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Minimizing Adverse Effects of Salinity in Vineyards

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Abstract: This study was aimed to examine the effect of some materials namely humic acid, Uni-sal, magnetic iron and arbuscular mycorrhizal fungi to avoid or minimize salt hazard on grapevines growth and production during 2010 and 2011 seasons. This study was applied in a private vineyard at Al-Alamine district on five years old Thompson Seedless grapevines that irrigated using drip irrigation system and planted in saline sandy soil (Ec= 4.2 ds/m) at 2 x 3 meters apart. All grapevines were pruned and trellised by Gable system. Eight treatments were done as follows: control (untreated vines): humic acid (6 and 9 liter/feddan) and (Uni-sal 4 and 6 liter/feddan). All treatments were applied equal batches three times, firstly, at growth start, secondly, after berry set, thirdly, three weeks later after setting. While magnetic iron (100 and 150 kg / feddan) and Inoculation with arbuscular mycorrhizal (AM) (175 kg/Feddan) were added once just after carrying out winter pruning. The obtained results appeared that all treatments were very effective in stimulating growth parameters (main shoot length), total leaf area/vine and coefficient of wood ripening. Chlorophyll, nitrogen, phosphorus, potassium, calcium, magnesium and iron percentages in leaves and total carbohydrates in the canes were also increased. On the contrary, leaf proline amino acid, sodium and chloride content was decreased by increasing the rates of any treatment. Yield expressed in weight and numbers of cluster/vine, cluster weight, berry weight and size, total soluble solids, total soluble solids/total acidity were increased. Whereas total acidity was reduced affecting by high rates of any treatment. The results also indicated that increasing rates of treatment had reduced Ec of soil. Application of humic acid and Uni-sal were more effecting in reducing salinity of soil, improving growth, yield and berry quality characters. Generally, the best treatments were 9 liter/feddan humic acid or 6 liter/feddan Uni-sal. The both treatments were more effective in reducing Ec from 4.2 ds/m in soil to (1.8 humic acid and 1.9 Uni-sal) ds/m, respectively and avoiding the adverse effects of soil salinity on growth and fruiting of vines comparing with other treatments used. Also, Yield and berries quality were promoted these promising materials.

Key words: Salinity-vine

INTRODUCTION

Grapevines cultivation area in Egypt has developed progressively in the last few years. More than a great of this area is concentrated in the new reclaimed soils where grapes have recently become a key component of Egyptian horticultural exports. Soil salinity is becoming a major problem in widespread areas of the cultivated land in Egypt. Newly reclaimed sandy soil may be affected at various degrees by some sorts of salinity. It is well known that salt can impair the performance of production and growth of many horticultural plants especially fruit trees. Growth, fruit production and quality parameters today are seriously affected by soil [1-4]. High salinity causes both the hypesosmotic and hyperionic effects stress and consequence of these can be plant deterioration [5,6]. The most harmful effect is osmotic stress increases due to high salt concentration in soil solution. Consequently, the decrease in the soil water potential reduction in assimilates partitioning to roots [7] and imbalance in overall concentrations of the ions due to ion toxic on physiological processes [8] such as growth inhibitor [9] photosynthesis [10] respiration [11] and change of enzyme activity [12]. In recent years, considerable attention has been paid by application of organic material, *i.e.*, humic acid, agrochemical, *i.e.*, Uni-sal and magnetic iron and bio-agents like inoculation with Arbuscular mycorrhizae fungi to reduce salinity in the soil.

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Humic acid (polymeric polyhydroxy acid) is the most significant component of organic substances in aquatie system [13]. Liu and Cooper [14] showed that humic acid enhanced root growth of salt stressed plants and improved salinity tolerance. Also, Hartwigsen and vans [15] indicated that humic acid significantly increased root fresh weight and total length of lateral roots. It improves soil structure, organic matter, nutrient uptake, root development and microbial activity [16]. Magnetic treatment changes the physiochemical characteristics of soil leading to improved dissolvability of different chemical elements, more salts out of the soil and at the same time increasing oxygen concentrations by 10 %. Uni-sal contains polyethylene glycol (PEG), some elements and amino acids. Munir and Aftab [17] reported that (PEG) lowers the osmotic potential of nutrient solutions and is not phytotoxic. Also, Kawasaki *et al.* [18, 19] indicated that, polyethylene glycol has been successfully used as an osmotic for subjecting plant tissues.

Application of Uni-sal which contains amino acids (gliteric acid) makes activation by bio formation of proline, which is considered one of the most important amino acid that help the plant for resisting most of stress like salinity and drought [20]. Furthermore, spraying amino acids increased chlorophyll content due to its role in increasing protein biosynthesis essential for chlorophyll formation, enhancing growth, yield and physical and chemical characteristics of the berries [20-22]. Calcium plays promising role in reducing soil salinity and stimulating growth and productivity in various grapevine cvs [4, 23]. The effect has been attributed to calcium preventing the uptake of sodium ion to injurious levels and allowing the uptake of potassium [24]. Calcium also reduced the solubility and toxicity of elements such as manganese, copper and aluminum plant supplied with calcium well tolerates toxic levels of these elements [25]. One of the natural and technological ways which has been among the most studied subjects for the last decades to reduce the salinity damages in crops was the inoculation with Arbuscular mycorrhizae fungi.

AM fungi can benefit plants by stimulating growth regulating substances, improving osmotic adjustment under salinity stress and improving soil properties [26, 27].

This study was designed to examine the effect of some materials namely humic acid Uni-sal and magnetic iron and arbuscular mycorrhizal (AM) to reduce soil salinity to avoid or minimize the hazard of salts on growth and production of Thompson Seedless grapevines.

MATERIALS AND METHODS

This investigation was conducted in a private vineyard located at Alamine district, Alexandria Desert Road for two consecutive seasons (2010 and 2011). Thompson Seedless grapevines (five-years-old) were grown in a sandy soil. The vines were supported to the Gable system trellis and planted 2 x 3 m apart. In the first week of January, the vine was pruned to seven canes of 12 buds per each. The vineyard irrigated using drip irrigation system with two lateral lines per row and two 4 L/h emitters per vine. One hundred and twenty vines of similar vigour were chosen. Chemical and physical properties of the soil and water analysis were done according to the procedures of Jackson [28], Black [29] and Wilde *et al.* [30] as shown in Tables 1 and 2.

The Experimental Design: Eight treatments were arranged in a complete randomized design with three replicates and each replicates had five vines. The experiment involved the following treatments:

- Control.
- Humic acid 6 or 9 litre / feddan.

Humic acid content in the liquid organic fertilizer was determined using $BaCl_2$ precipitation method as described by Fataftah *et al.* [31]. The different constituents of the applied liquid organic fertilizer were determined and illustrated in Table 3.

Table 1: Chemical and physical properties of the experimental soil

Chemical and Physical properties													
Ec dS/m	pH 1:2.5	Ca++ meg/L	Mg++ meg/L	Na+ meg/L	K+ meg/L	HCO_3-meg/L	Cl-meg/L	Fe ppm	SAR	Sand %	Clay %	Silt %	Texture
4.2	8.08	12	4	8.1	0.47	2.0	5	0.6	7.4	92.31	4.295	3.36	Sandy

Table 2: Some chemical properties of the experimental water

		Cations, meg/L				Anions, meg/L		
pH	EC dS/m	Ca++	Mg++	Na++	K+	CO_3-	HCO_3-	Cl-
7.61	1.6	16	6	7.5	0.31	0	3.8	10

Table 3: Main characteristics of the used liquid organic fertilizer

Component	Value
Humic acid (%)	2.9
Organic matter / total solid (%)	42.51
Total humic acids / total solid (g/L)	165.84
Organic carbon (%)	24.64
C / N ratio	2.46
Total nitrogen (N%)*	10
Total phosphorus (P_2O_2 %)*	10
Total potassium (K_2O %)*	10
Total calcium (Ca %)**	0.06
Total magnesium (Mg %) **	0.05

*Soluble in distilled water **Digest by H_2SO_4

Uni-sal 4 or 6 litre/feddan: Uni-sal contains polyethylene glycol (PEG 9%) calcium 7.5%, nitrogen 5%, glutric acid 7% and citric acid 1%. Humic acid and Uni-sal were applied three times, firstly, at growth start, secondly, after berry set, thirdly, three weeks later after setting.

- Magnetic iron 100 or 150 kg / feddan were added once just after carrying out winter pruning.
- Inoculation with arbuscular mycorrhize (AM) at 175Kg/feddan were added once just after carrying out winter pruning.

Mycorrhizal spores were originally extracted from Egyptian soils. Soil drench was made around the roots of the vine. Spores of AM-mycorrhizae including the following genera Glomus, Gigaspora and Acaulospora were added after propagation. Extraction and counting of identified mycorrhizal spores occurred according to the method described by Massoud [32] where the soil mass was gently removed from root system of each vine (250g).

All trees were subjected to the common horticultural field practices.

The following parameters were adopted to evaluate the tested treatments:

Measuring soil salinity: Samples were collected before and after treatments three times at the beginning of growth recorded an average of 25 cm shoot length (before bloom), just after berry set and at the end of the growth season, depths of 0-30 and 30-60 cm and distances of 50 cm from the emitters in row and between row. Electrical conductivity was measured in 1: 10 soil water suspension of the soil samples according to the method of Jackson [28].

Vegetative Growth Parameters: Main shoot length (cm) and total surface area of the leaves/vine were determined as follows: leaf surface area was multiplied by the average number of leaves/shoot and then by number of shoots/vine, (using leaf area meter Model CI 203, U.S.A.). Coefficient of wood ripening was calculated by dividing length of the ripened part of the shoot by total length of the shoot according to Bouard [33].

Chemical Studies:

- Leaf total chlorophyll content (SPAD) was measured by using nondestructive Minolta chlorophyll meter SPAD 502 Wood *et al.* [34].
- Leaf proline content (mg/g) was colorimetrically estimated on fresh weight basis according to the method of Batels *et al.* [35].
- Cane content of total carbohydrate (%)[36].
- Leaf mineral content: N (%) [37], P% [38] and K (%) [28]. Mg (%), Ca (%), Cl (%), Na (%) and Fe (ppm) were estimated according to the methods of Wilde *et al.* [30].

Yield and Berry Characteristics:

- Number of clusters per vine, yield per vine (kg) and average cluster weight (g).
- Average berry weight (g), berry size (cm^3).
- Berry juice measurements:
- Total soluble solids percentage (TSS) using a hand refractometer.
- Titratable acidity percentage according to AOAC [39].
- Total soluble solids/acid ratio (TSS/acid).

Statistical Analysis: The completely randomized design was adopted for the experiment. The statistical analysis of the present data was carried out according to Snedecor and Cochran [40]. Averages were compared using the new LSD method at 5 % level.

RESULTS AND DISCUSSION

Vegetative Growth: Data presented in Table 4 show that application of humic acid, Uni-sal, magnetic iron and inoculation with arbuscular mycorrhizal (AM) under salinity conditions were significantly effective in increasing both main shoot length, total leaf area/vine and coefficient of wood ripening compared to control treatment. Increasing humic acid, Uni-sal and magnetic iron levels followed by a gradual increases in these parameters. The maximum significant values of vegetative growth were obtained with vines

Table 4: Influence of humic acid, Uni-sal, magnetic iron and inoculation with arbuscular mycorrhizal (AM) on some vegetative growth characteristics of Thompson Seedless grapevines during 2010 and 2011 seasons

	Main shoot length (cm)		Total leaf area / vine (m^2)		Coefficient of wood ripening	
Treatments	1st	2nd	1st	2nd	1st	2nd
Control	72.2	80.4	13.6	13.8	0.63	0.61
Humic acid 6	115.5	121.2	17.7	18.4	0.76	0.77
Humic acid 9	119.9	126.4	20.7	23.3	0.81	0.83
Uni-sal 4	113.0	118.9	16.9	17.5	0.72	0.74
Uni-sal 6	116.7	123.8	19.2	20.4	0.79	0.80
Magentic iron 100	106.0	114.0	15.6	16.0	0.66	0.68
Magentic iron 150	109.7	118.0	16.8	16.9	0.70	0.71
AM	103.6	111.1	14.8	15.3	0.65	0.66
New LS at 0.05 level	1.9	2.2	1.1	0.8	0.02	0.02

Table 5: Influence of humic acid, Uni-sal, magnetic iron and inoculation with arbuscular mycorrhizal (AM) on total chlorophyll and proline leaf content and carbohydrate cane content of Thompson Seedless grapevines during 2010 and 2011 seasons

	Total chlorophyll content (SAAD)		Leaf proline (mg/g FW)		Cane total carbohydrate content (%)	
Treatments	1st	2nd	1st	2nd	1st	2nd
Control	30.4	28.6	0.12	0.13	9.28	9.10
Humic acid 6	43.4	45.2	0.07	0.08	15.56	16.14
Humic acid 9	47.6	49.0	0.05	0.04	18.22	19.00
Uni-sal 4	41.9	42.7	0.07	0.06	14.42	14.98
Uni-sal 6	45.5	46.9	0.06	0.05	16.86	17.22
Magentic iron 100	36.2	38.3	0.09	0.08	11.42	12.22
Magentic iron 150	39.1	40.1	0.08	0.09	13.30	14.23
AM	34.3	36.8	0.11	0.10	10.89	11.00
New LSD at 0.05 level	1.4	1.6	0.01	0.01	0.9	0.11

received humic acid (9 litre/feddan). Whereas the untreated vines produced the minimum values. This means that the growth of the vines growing under saline were greatly inhibited without using salinity amendments. These results were true in both seasons. Humic acid improved vegetative growth by increasing nutrients availability, minimized the negative effects of salinity, promoted lateral root growth and increasing soil PK [41].

As regard, the effect of Uni-sal was due to lowering the osmotic potential of nutrient solutions and increasing tolerance to osmotic stress [17]. The stimulating influence of magnetic iron included a change of the physiochemical characteristics of soil leading to improved dissolvability of different chemical elements, more salts out of the soil and at the same time oxygen concentration was increased by 10 % and resulted in a better assimilation of nutrients and fertilizer in plants during the vegetation period [42]. Mycorrhizal fungi improved and enhanced growth of the tested Thompson Seedless grapevines under salinity were based on physiological processes like increasing carbon dioxide exchange rate, stomatal conductance and water efficiency rather than on nutrient uptake [43]. In addition, Feng *et al.* [44] showed that AM improved the resistance capacity to osmotic stress by increasing soluble sugar and electrolyte concentrations in plants root.

Leaf Total Chlorophyll Content: Data concerning total chlorophylls content of leaves are presented in table 5. It can be pointed out that total chlorophyll content in the leaves was positively affected by the application of humic acid, Uni-sal, magnetic iron and AM, compared to the control. The significant increase in total chlorophylls was associated by increasing in the level of applied material. Application of humic acid at 9 litre /feddan was found to be superior in this regard. The minimum values were recorded with untreated vines. There was a positive effect by using these materials on reducing salinity and increasing total chlorophyll in leaves. Such results held true in both seasons of study.

The adverse effects of salinity on total chlorophyll might be attributed to its negative action on interrupting and reducing water availability and nutrients particularly magnesium [45]. However, the important role of these materials on reducing salinity and the valuable effect on increasing water availability and nutrients as well as reducing soil salinity could explain the present results. The previous increases of total chlorophyll content in leaves due to humic acid application could be contributed to the nutritional regulation and adaptability of apple trees and enhancing photosynthesis and accumulation of nutrients [46].

Leaf Proline Content: The data in Table 2 cleared that using humic acid, Uni-sal, magnetic iron and (AM) was significantly reduced proline content in leaves comparing to control. Moreover, the lowest value was recorded with humic acid and Uni-sal. The maximum value of proline treatment that recorded with untreated vines might be attributed to increasing of hydrolytic enzymes that caused by chloride salts and salinity [47]. Furthermore, leaf proline content has been used as an evaluation parameter for selecting salinity [35]. In addition, plants build up proline in tissues to maintain osmotic balance with soil solution [47]. The application of Uni-sal with high level appeared a gradual decrease in leaf proline content. These results are in parallel with Naik and Joshi [48] who reported that PEG (which is a main content of Uni-sal) could not stimulate proline accumulation in sugar cane leaves.

Cane Total Carbohydrate Content: As shown in Table 5, it is obvious that total carbohydrates increased proportionally in relation to increase in the level of applied humic acid, Uni-sal and magnetic iron. Amending Thompson Seedless vines with humic acid at 9 litre/feddan recorded maximum values in this respect. As for the inoculation with AM fungi, it was found that soil with AM significantly improved cane total carbohydrates content comparing with control.

These results are in harmony with those of Kilany *et al.* [49] who found that water stress due to salinity in the soil and water effectively depressed the synthesis of carbohydrates. However, humic acid improved physiological processes, like water absorption capacity of plants by increasing root hydraulic conductivity. Also, Uni-sal had adjusted osmotic balance and composition of carbohydrates [17, 46].

Leaf Mineral Content: Results in Table 6 concerning leaf mineral content in Thompson Seedless grapevine in response to salinity and application of humic acid, Uni-sal, magnetic iron and AM inoculations was followed by alleviating the impaired effect of salinity on uptake of N, P, K, Ca, Mg, Fe, Na and Cl as compared with control. The data showed that application of these materials was significantly responsible for reducing percentages of Cl and Na and increasing N, P, K, Ca, Mg and Fe. Increasing the level of application of either humic acid, Uni-sal and magnetic iron significantly decreased Na and Cl and increased the N, P, K, Ca, Mg and Fe in the leaves. The pronouncing effect on the mineral content of the leaves (N, K, Ca and Mg) was observed on vines received humic acid, Uni-sal.

Improving mineral nutrient absorption by humic acid in plants grown under saline conditions might be related to conversion of unavailable minerals into soluble forms. Results in hand are agreed with those of previous studies [50-52]. They stated that improving plant nutrition by humic acid is due to stimulating the absorption of mineral

Table 6: Influence of humic acid, Uni-sal, magnetic iron and inoculation with arbuscular mycorrhizal (AM) on Leaf mineral content of Thompson Seedless grapevines during 2010 and 2011

	N (%)		P (%)		K (%)		Ca (%)		Mg (%)		Cl (%)		Na (%)		Fe (ppm)	
Treatments	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control	1.31	1.23	0.17	0.15	0.11	1.08	2.19	2.21	0.21	0.20	1.38	1.41	0.63	0.65	29.0	29.9
Humic acid 6	2.50	2.63	0.32	0.33	1.90	1.88	2.60	2.64	0.47	0.52	1.06	1.03	0.44	0.42	35.3	36.9
Humic acid 9	2.81	2.94	0.38	0.41	1.98	2.00	2.70	2.79	0.61	0.64	0.96	0.94	0.34	0.31	38.2	39.9
Uni-sal 4	2.38	2.41	0.27	0.29	1.82	1.85	2.52	2.56	0.41	0.44	1.11	1.09	0.47	0.46	34.0	35.6
Uni-sal 6	2.69	2.75	0.34	0.36	1.93	1.96	2.63	2.67	0.55	0.58	1.01	0.98	0.39	0.37	37.1	37.4
Magentic iron 100	2.18	2.14	0.21	0.23	1.71	1.73	2.39	2.43	0.31	0.32	1.24	1.20	0.57	0.55	41.2	42.7
Magentic iron 150	2.26	2.32	0.25	0.26	1.76	1.79	2.46	2.49	0.34	0.38	1.17	1.14	0.52	0.49	43.0	44.2
AM	2.01	2.07	0.42	0.43	1.63	1.67	2.31	2.35	0.25	0.27	1.31	1.27	0.59	0.60	31.3	33.0
New LSD at 5% level	0.07	0.05	0.02	0.03	0.05	0.03	0.04	0.06	0.02	0.03	0.05	0.04	0.03	0.04	1.1	1.1

Table 7: Influence of humic acid, Uni-sal, magnetic iron and inoculation with arbuscular mycorrhizal (AM) on yield (kg), cluster weight (g) and characteristics of physical and chemical Thompson Seedless grapevines berries during 2010 and 2011 seasons

Treatments	Yield (kg)		Cluster weight (g)		No. of cluster / vine		Berry weight (g)		Berry size (cm)		TSS %		Acidity %		T.S.S. / acid	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control	4.3	3.9	241	229.4	18	17	2.27	2.24	2.13	2.09	16.2	16.0	0.77	0.78	21	20.5
Humic acid 6	8.8	9.1	352	362	25	25	2.75	2.77	2.62	2.63	19.2	19.3	0.60	0.58	32.0	33.3
Humic acid 9	10.0	10.4	371	386	27	27	2.85	2.88	2.70	2.74	19.8	19.9	0.52	0.50	38.1	39.8
Uni-sal 4	7.8	8.1	337	339	23	24	2.69	2.72	2.55	2.58	18.5	18.7	0.63	0.62	29.4	30.2
Uni-sal 6	9.5	9.6	366	370	26	26	2.80	2.83	2.65	2.68	19.5	19.6	0.56	0.54	34.8	36.3
Magentic iron 100	7.0	7.2	302	311	23	23	2.55	2.57	2.41	2.43	17.4	17.5	0.71	0.69	24.5	25.4
Magentic iron 150	7.4	7.6	322	331	23	23	2.60	2.63	2.46	2.49	17.8	18.0	0.67	0.65	26.6	27.7
AM	6.4	6.5	285	291	22	22	2.50	2.53	2.36	2.39	16.9	17.2	0.75	0.73	22.5	23.6
New LSD at 5% level	0.3	0.4	5.0	4.0	1.0	1.0	0.05	0.05	0.04	0.03	0.3	0.3	0.02	0.03	2.1	2.3

elements through roots. Thus, stimulating root growth thereby, enabling better uptake of nutrients. Magnetic iron and AM came in descending order, while, highest content of Fe was obtained from magnetic iron. In this respect, leaf P (%) content gave the highest significant increase due to inoculation with AM fungi. Un-treating vines gave the maximum Cl, Na and the minimum N, P, K, Ca, Mg and Fe content in the leaves. This might attribute to increasing in osmotic pressure, thereby, reducing uptakes of water and nutrients by vines. These results were true in both seasons and confirmed by Stevens and Walker [3] and Sivritepe [53]. The obtained results also showed that, Na and Cl excess in saline soils can be corrected by the addition of humic acid and Uni-sal. These results are in the same line with those obtained by Nijjar [45] who mentioned that Ca replaced sodium through complex exchanges by many reactions. In addition, decomposition of organic materials and formation of carbonic acid and calcium bicarbonate lead to Ca replaced Na. Some mechanisms have been suggested to explain effects of humic acid Uni-sal, magnetic iron and AM inoculation such as improving salt tolerance through inducing osmotic adjustment [17], increased ability of soil to get rid of salts and results in a better assimilation of nutrients and fertilizer in plants. However, magnetic treatment easily takes up mineral salts out from the soil and no sediment is formed on the soil surface [42]. AM improves salt tolerance by improving and balancing nutrient in plants. In this respect Cantrll and Linderman [54] suggested that AM fungi in plants grown under saline condition might be able to reduce the negative effects of Na and Cl and retain them in roots without being translocated to the shoots by maintaining vacuolar membrane integrity and retaining in intracellular. AM fungal hyphae were compartmentalized in cell root vacuoles, which prevented these ions from interfering during metabolic pathways of growth. There was a reduction occurring in N, P, K, Mg, Ca and Fe contents in vines leaves under salt stress.

Yield and Cluster Weight: Data in Table 7 showed that all treatments significantly enhanced vine yield as expressed in weight and number of clusters/vine in comparison with vines under salinity stress conditions. The highest values were observed with vines that applied by humic acid.

Application of humic acid, Uin-sal and magnetic iron at highest rate were found to be superio in this regard. Our results cleared that vines that suffer from salinity gave the minimum values of yield, cluster weight and its number. This may be due to salinity negative effect on reducing roots feeder (NPK uptake) and reduction its ability to withstand stress. On the other hand, the results revealed that all applications were effective in improving micronutrients availability in the soil, as well as, improving vegetative growth, consequently increasing yield characteristics of Thompson Seedless grapevines.

The improving effect of humic acid on yield and its components could be attributed to its vital role in lowering soil ph. Consequently, nutritional status is being improved in favour of producing more clusters/vine and yield/vine. These results are nearly in the same line with those obtained by prior studies [52, 55, 56]. Moreover, Uni-sal had a positive effect on growth parameters and yield. This may be due to its enrichment with polyethylene glycol, which lowered osmotic potential of nutrient solutions and increased nutrient availability. Munir and Aftab [17] pointed out that magnetic iron application had increased ability of soil to get rid of salts. It was also resulted in a better assimilation of nutrients and fertilizer in plants during the vegetation period and increase crop production [42]. Yield produced, in response to inoculation by AM, could be mainly attributed to the enhancement on cluster weight.

The positive effect of AM which is able to absorb and translocation elements to host root tissues, in addition, they can also break down certain complex, minerals and organic substances in the soil and make them available to their hosts [57].

Physical and Chemical Characteristics of Berries: Data in Table 7 revealed that berry weight, size, total soluble solids and total soluble solids/acid ratio had significantly increased affecting by all treatments used; and acidity content significantly decreased in both seasons of the study. The best result in this respect was obtained from vines receiving humic acid at the highest levels. Increasing humic acid, Uni-sal and magnetic iron levels caused a gradual promotion on berries quality, while inoculation with arbuscular mycorrhizal (AM) came next. Unfavorable effects on fruit quality were observed when the vines grown under salinity and untreated with each material. The positive influence of these materials may be due to the increased total surface leaves area and increased the availability of micronutrients in the soil leading to an increase in total chlorophyll that may result in accumulating more carbohydrates thereby enhancing fruit ripening. Many workers in this field supported the improving effect of these materials on berry quality [42, 52, 55, 57].

Salt Distribution: Presented data in Fig. 1 showed that average values of salt concentrations (EC) at various depths (0-30 cm, 30-60 cm) and distances (0-50 cm) from the emitter at the same line and between rows at three times after application of treatments. Concerning salt distribution between rows, the lowest salinity level was recorded at 0-30cm in depth and 50cm distance; whereas, the highest salinity level was found at 30 to 60 cm depth and 50 cm far from the emitter and toward the next row. As regards salt distribution at the same row, the results showed that highest salinity was found at 50 cm away from the emitter and 30-60 cm depth. Meanwhile, the lowest salinity level was recorded at 0-30 cm depth. Similar results were recorded by Bucks *et al.* [58] and Salih [59] on grapevine. They found that the highest salinity values were located at 30-60 cm depth and 0-50 cm from the emitter. As regards to the effect of humic acid, Uni-sal, magnetic iron and inoculation with AM fungi, it is clear that with all applied treatments, salinity decreased at 0-30 cm and 30-60 cm depth and 50 cm away from the emitter. Also, the best results were gained from the application of humic acid and Uni-sal followed by magnetic iron; and AM treatment come next in this respect. The effect on salinity decreasing was associated with increasing rate of humic acid, Uni-sal and magnetic iron application. Salinity was estimated three times in the soil during the two seasons under investigation. Hence, it can be noticed from Figs. 1 and 2 that salinity decreased gradually at beginning of growth, fruit set and after harvest. In addition, it is obvious that there were differences between all treatments under study. However, Uni-sal and humic acid gave the lowest EC being almost horizontally, as well as, vertically at direction in comparison with other treatments. Under saline conditions and untreated with such treatments showed the highest EC. It is important to mention that all levels of salinity recorded between rows

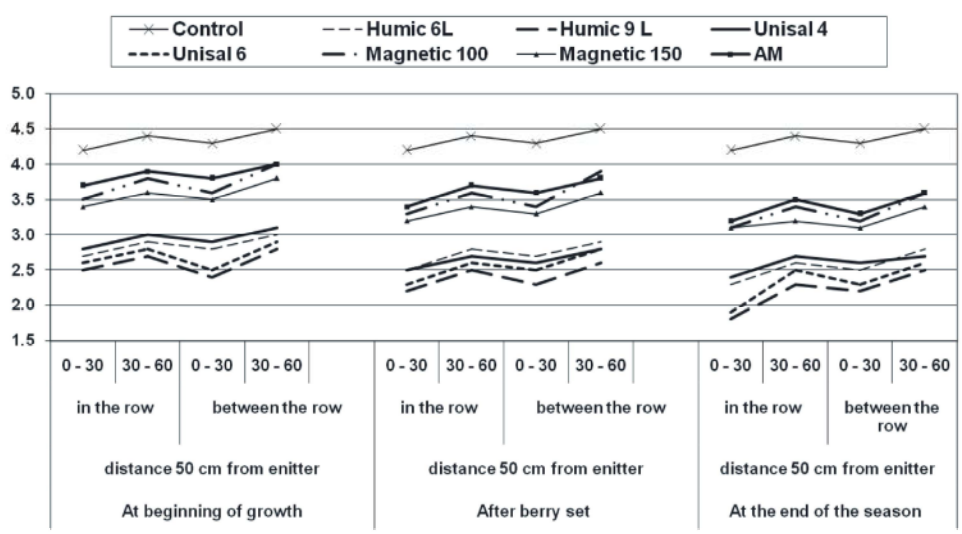

Fig. 1: Influnce of Humic acid, Unisal, Magnetic Iron and inoculation with arbuscular mycorrhiza (AM) on average values of salt distribution in the soil during first season

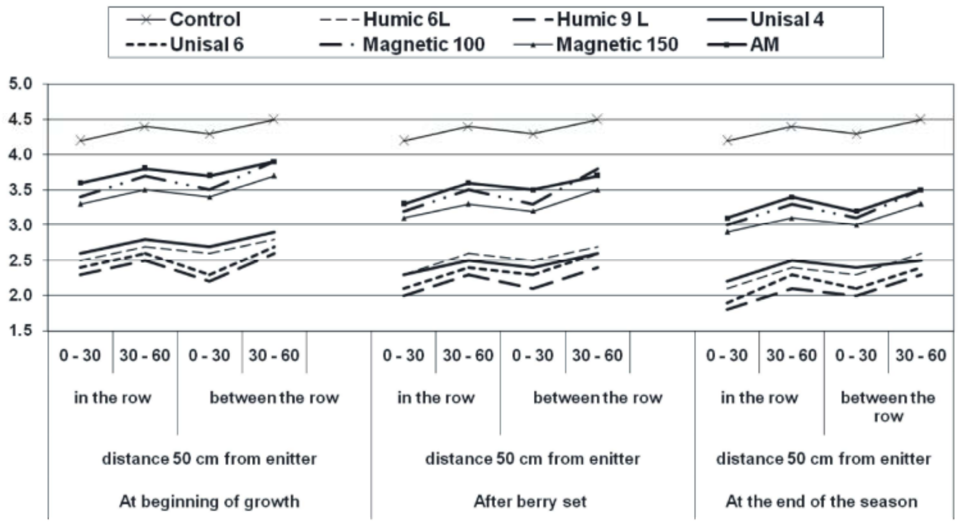

Fig. 2: Influnce of Humic acid, Unisal, magnetic Iron and inoculation with arbuscular mycorrhiza (AM) on average values od salt distribution in the soil during second season

or emitters on the same row were not considered as barriers to root growth. These findings can be interpreted as use humic acid treatment effectively decreased the deleterious effect due to salt accumulation in the soil [55]. Uni-sal enrichment with calcium might reduce sodium ion in soil by replacing sodium [25]. Magnetic iron applications increase ability of soil to get rid of salts [42] and Arbuscular mycorrhizal (AM) fungi capability of dissolving weakly soluble soil minerals by releasing acids [60].

Overall, it can be concluded that application of humic acid, Uni-sal, magnetic iron and AM have profoundly alleviated salinity effects and improved vine performance by increasing productivity and fruit quality as evidenced by application high rates of humic acid at 9litres /feddan and Uni-sal at 6litres/feddan.

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