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INFLUENCE OF SULPHURIC ACID, HUMIC ACID, SULPHUR AND IRRIGATION WATER ON GROWTH AND PRODUCTIVITY OF SUPERIOR SEEDLESS VINES GROWN UNDER SALINE CONDITIONS

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ABSTRACT

Superior Seedless grapevines of 7 years old grown in a loamy sandy soil ($E.C_e$ = 3.7 ds/m) and drip irrigated ($E.C_{iw}$ = 2.3 ds/m) were subjected to sulphuric acid (2, 4 and 6 litre/feddan/2 weeks), humic acid (6, 9 and 12 litre/feddan divided into 4 dosages), sulphur (25, 50 and 100 kg/feddan applied in winter), irrigation water (30, 35 and 40 litre/vine at different intervals) and control. All treatments increased leaf area, length of mature portion of the cane, internode length & diameter; number & weight of clusters, berry weight & size and yield/vine. The best results were obtained as a result of increasing irrigation water up to 40 litre/vine at different intervals. Potassium was proportionally increased with increasing the rates of any treatment. However, Cl and Na took a reverse trend. Total free amino acids were insignificantly affected by H_2SO_4, humic acid or S, whereas increasing irrigation water up to 40 litre/vine at different intervals followed in the vineyard itself reduced total free amino acids. Increasing irrigation water up to 30-40 litre/vine at different intervals reduced proline. Leaves contained more total free amino acids as well as proline than shoots or roots. Humic acid and increasing irrigation water achieved more carbohydrate storage in the canes. It was concluded that raising irrigation water up to 40 litre/vine at different intervals was enough to reduce or counteract the harmful effects of salinity on Superior Seedless vines in that region.

INTRODUCTION

Among various stress conditions experienced by fruit crops, salt stress has adverse effects on growth and production. Due to the expansion of horticultural crops, more of saline lands have been put into cultivation and the probability of using water with relatively high content of soluble salts has increased. Saline soils are soils having excess of soluble salts that make the soil solution sufficiently concentrated enough to injure plants and impair its productivity (Russell, 1978).

Grapes has been classified as moderately sensitive to salt, although studies have shown cultivar differences in sensitivity (Ehlig, 1960; Bernstein *et al.,* 1969 and Groot-obbink & Alexander, 1973). Increasing of salinity, EC (ds/m), induced possible soil salinity problems in the vineyards; Ayers and Wescott (1985) showed that vines growing normally with less than 10% production at EC_e 1.5-2.5 (ds/m); but at EC_e 2.5-4.0 the production decreased by 10-15%, where a severe damage occurred at EC_e 4.7 ds/m decreasing the production by 25-50%. The use of soil amendments and increasing the amount of irrigation water is necessary to improve vine growth and productivity. Sulphuric acid has been used to introduce Ca in the profile and displace Na as sodium sulphate. Sulphur is an alternative solution, but its effect is slower than sulphuric acid, because it needs to be biologically oxidized to form sulphuric acid (Richards, 1954 and Alonso, 2000) which reacts with native $CaCO_3$ to form gypsum (Jones, 1979 and Curtine *et al.*, 1993). The use of H_2SO_4 must be with precaution, since an excess of it make the micronutrients poorer in the soil (Alonso, 2000). Humic acid influences plant metabolism and makes the nutrients in the soil more available by its chelating capacity with micronutrients (Schnitzer and Skinner, 1962), besides its effects in improving aeration, water penetration and moisture holding capacity in sandy soils (Schnitzer and Khan, 1972). Leaching is the only practical way of removing soluble salts from the soil (Neja *et al.*, 1978).

This investigation aimed to study the use of H_2SO_4, humic acid, sulphur and increasing irrigation water to reduce the effect of salinity on Superior Seedless grapevines.

MATERIALS AND METHODS

The present experiment was conducted for two successive years 2003 & 2004 on seven years old Superior Seedless grapevines supported by Spanish Parron system and planted 2 × 3 m apart. The texture of the soil was loamy sand (Table 1) located in Belbase, Sharkiya governorate. The vines were drip irrigated according to the regime in Table (2). The number of laterals /row was one, one emitter per plant, one meter apart. Fertigation method was followed to fertilize the vines. Nitrogen (60 kg N/feddan), potassium (100 kg K_2O/feddan) and phosphorus as phosphoric acid (1 litre/2 weeks) were added. Chelated Fe, Zn and Mn at 200 g; 100g and 100g respectively per 600 litre water were sprayed two times, once 10 days before anthesis and the other after fruit set (at 3-4 mm berry diameter).

At winter pruning (December), one hundred and seventeen vines of, almost, the same viguor were chosen, pruned according to the cane pruning system. Vine load was 80 buds (8 canes × 10 buds). The treatments included : control, sulphuric acid (2, 4 and 6 litre/feddan/2 weeks), humic acid (6, 9 and 12 litre/feddan) divided into four equal doses added in February, April, May and June, sulphur (25, 50 and 100 kg/feddan in January) and irrigation water (I.W) was 30, 35 and 40 litre/vine at the same intervals shown followed in the vineyard (Table 2). The randomized complete block design was followed with three replicates per treatment three vines each. Leaves opposite to the clusters, shoots (5 to 10^{th} nodes) and absorbed roots were collected then dried to estimate sodium and potassium (flame photometer, Brown and Lilleland, 1946), Cl (according to Jackson, 1958); total free amino acids (Jayaraman, 1985); proline following the method of Batels *et al.*, (1973); total carbohydrates in canes in December (according to Dubois *et al.*, 1956). Leaf area, length of mature portion of the cane (in December), internode length, yield and number of clusters per vine, cluster weight, berry weight & size.

The statistical analysis of variance followed Duncan's multiple range method (Snedecor and Cochran, 1980).

Table (1) : Soil and irrigation water analysis

Soil analysis		Water analysis	
Sand %	82.4	$E.C._{i.w}$ (ds/m)	2.3
Silt %	10.0	**Soluble anions (meq/L)**	
Clay %	7.60	CO_3	---
Texture	Loamy sand	HCO_3	2.11
		Cl	16.2
$E.C._e$ (ds/m)	3.77	SO_4	5.83
pH	7.94	**Soluble cations (meq/L)**	
Soluble anions (meq/L)		Ca	4.61
CO_3	---	Mg	8.26
HCO_3	2.8	Na	10.95
Cl	20.9	K	0.32
SO_4	16.2	SAR	4.32
Soluble cations (meq/L)			
Ca	13.4		
Mg	4.4		
Na	20.4		
K	1.7		
SAR	6.8		

Table (2) : Schedule of irrigartion (litre/vine) in the vineyard

January	One heavy irrigation	**July**	25L /day
February	5L / day	**August**	30L / 2 days
March	15L / 2 days	**September**	30L / 3 days
April	20L / day	**October**	20L / week
May	40L / day	**November**	10L / 2 weeks
June	30L / day	**December**	0

Abbreviations : I.W = Irrigation water; L.M.P.C. = Length of mature portion of the cane; $E.C._e$ = Electric conductivity of the soil; $E.C._{i.w}$ = Electric conductivity of irrigation water. Total free amino acids = T.F.A.A.

RESULTS AND DISCUSSION

Total free amino acids, proline and total carbohydrates :

Total free amino acids (T.F.A.A) as affected by H_2SO_4, humic acid, S and increasing I.W. (irrigation water) are presented in Table (3). Increasing the amount of H_2SO_4 had no significant effect on T.F.A.A. This observation is true for humic acid and sulfur, whereas increasing I.W. decreased total free amino acids. It is clear that the content of amino acids in different vine portions can be arranged in a descending order as follows: leaves, shoots and roots. Total amino acids content as affected by various treatments could be ranked as follows : increasing I.W., sulphur, sulphuric acid, humic acid and control as arranged in a descending order (table 3).

Table (3) : Effect of H_2SO_4, humic acid, S and irrigation water on total free amino acids (mg/g) of Superior Seedless vines grown under saline conditions

Treatment	1st season					2nd season				
	Leaves	Shoots	Roots	Avg.	Treat. avg.	Leaves	Shoots	Roots	Avg.	Treat. avg.
Control	**1.530^{A}**	**1.069^{A}**	**0.089^{A}**		**0.896^{a}**	**1.601^{A}**	**1.100^{A}**	**0.090^{A}**		**0.930^{a}**
2	1.530^{a}	1.050^{a}	0.088^{a}	0.889^{a}		1.600^{a}	1.060^{a}	0.090^{a}	0.917^{a}	
H_2SO_4 4	1.500^{a}	1.050^{a}	0.088^{a}	0.879^{a}		1.560^{a}	1.054^{a}	0.090^{a}	0.901^{a}	
6	1.500^{a}	1.050^{a}	0.088^{a}	0.879^{a}		1.560^{a}	1.050^{a}	0.090^{a}	0.900^{a}	
Avg.	**1.510^{A}**	**1.050^{A}**	**0.088^{A}**		**0.883^{a}**	**1.57^{A}**	**1.055^{A}**	**0.090^{A}**		**0.905^{a}**
6	1.510^{a}	1.059^{a}	0.88^{a}	0.886^{a}		1.60^{a}	1.100^{a}	0.090^{a}	0.930^{a}	
Humic9	1.510^{a}	1.059^{a}	0.888^{a}	0.886^{a}		1.60^{a}	1.090^{a}	0.089^{a}	0.926^{a}	
12	1.500^{a}	1.059^{a}	0.088^{a}	0.882^{a}		1.55^{a}	1.080^{a}	0.089^{a}	0.906^{a}	
Avg.	**1.510^{A}**	**1.059^{A}**	**0.088^{A}**		**0.886^{a}**	**1.58^{A}**	**1.09^{A}**	**0.089^{A}**		**0.920^{a}**
25	1.500^{a}	1.059^{a}	0.089^{a}	0.883^{a}		1.580^{a}	1.100^{a}	0.089^{a}	0.923^{a}	
S 50	1.500a	1.059^{a}	0.086^{a}	0.882^{a}		1.580^{a}	1.100^{a}	0.081^{a}	0.920^{a}	
100	1.500^{a}	1.059^{a}	0.086^{a}	0.882^{a}		1.580^{a}	1.040^{a}	0.080^{a}	0.900^{a}	
Avg	**1.500^{A}**	**1.059^{A}**	**0.087^{A}**		**0.882^{a}**	**1.581^{A}**	**1.08^{A}**	**0.083^{A}**		**0.914^{a}**
30	0.957^{b}	0.905^{b}	0.080^{a}	0.647^{b}		0.951^{b}	0.900^{b}	0.080^{a}	0.644^{b}	
IW 35	0.991^{b}	0.862^{b}	0.080^{a}	0.644^{b}		0.900^{b}	0.852^{b}	0.079^{a}	0.610^{bc}	
40	0.982^{b}	0.797^{a}	0.080^{a}	0.620^{b}		0.871^{b}	0.800^{b}	0.075^{a}	0.582^{c}	
Avg.	**0.977^{B}**	**0.855^{B}**	**0.080^{A}**		**0.637^{b}**	**0.907^{B}**	**0.851^{B}**	**0.078^{B}**		**0.612^{b}**

Values with the same letter(s) are not significantly different at $p \leq 0.05$.
Treat. Avg. = Treatment average

Proline was significantly decreased as H2SO4, humic acid, S and I.W were applied. The lowest value was recorded for I.W. It is obvious that leaves contained more proline than shoots or roots. In addition, I.W at 30, 35 or 40 liter was effective in decreasing proline in the three portions (Table, 4).

Table (4) : Effect of H_2SO_4, humic acid, S and irrigation water on proline (mg/g) of Superior Seedless vines grown under saline conditions

Treatment	1st season					2nd season				
	Leaves	Shoots	Roots	Avg.	Treat. avg.	Leaves	Shoots	Roots	Avg.	Treat. avg.
Control	**0.095^{A}**	**0.076^{A}**	**0.006^{A}**		**0.059^{a}**	**0.099^{A}**	**0.085^{A}**	**0.008^{A}**		**0.064^{a}**
2	0.094^{a}	0.065^{b}	0.006^{a}	0.055^{a}		0.098^{a}	0.065^{b}	0.007^{a}	0.057^{a}	
H_2SO_4 4	0.092^{ab}	0.064^{b}	0.006^{a}	0.054^{a}		0.098^{a}	0.065^{b}	0.007^{a}	0.057^{a}	
6	0.092^{ab}	0.064^{b}	0.006^{a}	0.054^{a}		0.097^{a}	0.064^{b}	0.007^{a}	0.056^{a}	
Avg.	**0.093^{A}**	**0.064^{A}**	**0.006^{A}**		**0.054^{b}**	**0.098^{A}**	**0.065^{B}**	**0.007^{AB}**		**0.057^{b}**
6	0.093^{a}	0.064^{b}	0.005^{a}	0.054^{a}		0.097^{a}	0.066^{b}	0.006^{a}	0.056^{a}	
Humic9	0.091^{b}	0.064^{b}	0.005^{a}	0.053^{a}		0.092^{b}	0.066^{b}	0.006^{a}	0.055^{a}	
12	0.090^{b}	0.063^{bc}	0.005^{a}	0.053^{a}		0.091^{b}	0.064^{b}	0.006^{a}	0.054^{a}	
Avg.	**0.091^{A}**	**0.064^{B}**	**0.005^{A}**		**0.053^{b}**	**0.093^{AB}**	**0.065^{B}**	**0.006^{B}**		**0.055^{b}**
25	0.095^{a}	0.062^{c}	0.006^{a}	0.055^{a}		0.097^{a}	0.065^{b}	0.007^{a}	0.056^{a}	
S 50	0.093^{a}	0.062^{c}	0.006^{a}	0.054^{a}		0.095a^{b}	0.065^{b}	0.007^{a}	0.056^{a}	
100	0.093^{a}	0.061^{c}	0.006^{a}	0.053^{a}		0.092^{b}	0.064^{b}	0.007^{a}	0.054^{a}	
Avg	**0.094^{A}**	**0.062^{B}**	**0.006^{A}**		**0.054^{b}**	**0.095^{A}**	**0.065^{B}**	**0.007^{AB}**		**0.055^{b}**
30	0.081^{c}	0.056^{d}	0.005^{a}	0.047^{b}		0.086^{c}	0.055^{c}	0.004^{b}	0.048^{b}	
IW 35	0.081^{c}	0.052^{e}	0.004^{ab}	0.046^{b}		0.081^{c}	0.054^{c}	0.004^{b}	0.046^{b}	
40	0.080^{c}	0.050^{e}	0.003^{b}	0.044^{b}		0.080^{c}	0.054^{c}	0.003^{b}	0.046^{b}	
Avg.	**0.081^{B}**	**0.053^{C}**	**0.003^{B}**		**0.045^{c}**	**0.092^{B}**	**0.054^{C}**	**0.004^{C}**		**0.047^{c}**

Values with the same letter(s) are not significantly different at $p \leq 0.05$.
Treat. Avg. = Treatment average

The trend of total carbohydrates was opposite to that of T.F.A.A or proline. Total carbohydrates were increased proportionally with the amount of H_2SO_4, humic acid, sulphur or increasing I.W. (Table, 8). Increasing I.W was the best in increasing carbohydrate content in the canes, followed by sulphur, humic acid, H_2SO_4 and control due to their effect on decreasing Na and Cl (tables 6, 7). The control vines showed higher contents of T.F.A.A, proline and lower carbohydrates due to the increase of hydrolytic enzymes caused by chloride salts and salinity (Klyskov & Rakova, 1964 and Salisbury & Ross, 1992) which increases T.F.A.A, proline and reduces total carbohydrates (Strogonov, 1964 and Hasio, 1973). In addition, plants build up proline in the tissues to maintain osmotic balance with the soil solution (Salisbury & Ross, 1992)

Na, K and Cl in roots, shoots and leaves :

The application of humic acid, sulphur and I.W significantly decreased Na in Superior Seedless grapevines (Table, 6), sulphuric acid was not effective in this concern. Increasing the level of application of either humic acid, sulphur or increasing I.W significantly decreased Na in the vines. It was also observed that increasing I.W significantly decreased Na in the leaves, shoots and roots in the two seasons of the studt. It is also obvious that the increase of I.W was effective in reducing Na in the leaves through decreasing it in the roots (Table, 5) due to the leaching effect of increasing I.W.

Table (5) : Effect of H_2SO_4, humic acid, S and increasing irrigation water on Na % in Superior Seedless vines grown under saline conditions

Treatment	1st season					2nd season				
	Leaves	Shoots	Roots	Avg.	Treat. avg.	Leaves	Shoots	Roots	Avg.	Treat. avg.
Control	0.50^{A}	0.48^{A}	0.46^{A}		0.48^{a}	0.55^{A}	0.50^{A}	0.45^{A}	0.50^{a}	0.50^{a}
H_2SO_4 2	0.50^{a}	0.48^{a}	0.42^{a}	0.46^{a}		0.52^{a}	0.48^{a}	0.43^{a}	0.48^{a}	
H_2SO_4 4	0.48^{a}	0.45^{a}	0.42^{a}	0.45^{a}		0.50^{ab}	0.47^{a}	0.41^{a}	0.46^{a}	
H_2SO_4 6	0.47^{a}	0.45^{ab}	0.41^{ab}	0.44^{b}		0.50^{ab}	0.45^{ab}	0.40^{ab}	0.45^{ab}	
Avg.	0.48^{A}	0.45^{AB}	0.42^{A}		0.45^{a}	0.51^{A}	0.47^{A}	0.41^{A}		0.46^{a}
Humic 6	0.50^{a}	0.45^{a}	0.40^{b}	0.45^{a}		0.51^{a}	0.46^{a}	0.40^{ab}	0.46^{a}	
Humic 9	0.45^{b}	0.41^{b}	0.35^{bc}	0.40^{c}		0.50^{a}	0.46^{a}	0.40^{ab}	0.45^{ab}	
Humic 12	0.40^{c}	0.35^{cd}	0.32^{c}	0.36^{d}		0.48^{b}	0.42^{b}	0.38^{b}	0.43^{b}	
Avg.	0.45^{A}	0.40^{B}	0.36^{B}		0.40^{b}	0.50^{AB}	0.45^{B}	0.39^{B}		0.45^{ab}
S 25	0.46^{ab}	0.44^{a}	0.40^{b}	0.43^{c}		0.48^{b}	0.45^{ab}	0.40^{ab}	0.44^{b}	
S 50	0.44^{b}	0.41^{b}	0.38^{b}	0.41^{c}		0.46^{bc}	0.41^{bc}	0.37^{b}	0.41^{bc}	
S 100	0.40^{c}	0.38^{c}	0.35^{bc}	0.38^{d}		0.42^{c}	0.39^{c}	0.32^{c}	0.38^{c}	
Avg.	0.43^{B}	0.41^{B}	0.38^{B}		0.41^{b}	0.45^{B}	0.42B	0.38^{B}		0.42^{b}
IW 30	0.43^{b}	0.40^{bc}	0.35^{b}	0.39^{d}		0.40^{c}	0.37^{c}	0.34^{bc}	0.37^{c}	
IW 35	0.40^{c}	0.35^{cd}	0.31^{c}	0.35^{e}		0.35^{d}	0.30^{d}	0.28^{d}	0.31^{d}	
IW 40	0.33^{d}	0.30^{d}	0.26^{d}	0.36^{f}		0.30^{d}	0.25^{e}	0.21^{e}	0.25^{d}	
Avg.	0.39^{C}	0.35^{C}	0.31^{C}		0.35^{c}	0.35^{C}	0.31^{C}	0.28^{C}		0.31^{c}

Values with the same letter(s) are not significantly different at $p \leq 0.05$.
Treat. Avg. = Treatment average

A reverse trend was noticed for K, since a significant increase was found when H_2SO_4, humic acid, sulphur or increasing I.W were applied (Table, 6). The addition of the above treatments at any level significantly increased K^+ percentage in the vines. K percentage in the petioles was higher than in shoots or roots. The results showed that the treatments used in this experiment significantly increased K in the various parts of the vine compared with the control. In addition, increasing the level of application significantly increased K in petioles, roots and shoots. The increase of Na under saline conditions due to the absorbance and translocation of Na at such a rate that a high concentration was built up in the leaves (Lahaye and Epstien, 1971). The reduction in Na is due to sulphuric acid which helps in leaching out the Na^+ through forming gypsum (Salisbury & Ross, 1992) which increases Ca in the soil solution. Sulphur has the same effect because it becomes oxidized to produce sulphuric acid (Miller & Donahue, 1990).

Table (6) : Effect of H_2SO_4, humic acid, S and irrigation water on K % in Superior Seedless vines grown under saline conditions

Treatment	1st season					2nd season				
	Leaves	Shoots	Roots	Avg.	Treat. avg.	Leaves	Shoots	Roots	Avg.	Treat. avg.
Control	0.90^{C}	0.52^{B}	0.45^{C}		0.62^{c}	0.95^{B}	0.53^{C}	0.43^{B}		0.64^{c}
H_2SO_4 2	0.90^{c}	0.51^{c}	0.46^{d}	0.63^{c}		1.00^{c}	0.54^{bc}	0.49^{bc}	0.68^{b}	
4	0.95^{c}	0.52c	0.49^{c}	0.66^{c}		1.00^{c}	0.55^{b}	0.50^{b}	0.68^{b}	
6	1.00^{b}	0.52^{c}	0.50^{bc}	0.69^{b}		1.05^{b}	0.55^{b}	0.50^{b}	0.70^{b}	
Avg.	0.95^{B}	0.52^{B}	0.48^{BC}		0.66^{b}	1.02^{B}	0.55^{A}	0.51^{A}		0.69^{ab}
Humic 6	0.97^{b}	0.58^{a}	0.55^{a}	0.68^{b}		0.99^{c}	0.56^{ab}	0.49^{bc}	0.68^{b}	
9	1.00^{b}	0.58^{a}	0.56^{a}	0.70^{b}		1.07^{b}	0.56^{ab}	0.49^{bc}	0.71^{ab}	
12	1.10^{a}	0.59^{a}	0.57^{a}	0.75^{a}		1.15^{a}	0.57^{a}	0.52^{a}	0.75^{a}	
Avg.	1.02^{A}	0.58^{A}	0.54^{A}		0.71^{a}	1.07^{A}	0.56^{A}	0.50^{A}		0.71^{a}
S 25	0.92^{c}	0.55^{b}	0.47^{cd}	0.65^{c}		0.98^{c}	0.55^{b}	0.48^{c}	0.67^{bc}	
50	0.97^{b}	0.55^{b}	0.49^{c}	0.67^{bc}		1.10^{b}	0.57^{a}	0.49^{bc}	0.72^{a}	
100	1.00^{b}	0.58^{a}	0.53^{b}	0.70^{b}		1.16^{a}	0.58^{a}	0.51^{a}	0.75^{a}	
Avg	0.96^{B}	0.56^{A}	0.50^{B}		0.67^{b}	1.08	0.57^{A}	0.49^{A}		0.71^{a}
IW 30	0.99^{b}	0.52^{c}	0.42^{e}	0.64^{c}		1.00^{c}	0.55^{b}	0.48^{c}	0.65^{c}	
35	1.00^{b}	0.59^{a}	0.43^{e}	0.67^{bc}		1.00^{c}	0.56^{ab}	0.48^{c}	0.66^{c}	
40	1.15^{a}	0.59^{a}	0.47^{cd}	0.74^{a}		1.20^{a}	0.57^{a}	0.48^{c}	0.73^{a}	
Avg.	1.05^{A}	0.57^{A}	0.44^{C}		0.68^{ab}	1.07^{A}	0.56^{A}	0.48^{A}		0.68^{b}

Values with the same letter(s) are not significantly different at $p \leq 0.05$.
Treat. Avg. = Treatment average

Increasing I.W leached the soluble salts from root zone (Russell, 1978), which decreased it in vine tissues because Na in plants is proportional to its amount in the growth medium (Downton, 1977 and Alsaidi *et al.,* 1988) as a first possibility and the second one arises from regular K fertilization which increases K uptake over Na and/or through the application of humic acid (Schnitzer & Khan, 1972).

Table (7) clearly showed that humic acid, sulphur and I.W significantly reduced Cl in Superior Seedless vines. Raising the level of the applied chemicals or I.W significantly reduced Cl, and the lowest values were recorded for increasing I.W. Concerning the different parts of the vine, humic acid, sulphur and I.W significantly reduced Cl in the leaves and roots, where sulphuric acid reduced Cl in the leaves. Cl in leaves and roots was decreased as the level of application increased. The reduction in Cl^- can be ascribed to: a) Cl is an anion which, like the soil, has a negative charge so, it is easy to be leached out and b) The formation of NaCl which is easily leached out because all common sodium salts are soluble (Miller & Donahue, 1990).

Table (7) : Effect of H_2SO_4, humic acid, S and increasing irrigation water on Cl % in Superior Seedless vines grown under saline conditions

Treatment	1st season					2nd season				
	Leaves	Shoots	Roots	Avg.	Avg. of three parts	Leaves	Shoots	Roots	Avg.	Avg. of three parts
Control	2.76^{A}	0.59^{A}	1.66^{A}		1.67^{a}	2.65^{A}	0.63^{A}	1.62^{A}		1.63^{a}
H_2SO_4 2	2.64^{a}	0.59^{a}	1.64^{a}	1.62^{a}		2.62^{a}	0.62^{a}	1.60^{a}	1.61^{a}	
4	2.55^{b}	0.58^{a}	1.63^{a}	1.59^{a}		2.60^{a}	0.60^{a}	1.60^{a}	1.60^{a}	
6	2.27^{c}	0.55^{a}	1.42^{b}	1.41^{b}		2.50^{ab}	0.60^{a}	1.50^{a}	1.51^{ab}	
Avg.	2.49^{B}	0.57^{A}	1.56^{A}		1.54^{ab}	2.57^{A}	0.61^{A}	1.57^{A}		1.58^{ab}
Humic 6	2.45^{b}	0.59^{a}	1.60^{a}	1.55^{a}		2.40^{b}	0.63^{a}	1.52^{a}	1.52^{a}	
9	2.44^{b}	0.59^{a}	1.48^{b}	1.50^{ab}		2.40^{b}	0.62^{a}	1.50^{a}	1.51^{a}	
12	2.41^{b}	0.54^{a}	1.40^{b}	1.45^{b}		2.20^{c}	0.60^{a}	1.45^{a}	1.42^{bc}	
Avg.	2.43^{B}	0.57^{A}	1.49^{B}		1.47^{b}	2.33^{B}	0.62^{A}	1.49^{A}		1.48^{b}
S 25	2.52^{b}	0.57^{a}	1.60^{a}	1.56^{a}		2.55^{a}	0.63^{a}	1.60^{a}	1.59^{a}	
50	2.38^{c}	0.57^{a}	1.51^{b}	1.49^{b}		2.31b	0.62^{a}	1.55^{a}	1.44^{b}	
100	2.26^{c}	0.57^{a}	1.40^{b}	1.41^{b}		2.30^{b}	0.58^{a}	1.50^{ab}	1.46^{b}	
Avg.	2.39^{B}	0.57^{A}	1.50^{B}		1.42^{b}	2.39^{B}	0.61^{A}	1.55^{A}		1.52^{b}
IW 30	2.33^{c}	0.53^{a}	1.22^{c}	1.36^{bc}		2.25^{c}	0.63^{a}	1.40^{b}	1.43^{b}	
35	2.23^{c}	0.52^{a}	1.20^{c}	1.32^{bc}		2.20^{c}	0.60^{a}	1.30^{bc}	1.37^{c}	
40	2.10^{d}	0.50^{a}	1.19^{c}	1.26^{c}		2.15^{c}	0.54a	1.21^{c}	1.30^{c}	
Avg.	2.22^{C}	0.52^{A}	1.20^{C}		1.31^{c}	2.20^{C}	0.59^{A}	1.30^{B}		1.36^{c}

Values with the same letter(s) are not significantly different at $p \leq 0.05$.

Vegetative growth :

Increasing I.W significantly increased leaf area, LMPC and length & diameter of the internode. The same effect was noticed for sulphuric acid, humic acid and sulphur. Increasing the level of each treatment increased the above component of vegetative growth. For example, internode diameter was 7.4 cm at 30/L/vine of I.W increased to 7.9 and 8.7 mm at 35 and 40/L/vine in the first season and it was 7.7 mm at 30/L/vine raised to 8 mm at 35 and 8.6 at 40/L/vine. The same trend was true for the other treatments. It is clear that H_2SO_4 produced shorter internodes and shorter LMPC. Increasing I.W produced longer LMPC and longer internodes which indicate that increasing I.W was more effective in improving vegetative growth. The other treatments were in between. Humic acid improved vegetative growth through its effect on increasing nutrients availability, increasing soil P; K; accelerating cell division and root system development (Schnitzer & Skinner, 1962 and Yagodin, 1984). The effects of H_2SO_4, S, humic acid and I.w are due to their effect on increasing total carbohydrates, K. and decreasing Na and Cl which is reflected in improving vegetative growth (Tables 5, 6, 7 and 8). The amount of irrigation water in winter was low (10 L/vine/15 days in November, no irrigation in December, heavy irrigation in January, 5 L/vine/day in February and 15 L/vine/two days in March (Table, 2). This method of water management keeps the soil containing little amount of water in November or dry in December and has no enough water in spring (beginning of growth) which increase salt concentration in the soil solution resulting in short & thin internodes and decreasing mature portions of the cane.

Table (8) : Effect of sulphuric acid, humic acid, Sulphur and irrigation water on some vegetative & fruit characteristics and yield of Superior Seedless vines grown under saline conditions

Treatment		Leaf area (cm^2)		L.M.P.C. (cm)		Internode length (cm)		Internode diameter (mm)		Berry weight (g)		Berry size (cm^3)		Number of clusters		Cluster weight (g)		Yield (kg/vine)		Carbohydrates (g/100g)	
		1*	2**	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Control		**133.3^{D}**	**130.5^{D}**	**60^{C}**	**62^{D}**	**4.6^{D}**	**5.0^{C}**	**5.6^{D}**	**6.0^{C}**	**2.7^{C}**	**2.5^{C}**	**2.4^{B}**	**2.3^{B}**	**12^{B}**	**12^{C}**	**433^{E}**	**440^{E}**	**5.2^{D}**	**5.3^{E}**	**11.2^{C}**	**11.1^{C}**
H_2SO_4	2	145.0^{e}	140.1^{c}	67^{c}	66^{f}	5.0^{ef}	5.4^{e}	5.8^{e}	6.1^{d}	2.7^{d}	2.6^{d}	2.4^{c}	2.3^{c}	14^{b}	14^{b}	461^{e}	455^{f}	6.5^{d}	6.4^{f}	11.9^{d}	11.7^{c}
	4	149.0^{d}	145.2^{d}	68^{c}	69+	5.2^{e}	5.4^{e}	6.0^{e}	6.3^{c}	2.9^{cd}	2.9^{cd}	2.5^{c}	2.4^{bc}	15^{ab}	14^{b}	464^{e}	470^{f}	7.0^{c}	6.6^{f}	12.6^{c}	12.3^{b}
	6	149.0^{d}	153.5^{d}	71^{b}	70^{ef}	5.6^{e}	5.5^{de}	6.4^{de}	6.5^{c}	3.0^{c}	2.9^{cd}	2.6^{bc}	2.4^{bc}	15^{ab}	15^{ab}	467^{e}	472^{f}	7.0^{c}	7.1^{de}	12.8^{c}	12.3^{b}
Avg.		**147.7^{C}**	**146.2^{C}**	**68.7^{CD}**	**68.3^{C}**	**5.3^{C}**	**5.4^{C}**	**6.1^{C}**	**6.3^{C}**	**2.9^{BC}**	**2.8^{C}**	**2.5^{B}**	**2.4^{B}**	**15^{A}**	**14^{B}**	**464^{D}**	**466^{D}**	**6.8^{C}**	**6.7^{D}**	**12.4^{B}**	**12.1^{B}**
Humic	6	150.0^{cd}	152.3^{d}	68	64^{fg}	601^{d}	5.8^{d}	7.0^{cd}	7.2^{bc}	3.0^{c}	3.2^{bc}	2.6^{bc}	2.4^{bc}	14^{b}	15^{ab}	467^{e}	500^{e}	6.5^{d}	7.5^{d}	13.1^{bc}	12.8^{b}
	9	160.2^{b}	162.1^{bc}	70^{bc}	71^{e}	6.6^{cd}	6.7^{c}	7.5^{bc}	7.4^{b}	3.2^{c}	3.2^{bc}	2.6^{bc}	2.5^{b}	15^{ab}	16^{a}	531^{d}	525^{e}	8.0^{b}	8.4^{b}	13.5^{b}	12.9^{b}
	12	165.4^{b}	169.8^{b}	75^{ab}	72de	6.9^{c}	7.2^{bc}	8.0^{b}	7.8^{ab}	3.2	3.3^{b}	2.8^{b}	2.7^{b}	16^{a}	16^{a}	531^{d}	540^{d}	8.5^{a}	8.6^{ab}	13.9^{a}	13.2^{a}
Avg.		**158.5^{B}**	**161.4^{B}**	**71.1^{B}**	**69.0^{C}**	**6.5^{B}**	**6.6^{B}**	**7.5^{A}**	**7.5^{B}**	**3.1^{B}**	**3.2^{B}**	**2.7^{B}**	**2.5^{B}**	**15^{A}**	**16^{A}**	**510^{C}**	**522^{C}**	**7.8^{B}**	**8.2^{B}**	**13.5^{A}**	**13.0^{A}**
S	25	155.0^{c}	151.3^{d}	70^{b}	75^{d}	6.2^{d}	6.0^{d}	6.4^{de}	6.8^{c}	3.1^{c}	3.1^{c}	2.7^{b}	2.6^{b}	13^{c}	14^{b}	536^{d}	590^{e}	7.0^{c}	7.0^{e}	12.9^{b}	13.1^{ab}
	50	161.0	163.7^{b}	70^{b}	78^{d}	6.9^{c}	6.8^{c}	6.8^{d}	7.3^{b}	3.2^{c}	3.2^{bc}	2.7^{b}	2.6^{b}	14^{b}	14^{b}	538^{d}	542^{d}	7.50^{b}	7.6^{cd}	12.9^{b}	13.2^{a}
	100	164.7^{b}	165.6^{b}	78^{a}	80^{d}	7.7^{b}	7.8^{b}	7.3^{c}	7.9^{ab}	3.3^{b}	3.4^{b}	2.8^{b}	2.7^{b}	14^{b}	14^{b}	554^{d}	550^{c}	7.8^{b}	7.7^{c}	13.3^{b}	13.2^{a}
Avg		**160.2^{AB}**	**160.2^{B}**	**72.7^{B}**	**77.7^{B}**	**6.9^{B}**	**6.9^{B}**	**6.8^{B}**	**7.3^{B}**	**3.2^{B}**	**3.2^{B}**	**2.8^{B}**	**2.6^{B}**	**14^{A}**	**14^{B}**	**543^{B}**	**531^{B}**	**7.4^{B}**	**7.4^{C}**	**13.0^{A}**	**13.2^{A}**
IW	30	150.7^{c}	151.1^{d}	75^{ab}	90^{c}	6.7^{c}	6.6^{c}	7.4^{c}	7.7^{b}	3.5^{ab}	3.8^{ab}	3.0^{ab}	3.2^{a}	14^{b}	15^{ab}	571^{c}	565^{c}	8.0^{b}	8.5^{b}	13.4^{b}	13.5^{a}
	35	167.2^{ab}	170.1^{ab}	80^{a}	100^{b}	7.7^{b}	7.5^{b}	7.9^{b}	8.0^{ab}	3.9^{a}	4.0^{a}	3.2^{a}	3.5^{a}	14^{b}	15^{ab}	607^{b}	595^{b}	8.5^{a}	8.9^{a}	13.8^{a}	13.5^{a}
	40	175.2^{a}	178.3^{a}	86^{a}	120^{a}	8.5^{a}	8.7^{a}	8.7^{a}	8.6^{a}	4.0^{a}	4.1^{a}	3.3^{a}	3.5^{a}	14^{b}	15^{ab}	643^{a}	630^{a}	9.0^{a}	9.5^{a}	14.2^{a}	13.7^{a}
Avg.		**164.4^{A}**	**166.5^{A}**	**80.3^{A}**	**103.3^{A}**	**7.6^{A}**	**7.6^{A}**	**8.0^{A}**	**8.1^{A}**	**3.8^{A}**	**4.0^{A}**	**3.2^{A}**	**3.4^{A}**	**14^{A}**	**15^{AB}**	**607^{A}**	**597^{A}**	**8.5^{A}**	**9.0^{A}**	**13.8^{A}**	**13.7^{A}**

Values with the same letter(s) are not significantly different at $p \leq 0.05$.
L.M.P.C. = Length of mature portion of the cane
1* = 1st season
2** = 2nd season.

The increase of the irrigation water 30, 35 and 40 litre/vine at different intervals followed in the vineyard it self positively affected vine growth and yield due to the dilution effect and leaching out the soluble salts from root zone. This result is in agreement with Balba & Bassiuny (1977) who stated that increasing irrigation water reduced soil content of soluble salts and provided more suitable conditions for plant growth. In addition, Ca in the irrigation water decreases the deleterious effect of Na (Rhoades and Loveday, 1990).

Yield and its components :

Number of clusters & yield per vine, berry weight and size were significantly increased as a result of applying the different treatments. Increasing the level of the applied treatments increased the number and weight of clusters. The same effect extended to berry weight and size. Yield/vine positively responded to the treatments, that it was significantly increased compared with the control. The use of the chemical substances sulphuric acid, sulphur and humic acid as well as irrigation water up to 40 L reduced Na, Cl and raised K percentages in the vine (Tables 5, 6 and 7), that increased leaf area and vegetative growth (Table, 8) leading to an increase in the yield and its components. Schnitzer & Khan (1972) showed that humic acid improved plant production and quality. In addition, humic acid increased yield and its components by increasing the availability of nutrients through its chelating capacity with micronutrients (Schnitzer & Skinner, 1962). Furthermore, gypsum and sulphur sediments had favorable effects on growth and yield (Kumar & Singh, 1980 and Ismail *et al.,* 1993).

In conclusion, increasing irrigation water up to 40 litre/vine at different intervals is necessary to improve vine growth and yield of Superior Seedless grapevines grown under saline conditions.

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تأثير حمض الكبريتيك ، حمض الهيوميك ، الكبريت وزيادة مياه الري علي النمو والإنتاجية لعنب السوبريور اللابذري النامي تحت ظروف ملحية

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أجريت التجربة في مزرعة عنب صنف السوبريور عديم البذور ، عمر ٧ سنوات ذات تربة رملية طميية (EC_e = 3.7 ds/m) وتروي عن طريق الري بالتنقيط ($EC_{i.w}$ = 2.3 ds/m) . كانت المعاملات هي المقارنة ، حمض الكبريتيك (٢ ، ٤ ، ٦ لتر/فدان كل أسبوعين) ، حمض الهيوميك (٦ ، ٩ ، ١٢ لتر/فدان مقسمة علي ٤ دفعات) ، الكبريت (٢٥ ، ٥٠ ، ١٠٠ كجم/فدان تضاف أثناء الخدمة الشتوية) والري (٣٠ ، ٣٥ ، ٤٠ لتر/كرمة/يوم). أدت جميع المعاملات إلي زيادة مساحة الورقة ، طول الجزء الناضج من القصبة ، طول وسمك السلامية ، عدد ووزن العناقيد ، وزن وحجم الحبة ، وكذلك المحصول ، وكانت أفضل النتائج هي زياة مياه الري إلي ٤٠ لتر/كرمة لفترات مختلفة. زادت النسبة المئوية للبوتاسيوم في الأوراق ، والسوق والجذور كانت متناسبة مع زيادة معدل المعاملات بينما اتخذ منحنياً الصوديوم والكلور إتجاهاً معاكساً. لم يكن هناك تاثير يذكر لمعاملات حمض الكبريتيك ، الهيوميك والكبريت علي الأحماض الأمينية الحرة بينما ادي زيادة مياه الري إلي ٤٠ لتر/كرمة لفترات مختلفة إلي نقص في الأحماض الأمينية الحرة في الأوراق والأفرخ والجذور. ولم يتأثر البرولين بأي من المعاملات ، وتلاحظ أن الأوراق تحتوي علي أحماض أمينية حرة وبرولين أكثر من الأفرخ والجذور إضافة إلي ذلك فإن المعاملة بحمض الهيوميك والري حتي ٤٠ لتر/كرمة لفترات مختلفة زادت من محتوي القصبات من الكربوهيدرات.

وقد استنتج أن ري الكروم بمعدل ٤٠ لتر/كرمة لفترات مختلفة كان كافياً للإقلال من تأثير الأملاح في هذه المنطقة.