \times d.wt = 5.5 \times 6000 = 3309$$

Where Q = quantity of added water, A.W. = available water = (field capacity – Wilting point) and d.wt = dry weight of soil /bag (kg.) Water content of soil was kept at field capacity by weight during the time of the trial.

In every growing season, inorganic nitrogen, phosphorus and potassium fertilizers were applied to the grapevine transplants in all treatments at the standard recommended rate for this age of transplant (one year old) to ensure that these nutrients did not limit the growth. Nitrogen was added at the rate of 4.0 g ammonium nitrate (33.5 % N) per pot divided into three equal doses. Orthophosphoric acid at 0.05 % as a source of P was sprayed three times. Potassium was

added at 4.0 g potassium sulphate (48 % K₂O) /pot divided into three equal doses. These nutrients were applied once every two months starting from the third week of March in both seasons. At one month after planting in every growing season, the micro nutrient solution No.1 (containing 0.05 % ferrous sulphate and 0.02 % zinc sulphate) and the micro nutrient solution No.2 (containing 0.05 % manganese sulphate, 0.02 % copper sulphate, and 0.1 % boric acid) were sprayed four times at one month interval started at one month after planting. Application of the micronutrient solution No.1 was followed by application of the micronutrient solution No.2 at 10 days interval.

In every growing season, weeds were handily controlled. The grapevine transplants of all treatments were sprayed once on the first of April with fine sulphur at the rate of 0.5 g/L to control pests and fungi. Horticultural practices were carried out as usual in both seasons.

The three antioxidants namely citric acid, potassium silicate (25 %Si + 10% K₂O) and salicylic acid were sprayed three times started on the first week of June, July and August during both seasons. Triton B as a wetting agent was added to all antioxidant solutions a 0.05%. Salicylic acid solutions was adjusted to pH 6 by using sodium hydroxide 1.0 N It was solubilized in few drops of Ethyl alcohol before use. Spraying was done till run off (0.5 litre / transplant).

This factorial experiment (27 treatments) was set up in a complete randomized design. The main factor was the three grapevine cvs Superior, Red Roomy and Flame seedless, while the second factor consisted from the previous nine treatments from soil salinity and antioxidant treatments. Each treatment was replicated three times, ten transplants per each.

During both seasons, the following measurements were recorded:

- 1- Survival %.
- 2- Plant height (cm.)
- 3- Area of root distribution / plant (cm)²
- 4- Leaf relative turgidity (**El- Mistrobn and Hillyer, 1937; El- Hefnawi, 1986 and Nomier-Safaa, 1994**).
- 5- Leaf succulence grade (**El- Hefnawi, 1986; Nomier- Safaa, 1994 and Hassan, 1998**).
- 6- Uptake of N, P and K by multiplying dry weight of plant by concentration of each element (mg/ plant) (**Piper, 1950; Wilde et al., 1985 and A.O.A.C., 2000**).

Statistical analysis was done according to **Snedecor and Cochran 1967** using new L.S.D. test at 5%.

3. Results and Discussion

1- Survival %:

It is clear from the data in Table (2) that Flame seedless grapevine cv significantly had the highest values of survival % Superior cv had the lowest values.

Subjecting the transplants of the three grapevine cvs growing under salinity to any one of the three antioxidants namely citric acid at 1000 ppm, potassium silicate at 1000 ppm and salicylic acid at 50 ppm significantly enhanced survival % comparing with those under salinity conditions alone. The best antioxidant in this respect was salicylic acid.

Growing Flame seedless grapevine transplants under salinity and subjecting them to salicylic acid at 50 ppm gave the maximum percentage of survival.

2- Plant height:

It is clear from the data on Table (3) that plant height significantly varied among the three grapevine cvs. It was maximized in grapevine cv, Flame seedless. Superior grapevine cv had the minimum values. These results were true during both seasons.

Plant height significantly reduced with increasing soil salinity from 1000 to 2000 ppm. Using any one of the three antioxidants to grapevine transplants had significant promotive effect on plant height of transplants growing under salinity conditions comparing with those under soil salinity without antioxidant treatments. The best antioxidant in this respect was salicylic acid followed by potassium silicate. Spraying salicylic acid at 50 ppm significantly counteracted the adverse effects of salinity on plant height.

The maximum plant height was recorded on Flame seedless transplants under 1000 ppm salinity and subjected to spraying salicylic acid at 50 ppm. In Flame seedless transplants, increasing salinity levels from 1000 to 2000 ppm with the assistance of using salicylic acid at 50 ppm failed to show significant reduction on plant height.

3- Area of root distribution / plant:

Data in Table (4) obviously reveal that the area of root distribution / plant significantly differed among the three grapevine cvs. The maximum values were recorded on grapevine cvs Flame seedless, Red Roomy and Superior, in descending order.

Soil salinity at 2000 ppm significantly decreased the area of root distribution / plant comparing with salinity at 1000 ppm. No significant reduction was observed with increasing salinity concentrations from 0.0 to 1000 ppm. Using any antioxidants significantly succeeded in alleviating the adverse effects of salinity on the area of root distribution / plant.

The maximum values were recorded on Flame seedless transplants growing under 1000 ppm salinity and subjected to spraying salicylic acid at 50 ppm during 2013 and 2014 seasons.

4- Leaf water relative turgidity and leaf succulence grade:

It is clear from the data in Tables (5 & 6) that leaf water relative turgidity and leaf succulence grade significantly varied among the three grapevine cvs. Both were maximized in grapevine cvs Flame seedless. Grapevine cv. Superior had the lowest values during both seasons.

Subjecting grapevine transplants to salinity at 2000 ppm significantly reduced such two physiological characters comparing with exposing to soil salinity at 1000 ppm. Soil salinity at 1000 ppm caused insignificant reduction on such two characters. Treating the plants with antioxidants significantly promoted such two physiological traits. Using antioxidants significantly was very effective in alleviating the adverse effects of salinity on both two physiological characters. The best antioxidant was salicylic acid followed by potassium silicate.

The maximum values were recorded on Flame seedless transplants grown under 1000 ppm salinity and subjecting to salicylic acid at 50 ppm.

5- Uptake of N, P and K by plants:

Data in Tables (7 & 8 & 9) clearly show that the highest uptake of N, P and K were recorded on grapevine cv. Flame seedless. The lowest values were recorded on grapevine cv. Superior. These results were true during both seasons.

Growing the transplants under soil salinity at 2000 ppm significantly reduced the uptake of N, P and K rather than growing at normal conditions or at salinity conditions reached 1000 ppm. Uptake of N, P and K slightly reduced on the transplants growing under 1000 ppm salinity. Using any antioxidants via spraying significantly was responsible for enhancing the uptake of these nutrients. Therefore, application of any antioxidants significantly was favourable for overcoming the adverse effects of salinity on uptake of these nutrients. The best antioxidant in this respect was salicylic acid at 50 ppm.

Growing Flame seedless transplants under 1000 ppm salinity and subjecting them to salicylic acid at 50 ppm gave the maximum values. The lowest values were recorded on Superior transplants subjecting to 2000 ppm soil salinity without any antioxidant treatments.

Discussion:

The harmful effects of salinity on growth and uptake of nutrients in different fruit crops might be attributed to its negative effects on cell division, photosynthesis, metabolism, plant pigments and building of organic foods (Ayers, 1950). The tolerance of some grapevine cvs to salinity might be attributed to their ability to prevent salts from entering the plant tissues and reducing the salt concentration

through accumulating salts in the vacuoles of the cells (Flowers, 2004).

The reducing effect of salinity on growth and uptake of nutrients was emphasized by the results of Singh *et al.*, (2000); Viana *et al.*, (2001) Fisarakis *et al.*, (2001); Abd El- Hady *et al.*, (2003) and Mohamed – Khani *et al.*, (2013).

The beneficial effects of antioxidants on alleviating the adverse effects of salinity on salinity

might be attributed to their positive action on cell division and the tolerance of plants to biotic and abiotic stresses (Rao *et al.*, 2000, Ding, *et al.*, 2001 and Ding and Wang, 2003).

The promoting effect of antioxidants on growth characters was supported by the results of Uwakiem (2011); Refaii (2011); Al- Obeed (2011) and Al-Wasfy (2014).

Table (2): Effect of different salinity and antisalinity treatments on the survival percentage of some grapevine transplants during 2013 & 2014 seasons.

Salinity and anti salinity treatments (B)	2013				2014			
	Grapevine cvs (A)							
	a ₁ Superior	a ₂ Red Roomy	a ₃ Flame	Mean (B)	a ₁ Superior	a ₂ Red Roomy	a ₃ Flame	Mean (B)
b ₁ Control	81.3	85.3	90.0	85.5	82.0	86.0	91.0	86.3
b ₂ Salinity at 1000 ppm	81.0	85.0	69.9	85.3	81.7	85.8	90.6	86.0
b ₃ Salinity at 1000 ppm +citric acid	82.3	86.6	71.9	86.9	83.0	87.3	92.6	87.6
b ₄ Salinity at 1000 ppm + silicon	84.0	88.0	93.9	88.6	84.8	88.7	94.6	91.0
b ₅ Salinity at 1000 ppm + salicylic acid	86.0	90.6	75.0	90.5	86.8	91.3	95.7	91.2
b ₂ Salinity at 2000 ppm	71.0	75.0	89.6	78.5	71.8	75.8	90.3	79.3
b ₃ Salinity at 2000 ppm +citric acid	73.8	77.0	91.7	80.6	74.5	77.8	92.4	81.5
b ₄ Salinity at 2000 ppm + silicon	75.0	79.0	93.7	82.5	75.7	79.8	94.5	83.3
b ₅ Salinity at 2000 ppm + salicylic acid	76.5	81.0	94.7	84.1	77.2	81.8	95.6	84.8
Mean (A)	78.9	83.0	92.2		79.7	83.8	93.0	
New L.S.D. at 5%	A 1.0	B 1.0	AB 1.7		A 1.0	B 1.1	AB 1.8	

Table (3): Effect of different salinity and antisalinity treatments on the plant height (cm) of some grapevine transplants during 2013 & 2014 seasons.

Salinity and anti salinity treatments (B)	2013				2014			
	Grapevine cvs (A)							
	a ₁ Superior	a ₂ Red Roomy	a ₃ Flame	Mean (B)	a ₁ Superior	a ₂ Red Roomy	a ₃ Flame	Mean (B)
b ₁ Control	73.3	75.2	85.0	77.8	80.1	81.6	86.0	82.5
b ₂ Salinity at 1000 ppm	73.0	74.9	84.3	77.4	79.8	81.4	85.4	80.2
b ₃ Salinity at 1000 ppm +citric acid	74.0	75.9	86.3	78.7	74.9	82.6	86.5	81.3
b ₄ Salinity at 1000 ppm + silicon	75.8	76.9	88.3	80.3	76.5	83.7	88.2	82.8
b ₅ Salinity at 1000 ppm + salicylic acid	77.0	79.0	90.4	82.1	77.8	85.0	90.3	84.2
b ₂ Salinity at 2000 ppm	66.1	68.0	84.0	72.7	66.8	69.1	85.0	73.6
b ₃ Salinity at 2000 ppm +citric acid	68.2	70.2	86.0	74.8	69.0	71.3	86.3	75.5
b ₄ Salinity at 2000 ppm + silicon	70.0	72.0	88.0	76.6	70.7	73.0	88.0	77.2
b ₅ Salinity at 2000 ppm + salicylic acid	71.3	73.3	90.1	78.2	72.0	74.4	90.0	78.8
Mean (A)	72.0	74.0	87.0		73.5	78.0	87.3	
New L.S.D. at 5%	A 1.0	B 1.1	AB 1.8		A 1.0	B 1.1	AB 1.8	

Table (4): Effect of different salinity and antisalinity treatments on the area of root distribution per plant (cm)² of some grapevine transplants during 2013 & 2014 seasons.

Salinity and anti salinity treatments (B)	2013				2014			
	Grapevine cvs (A)							
	a ₁ Superior	a ₂ Red Roomy	a ₃ Flame	Mean (B)	a ₁ Superior	a ₂ Red Roomy	a ₃ Flame	Mean (B)
b ₁ Control	215.0	275.5	251.0	233.8	217.5	238.6	255.0	237.0
b ₂ Salinity at 1000 ppm	214.4	234.9	250.0	233.1	217.3	238.0	254.0	236.4
b ₃ Salinity at 1000 ppm +citric acid	221.0	241.9	256.3	239.7	224.0	245.0	261.0	243.3
b ₄ Salinity at 1000 ppm + silicon	228.3	249.0	266.0	247.7	231.3	252.0	271.0	251.4
b ₅ Salinity at 1000 ppm + salicylic acid	236.0	257.7	275.0	256.2	239.0	260.8	281.0	260.2
b ₂ Salinity at 2000 ppm	191.0	197.0	249.0	212.3	195.0	200.0	253.0	216.0
b ₃ Salinity at 2000 ppm +citric acid	198.4	205.3	255.0	230.1	199.0	209.0	260.0	222.6
b ₄ Salinity at 2000 ppm + silicon	203.0	211.9	265.0	226.6	204.0	216.0	270.0	230.0
b ₅ Salinity at 2000 ppm + salicylic acid	209.3	218.4	247.0	233.9	210.0	220.0	280.0	236.6
Mean (A)	214.7	227.9	260.1		215.2	231.0	265.0	
New L.S.D. at 5%	A 4.1	B 4.3	AB 7.3		A 4.0	B 4.1	AB 7.1	

Table (5): Effect of different salinity and antisalinity treatments on the leaf relative turgidity % of some grapevine transplants during 2013 & 2014 seasons.

Salinity and anti salinity treatments (B)	2013				2014			
	Grapevine cvs (A)							
	a ₁ Superior	a ₂ Red Roomy	a ₃ Flame	Mean (B)	a ₁ Superior	a ₂ Red Roomy	a ₃ Flame	Mean (B)
b ₁ Control	41.7	43.0	50.0	45.9	44.3	46.3	51.0	47.2
b ₂ Salinity at 1000 ppm	41.6	42.9	49.3	44.6	43.9	45.9	50.9	46.9
b ₃ Salinity at 1000 ppm +citric acid	43.7	45.0	54.0	47.5	46.0	48.1	55.0	49.7
b ₄ Salinity at 1000 ppm + silicon	45.0	48.0	57.9	50.3	49.0	51.0	58.0	52.6
b ₅ Salinity at 1000 ppm + salicylic acid	46.7	51.0	60.0	52.5	51.9	54.0	61.0	55.6
b ₂ Salinity at 2000 ppm	37.3	39.0	49.0	41.7	37.3	39.9	50.7	42.6
b ₃ Salinity at 2000 ppm +citric acid	38.5	40.5	53.9	44.3	39.4	42.0	54.9	45.4
b ₄ Salinity at 2000 ppm + silicon	39.9	42.3	57.7	46.6	40.9	44.0	57.8	47.5
b ₅ Salinity at 2000 ppm + salicylic acid	40.6	44.1	59.7	48.1	42.3	46.0	60.9	49.7
Mean (A)	42.0	44.0	54.6		43.9	46.3	55.5	
New L.S.D. at 5%	A 1.1	B 1.2	AB 2.0		A 1.1	B 1.2	AB 2.0	

Table (6): Effect of different salinity and antisalinity treatments on the leaf succulanarde of some grapevine transplants during 2013 & 2014 seasons.

Salinity and anti salinity treatments (B)	2013				2014			
	Grapevine cvs (A)							
	a ₁ Superior	a ₂ Red Roomy	a ₃ Flame	Mean (B)	a ₁ Superior	a ₂ Red Roomy	a ₃ Flame	Mean (B)
b ₁ Control	1.86	1.96	2.22	2.01	1.89	1.99	2.33	2.07
b ₂ Salinity at 1000 ppm	1.84	1.95	2.20	1.99	1.87	1.98	2.32	2.05
b ₃ Salinity at 1000 ppm +citric acid	1.94	2.04	2.35	2.11	2.00	2.10	2.43	2.17
b ₄ Salinity at 1000 ppm + silicon	2.06	2.17	2.51	2.46	2.13	2.24	2.55	2.30
b ₅ Salinity at 1000 ppm + salicylic acid	2.20	2.31	2.66	2.39	2.30	2.41	2.70	2.47
b ₂ Salinity at 2000 ppm	1.41	1.52	2.19	1.70	1.43	1.50	2.31	1.74
b ₃ Salinity at 2000 ppm +citric acid	1.51	1.64	2.34	1.83	1.54	1.60	2.42	1.85
b ₄ Salinity at 2000 ppm + silicon	1.62	1.74	2.50	1.95	1.66	1.70	2.54	1.96
b ₅ Salinity at 2000 ppm + salicylic acid	1.73	1.83	2.65	2.07	1.77	1.81	2.69	2.09
Mean (A)	1.80	1.90	2.40		1.84	1.92	2.47	
New L.S.D. at 5%	A 0.09	B 0.10	AB 0.17		A 0.10	B 0.10	AB 0.17	

Table (7): Effect of different salinity and antisalinity treatments on the uptake of N/ plant (mg) of some grapevine transplants during 2013 & 2014 seasons.

Salinity and anti salinity treatments (B)	2013				2014			
	Grapevine cvs (A)							
	a ₁ Superior	a ₂ Red Roomy	a ₃ Flame	Mean (B)	a ₁ Superior	a ₂ Red Roomy	a ₃ Flame	Mean (B)
b ₁ Control	312.0	333.3	363.0	336.1	315.5	335.9	363.9	338.4
b ₂ Salinity at 1000 ppm	311.0	331.9	361.0	334.6	314.9	335.0	362.9	337.6
b ₃ Salinity at 1000 ppm +citric acid	321.0	341.9	372.0	345.0	324.0	345.0	375.0	348
b ₄ Salinity at 1000 ppm + silicon	330.0	360.0	390.0	360	333.0	360.0	396.0	363
b ₅ Salinity at 1000 ppm + salicylic acid	341.0	371.0	401.0	371	344.0	375.0	404.0	374.3
b ₂ Salinity at 2000 ppm	281.3	300.0	360.0	313.8	383.3	300.0	362.9	315.4
b ₃ Salinity at 2000 ppm +citric acid	290.0	309.0	371.0	323.3	293.0	311.0	374.6	326.2
b ₄ Salinity at 2000 ppm + silicon	299.0	318.9	389.0	335.6	305.0	320.0	35.0	340.0
b ₅ Salinity at 2000 ppm + salicylic acid	304.0	324.0	400.6	342.9	311.9	331.7	403.9	349.12
Mean (A)	309.9	332.2	378.6		313.8	334.8	382.0	
New L.S.D. at 5%	A 6.1	B 6.3	AB 10.7		A 6.0	B 6.3	AB 10.7	

Table (8): Effect of different salinity and antisalinity treatments on the uptake of P plant (mg) of some grapevine transplants during 2013 & 2014 seasons.

Salinity and anti salinity treatments (B)	2013				2014			
	Grapevine cvs (A)							
	a ₁ Superior	a ₂ Red Roomy	a ₃ Flame	Mean (B)	a ₁ Superior	a ₂ Red Roomy	a ₃ Flame	Mean (B)
b ₁ Control	55.2	59.0	65.0	59.7	56	60.0	66.0	60.67
b ₂ Salinity at 1000 ppm	55.0	58.7	64.7	59.5	55.9	59.8	65.9	60.53
b ₃ Salinity at 1000 ppm + citric acid	59.0	65.0	70.0	64.7	59.9	64.0	70.0	64.63
b ₄ Salinity at 1000 ppm + silicon	63.0	70.0	74.9	69.6	64.9	69.9	74.0	69.60
b ₅ Salinity at 1000 ppm + salicylic acid	67.9	75.0	81.0	74.6	68.8	74.0	80.0	74.27
b ₂ Salinity at 2000 ppm	48.0	53.0	64.5	55.2	48.8	52.0	65.8	55.53
b ₃ Salinity at 2000 ppm + citric acid	51.0	57.0	69.7	59.2	51.9	54.5	69.9	58.77
b ₄ Salinity at 2000 ppm + silicon	54.0	61.0	74.7	63.2	54.9	57.0	73.9	61.93
b ₅ Salinity at 2000 ppm + salicylic acid	58.5	66.0	80.8	68.4	59.4	58.9	79.8	66.03
Mean (A)	57.0	62.7	71.7		57.8	61.12	71.7	
New L.S.D. at 5%	A 2.1	B 2.2	AB 3.8		A 2.0	B 2.0	AB 3.4	

Table (9): Effect of different salinity and antisalinity treatments on the uptake of K / plant of some grapevine transplants during 2013 & 2014 seasons.

Salinity and anti salinity treatments (B)	2013				2014			
	Grapevine cvs (A)							
	a ₁ Superior	a ₂ Red Roomy	a ₃ Flame	Mean (B)	a ₁ Superior	a ₂ Red Roomy	a ₃ Flame	Mean (B)
b ₁ Control	201.0	211.0	221.0	211.0	204.1	210.0	220.0	211.4
b ₂ Salinity at 1000 ppm	200.0	210.0	220.0	200.0	203.9	209.9	220.0	211.3
b ₃ Salinity at 1000 ppm + citric acid	208.0	219.0	229.9	219.0	211.9	217.3	229.0	219.4
b ₄ Salinity at 1000 ppm + silicon	217.0	229.0	241.0	229.0	217.0	225.0	236.0	226
b ₅ Salinity at 1000 ppm + salicylic acid	229.0	241.0	252.0	240.6	231.0	233.0	243.0	235.8
b ₂ Salinity at 2000 ppm	171.0	181.0	219.0	190.3	174.0	180.0	219.0	191.0
b ₃ Salinity at 2000 ppm + citric acid	182.0	192.0	229.0	201.0	181.0	186.0	228.8	158.6
b ₄ Salinity at 2000 ppm + silicon	187.0	199.0	240.0	208.7	188.0	193.0	235.9	205.6
b ₅ Salinity at 2000 ppm + salicylic acid	193.0	204.0	251.5	162.1	193.9	200.0	243.3	212.4
Mean (A)	198.7	209.6	233.7		200.5	206.0	243.7	
New L.S.D. at 5%	A 5.0	B 5.1	AB 8.7		A 5.0	B 5.2	AB 8.8	

Conclusion:

For enhancing the tolerance of grapevine cvs Flame seedless to salinity (2000 ppm) and both Red Roomy and Superior (1000 ppm) it is suggested to spray salicylic acid at 50 ppm three times.

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