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Impact of Magnetic Iron Applications and Foliar Spray of Some Antioxidants on Growth, and Productivity of "Flame seedless" Grapevines under Salt Affected Soil

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Abstract

This work was conducted during 2016 and 2017 growing seasons in a commercial vineyard located in Abo-Ghaleb El-Giza Governorate Egypt for evaluating the effect of magnetic iron, Salicylic acid (SA) and Ascorbic acid (AsA) on growth and productivity of "Flame seedless" (*Vitis vinifera* L.) grapevines. The vines had eight years old, grown in sandy soil under drip irrigation system and spaced at 2 x 3m in a row and between rows, respectively. Four magnetic iron levels (0, 150, 250 and 350g/vine) were applied as soil amendment once after winter pruning. Also, four foliar spray treatments (tap water, SA at 100, AsA at 150 and SA+ AsA at 100+ 150 mg/l, respectively) were applied two times (after fruit set and at veraison stage). The obtained results cleared that, the highest magnetic iron dose (350g/ vine) combined with the two antioxidants (SA+ AsA) was more effective in enhancing vine growth, yield and fruit quality parameters. Such combination treatment gave the highest significant values of growth characters in terms of leaf area, shoot length and leaf chlorophyll content as well as vine vigor parameters as internodes length, pruning's weight, the coefficient of wood ripening. Also, enhanced leaf nutrients content of N, P, K, Ca, Mg and Fe moreover, it was superior in reducing leaf Na, Cl and proline content. This combination treatment produced the highest yield/ vine, cluster weight, cluster length and best berries physical characters as berry diameter, length and volume as well as chemicals in terms of SSC%, SSC/acid ratio, anthocyanine pigments and reduced berry acidity. All magnetic iron applications were effective in reducing EC, pH and Sodium adsorption rate (SAR) of soil which partially elevate salinity hazer on vine growth and release more soil nutrients.

Keywords: Magnetic iron, Antioxidants, Salicylic acid, Ascorbic acid, Salinity and "Flame seedless".

Introduction

Grapes are one of the most important fruit crops in Egypt, due to the encouraging economic return both in domestic marketing and exporting. So, grapes areas were increased rapidly especially in newly reclaimed lands. The major problem of the newly reclaimed lands in Egypt is soil salinity, which occurred as a result of scarcity of water sources as known in arid and semi-arid regions for irrigation and leaching the excess salts from the plant root zone; also it could occur when poor quality water is used for irrigation. Salinity decreases grapevine growth and yield, due to osmotic stress, imbalance of nutrients uptake and ion toxicity **(Mittler, 2002 and Ennab, 2016).** The extension of grapes cultivation under the above-mentioned conditions is an incentive to carry out further researches for finding out some appropriate agricultural practices that promote growth and improving production under salt stress. In this respect, magnetic iron and antioxidants like Ascorbic acid and Salicylic acid can play an important role under these conditions.

Magnetized water is a technique which has become the attention of researchers as the physical way. It maintains a purity of the environment, easy to use and health safety. This technique makes some changes of water molecules when it passes through a magnetic field either through a magnetic tube or through magnetized iron particles as water electrical properties, elasticity, water surface tension, enhancing the capacity to dissolve salts, increasing the amount of oxygen dissolved in water, enhancing permeability and accelerate the soil chemical reactions **(Dandan and Shi, 2013)**. These changes are enhancing water molecules energy and flowing. So, it affects on soil physical, chemical and biochemical properties **(Al-Jubouri and Hamza, 2006)**. Magnetized water prevents damaging some metals as, nickel and lead from uptake by plant roots **(Taia *et al*., 2007)**. Moreover, soil application of magnetic iron increased soil macro and micronutrients this reflected increasing tree height, fresh and dry weight of pear leaves **(Osman *et al*., 2014)**. Magnetic iron was very effective in stimulating vegetative growth parameters of "Thompson seedless" as main shoot length, wood ripening and total leaf area/vine, also enhanced leaf nutrients N, P, K, Mg, Ca and Fe percentages and increased Yield and different berries quality parameters, however it reduced leaves chloride, proline and sodium contents **(Ali *et al*., 2013)**.

Antioxidants play an important role in improves salinity stress resistance in several plant species **(Khan *et al*., 2012)**. Ascorbic acid (AsA) is an important plant antioxidant; it is synthesized in higher plants mainly throughout the conversion of d-glucose to Ascorbic acid **(Foyer and Noctor, 2005)**.

It has an essential job in numerous physiological processes of plants as differentiation, growth, and metabolism. Moreover, AsA has fixed free radicals which produced as a result of plant metabolism, thus enhancing plant resistance mitigate stresses **(Shalata and Neumann, 2001)**. Exogenously applied of AsA was generally effective mitigating the negative effects of salt stress on leaf photosynthetic rate and membrane integrity through stimulating action on these parameters, it was more clear in plants under moderate and low salinity stress **(Hamada and Al-Hakimi, 2009)**. So, it can be used like growth regulator for improving the resistance of numerous plant species to salinity stress, enhancing growth and cluster quality of "Thompson seedless" grape **(Wassel *et al.,* 2007)** and "Flame seedless" grapevine **(Elsayed *et al.,* 2000)**.

Salicylic acid (SA) can be considered as an endogenous plant hormone where it has cleared an intermediate with the biosynthesis action of cytokinins and IBA. So it plays an essential role in plant growth **(Josephe *et al.,* 2010)**. SA is classified as a growth promoter since it enhancing plant growth, development and plant vigor under abiotic (drought, salinity and deficit irrigation) stresses **(Hayat *et al.,* 2010)**. External application of Salicylic acid with different methods (seeds soaking, in the hydroponic solution, with irrigation, or foliar sprays) resulted in enhancing various plant species protect against abiotic stress through inducing tolerance mechanisms processes **(Horvath *et al.,* 2007)**, enhancing, yield and berries quality of some grapevine cvs. **(El-Kady 2011, El-Hanafy 2011** and **Ahmed *et al.,* 2014)**. SA prevents fruit softening by affecting activities of major cell wall degrading enzyme such as cellulase, polygalacturonase and xylanase **(Wang *et al.,* 2015)**. Foliar application of salicylic acid at (100 and 150) mg/ l improved cluster weight, berries weight, juice volume, total chlorophyll content, N.P.K of leaves, T.S.S, acidity and total phenols of (Bez El-Naka) grapevine cultivar **(Abdel-Salam, 2016)**.

Therefore, the purpose of this study is evaluating the potential effects of magnetic iron and some antioxidants to mitigate the stress occur on vines growth, yield and fruit quality of "Flame seedless" grapevine grown in salt-affected soil.

Materials and Methods

This work was conducted during 2016 and 2017 seasons on 8-year-old own-rooted "Flame Seedless" (*Vitis vinifera* L.) grapevines. Vines were planted in sandy soil and spaced at 2 ×3 m in a row and between rows, respectively in a commercial orchard located in Abo Ghalib El-Giza Governorate Egypt. The vine bud load was adjusted to 60 buds/ vine during winter pruning (Last week of December). Spur pruning with Gable supporting trellis systems was used. Drip irrigation system with two laterals line per row and two emitters per vine (4L/h). The selected vines were uniform in vigor as possible and received the normal agricultural practices as recommended by agriculture ministry. The tested factors were arranged in split plot experiment as follow:

Main plots were arranged for four magnetic iron applications as:

M_0= Magnetic iron at 0 (control).

M_1= Magnetic iron at 150 g/ vine.

M_2= Magnetic iron at 250 g/ vine.

M_3= Magnetic iron at 350 g/ vine.

Sub plots were assigned by three antioxidants foliar sprays in addition to control:

S_0= Tap water (control).

S_1= Ascorbic acid (AsA) at 150 mg/l.

S_2= Salicylic acid (SA) at 100 mg/l.

S_3= (AsA) + (SA) at 150 and 100 mg/l, respectively.

The combinations between main and sub plots resulted in sixteen treatments (4 magnetic iron levels x 4 foliar spray treatments) each treatment replicated three times with two vines in each replicate. The soil magnetic iron applications were conducted after winter pruning (Last week of December of both seasons). However, foliar spray treatments were applied two times (one week later of berry set and at veraison). The surfactant Tritan B at 0.05% was used.

The following data were recorded

1. Vegetative growth and vine vigor parameters

Leaf area cm^2 was measured in five mature leaves per vine (leaves of 5-7th position from the top of shoots) that collected after reach to maximum expended. It measured using leaf area meter, Chlorophyll a, b and total Chlorophyll contents were determined in five mature leaves opposite to basal cluster at the 1st week of May of both seasons then determined according to **Wettstein (1957)** and expressed as mg/100g of fresh weight. Leaf proline content was determined using the same leaves and estimated using the acid ninhydrin method described by **Bates, *et al.* (1973)**. shoot length (cm) was measured in six shoots/ vine at the end of both growing seasons (when shoot apex becomes smaller, internodes being very short and leaves of top shoots seems smaller in size with yellowish color).

Internodes diameter and length (mm) of three basal internodes of six shoots/ vine were measured using vernier caliper tool at the dormant period after each growing season. Pruning weight (Kg) per vine was recorded at the winter pruning time of both seasons. Also, Wood ripening coefficient was measured at the end of the growing season by dividing the ripened part length of shoot (changing its color from greenish to brownish) by total shoot length according to **Bouard (1966)** as the following equation:

Wood ripening coefficient =

$$\frac{\text{The length of ripened part per shoot}}{\text{Total length of shoot}}$$

2. Leaf nutrients content

Five mature leaves opposite to cluster were collected and leaf nutrients were determinate in leaf dry samples as: N% using the modified micro-Kjeldahl apparatus as recommended by **Pregl (1945)**, P% using colorimetrically method according to **Snell and Snell (1967)**, K% by flame photometrically method according to **Jackson (1973)**. The percentages of Mg, Ca, Cl and Na, as well as Fe (ppm) were measured according to **Wilde *et al.* (1985)**.

3. Yield and cluster characteristics

The harvesting time was done when berry juice SSC reached about 16% as recommended by **Weaver (1976)**. At harvest date, clusters number/ vine were counted and four clusters/ vine were taken randomly for determination the average cluster weight (g) and cluster length. Yield/ vine were calculated using cluster weight (g) multiplied by clusters number and expressed as kg/vine.

4. **Berries physical and chemical quality parameters**

Berries diameter and length (mm) were measured in ten berries using digital vernier clipper. Also, berry volume was measured using the water displacement method. Berries chemical quality parameters as soluble solids contents (SSC %) was determined by handy refractometer and juice titratable acidity (%) was measured as mg of tartaric acid using NaOH (0.1N) in 100 ml of juice **(A.O.A.C., 1995)**. SSC: acid ratio was calculated. Moreover, anthocynin pigments of berries were measured according to **Hsia *et al.*, (1965)** and expressed as mg/100g of fruits.

5. Soil chemical properties

Soil and irrigation water characters were measured before the experiment in each season as shown in Tables (1and 2). Soil samples were collected from 0-30 and 30-60 cm depth and at 50 cm from the emitters in a row and also between rows distances. Electrical conductivity (EC) was determined two times/ season (after berry set and at the end of the growing season) in 1: 5 soil water extraction using electrical conductivity apparatus. The soil reaction (pH) values were measured in 1:2.5 soils to water suspensions, respectively**.** Soil soluble Cations (Ca^{++}, Mg^{++}, Na^{+}, K^{+}) and Anions (CO_3^{--}, HCO_3^{-}, Cl^{-}) were determined as meq/ L in the same extract of EC**.** However, SO_4^{--} was calculated by the difference between total Cations and Anions. Soil available nitrogen as well as the above soil properties was measured according to **Knudsen *et al.*, (1982)**. Also, available potassium was extracted using 1N ammonium acetate at pH 7 and measured by using flame photometrical method and phosphorus was extracted by 0.5N sodium bicarbonate and calorimetrically measured according to **Knudsen *et al.*, (1982)**. Also Sodium adsorption ratio (SAR) was calculated according to the following equation:

$$\text{SAR}=\frac{Na^{+}(meq/L)}{\sqrt{(Ca^{++}+Mg^{++})/2}}$$

Where: Na^{+}, Ca^{++} and Mg^{++} are soil soluble sodium, calcium and magnesium as meq/L, respectively.

Statistical analysis

The obtained data were statistical analysis as the complete randomized block design with two factors according to **Snedecor and Cochran (1980)** using M-statc computer software. Treatments means were compared using Duncan's multiple ranges tests according to **Duncan (1955)**.

Table 1. Mean values of some soil properties of the experimental site as an average of the two growing seasons**.**

Properties	Values		Properties	Values	
Depth (cm)	0 - 30	30 - 60	Depth (cm)	0 - 30	30 - 60
Sand (%)	90.42	91.24	EC (dS m^{-1}) 1:5 ext.	4.30	4.61
Silt (%)	3.75	3.11	SAR	3.46	5.21
Clay (%)	5.83	5.65	Soluble Ca^{++} (meq/L)	15.13	12.91
Texture	Sandy soil		Soluble Mg^{++} (meq/L)	13.79	4.81
pH in 1:2.5 suspension	8.40	8.61	Soluble Na^{+} (meq/L)	13.13	12.62
Soil organic (%)	0.43	0.38	Soluble K^{+} (meq/L)	1.83	1.64
Available N (ppm)	12.35	10.45	Soluble CO_3^{--} (meq/L)	--	--
Available P (ppm)	4.81	4.04	Soluble HCO_3^{-} (meq/L)	8.62	9.22
Available Fe (ppm)	2.95	3.21	Soluble Cl^{-} (meq/L)	19.87	22.30
Available Mn (ppm)	1.30	1.39	Soluble $SO4^{--}$ (meq/L)	15.39	15.63
Available Zn (ppm)	1.15	1.23			

Table 2. Some chemical properties of irrigation water

			Cations (meq/L)					Anions (meq/L)		
EC (dS/m)	SAR	pH	Ca^{++}	Mg^{++}	Na^{++}	K^{+}	$CO3^{-}$	$HCO3^{-}$	Cl^{-}	$SO4^{--}$
1.40	2.32	7.50	6.82	2.48	5.03	0.21	--	2.33	6.58	5.60

Results and Discussion

1. Vegetative growth and vine vigor parameters

1.1. Leaf area, shoot length and Wood ripening coefficient

Data of Table (3) showed that all magnetic iron (M_1, M_2 and M_3) treatments enhanced the vegetative growth parameters in terms of leaf area, shoot length and wood ripening coefficient of "Flame seedless" grapevines. The improvement of these characters was in ascending degree with the magnetic iron application since the vines received magnetic iron at M_3 level showed the highest values of these characters followed by vines that treated with M_2 and M_1, respectively, however the lowest value was obtained with control during the two study seasons.

Table 3. Effect of magnetic iron and antioxidants applications on leaf area, shoot length and wood ripening coefficient of "Flame seedless" grapevine during 2016 and 2017 seasons

Treatments		Leaf area (cm^2) 2016	Leaf area (cm^2) 2017	Shoot length (cm) 2016	Shoot length (cm) 2017	Wood ripening coefficient 2016	Wood ripening coefficient 2017
M_0		97.65 ^{d}	118.60 ^{c}	76.03 ^{d}	87.18 ^{d}	0.51 ^{c}	0.56 ^{c}
M_1		125.18 ^{b}	122.10 ^{c}	110.39 ^{c}	125.84 ^{c}	0.60 ^{b}	0.66 ^{b}
M_2		129.08 ^{b}	142.58 ^{b}	121.36 ^{b}	137.18 ^{b}	0.67 ^{b}	0.70 ^{ab}
M_3		138.00 ^{a}	149.70 ^{a}	137.09 ^{a}	147.25 ^{a}	0.76 ^{a}	0.73 ^{a}
S_0		105.58 ^{d}	111.03 ^{d}	95.45 ^{d}	108.11 ^{d}	0.55 ^{c}	0.56 ^{c}
S_1		116.18 ^{c}	130.45 ^{c}	104.75 ^{c}	118.74 ^{c}	0.60 ^{bc}	0.63 ^{b}
S_2		129.48 ^{b}	141.38 ^{b}	116.98 ^{b}	131.20 ^{b}	0.66 ^{b}	0.70 ^{ab}
S_3		138.68 ^{a}	150.13 ^{a}	127.69 ^{a}	139.40 ^{a}	0.73 ^{a}	0.76 ^{a}
M_0	S_0	81.30 ^{k}	95.20 ^{l}	65.35 ^{I}	71.55 ^{l}	0.41 ^{h}	0.47 ^{g}
	S_1	90.00 ^{j}	112.30 ^{j}	75.55 ^{h}	81.20 ^{k}	0.46 ^{gh}	0.51 ^{fg}
	S_2	103.00 ^{i}	127.30 ^{h}	75.75 ^{h}	93.33 ^{j}	0.54 ^{efg}	0.59 $^{d-g}$
	S_3	116.30 ^{g}	139.60 ^{e}	87.45 ^{g}	102.64 ^{i}	0.61 $^{c-f}$	0.66 $^{b-e}$
M_1	S_0	104.70 ^{i}	100.30 ^{k}	95.44 ^{f}	109.83 ^{h}	0.51 ^{fgh}	0.54 ^{efg}
	S_1	122.00 ^{f}	116.60 ^{i}	105.55 ^{e}	120.65 ^{g}	0.57 $^{d-g}$	0.64 ^{cde}
	S_2	133.30 ^{de}	131.20 ^{g}	115.22 ^{d}	135.63 ^{e}	0.62 $^{c-f}$	0.69 ^{bcd}
	S_3	140.70 ^{c}	140.30 ^{e}	125.35 ^{c}	137.25 ^{e}	0.71 ^{bc}	0.75 ^{abc}
M_2	S_0	113.30 ^{h}	113.30 ^{j}	103.55 ^{e}	119.50 ^{g}	0.61 $^{c-f}$	0.59 $^{d-g}$
	S_1	120.70 ^{f}	145.30 ^{e}	112.33 ^{d}	131.97 ^{f}	0.65 ^{cde}	0.67 ^{bcd}
	S_2	135.30 ^{d}	151.40 ^{d}	127.33 ^{c}	143.97 ^{c}	0.69 ^{bcd}	0.75 ^{abc}
	S_3	147.00 ^{b}	160.30 ^{b}	142.22 ^{b}	153.27 ^{b}	0.74 ^{abc}	0.79 ^{ab}
M_3	S_0	123.00 ^{f}	135.30 ^{f}	117.44 ^{d}	131.57 ^{f}	0.68 ^{bcd}	0.63 $^{c-f}$
	S_1	132.00 ^{e}	147.60 ^{c}	125.55 ^{c}	141.13 ^{d}	0.72 ^{abc}	0.70 $^{a-d}$
	S_2	146.30 ^{b}	155.60 ^{b}	149.63 ^{a}	151.85 ^{b}	0.78 ^{ab}	0.76 ^{abc}
	S_3	150.70 ^{a}	160.30 ^{a}	155.75 ^{a}	164.45 ^{a}	0.84 ^{a}	0.82 ^{a}

In a column under each category, numbers followed by the same litter had no significant difference at 0.05 levels by DMRT.
M_0, M_1, M_2 and M_3 = Magnetic iron applications at 0,150,250 and 350 g/vine, respectively. **S_0, S_1, S_2 and S_3** = Folia spray with tap water, Ascorbic acid (AsA) at 150 mg/ l, Salicylic acid (SA) at 100 mg/ l and AsA+ SA, respectively.

Concerning main effect of antioxidant treatments (S_1, S_2 and S_3), data cleared that, the combination between SA and AsA treatment (S_3) showed the highest values of leaf area, shoot length and wood ripening coefficient followed by foliar spray with SA at S_1 level, however control treatment (S_0) cleared the lowest values in both seasons.

Regarding interaction, data in Table (3) clearly showed that "Flame seedless" grape vines received M_3 + S_3 treatment cleared the highest significant values of these parameters as compared with other treatments. However, the lowest values were noticed with control (M_0 + S_0) vines, this trend was true during both seasons of the study. The enhancement effect of the magnetic iron application on vegetative growth could be reflected the positive effect on different soil chemical properties (EC, pH and SAR) and availability of macro and micro-nutrients which encourage the growth. Such results are in harmony with the findings of **Ashraf *et al.* (2013)** and **Aly *et al.* (2015)** they summarized that, irrigation with magnetic water stimulated vegetative growth parameters of Valencia Orange in terms of shoot length and total leaf area/ vine compared with nonmagnetic irrigation water. Moreover, **Gunes *et al.* (2008)** and **Ahmed *et al.* (2014)** they concluded that, SA applications significantly stimulated the leaf area, main shoot length, and the number of leaves per shoot of "Superior" grapevines under hot climates condition.

1.2. Internodes diameter, length and pruning weight

Data in Table (4) clear that, application of magnetic iron increased internodes diameter, length and pruning weight as compared to nonmagnetic treatment in both seasons. The highest significant values of these attributes were produced by vines that received M_3 as compared with the others and control (M_0).

Regarding anti-oxidant foliar spray treatments S_1, S_2 and S_3 were upper hands significantly over the control (S_0), the combination treatment (S_3) had a marked superiority over other foliar spray treatments of internodes length and pruning weight parameters; however internodes diameter data showed that vines treated with S_2 and S_3 recorded the highest values without significant differences between them in both seasons.

The interaction data presented in Table (4) cleared that, Flame seedless vines treated by the combination (M_3 +S_3) showed the highest significant increase in internodes length and pruning's weight in both seasons. However, vines treated with combinations of M_3 +S_2 and M_3 +S_3 treatments cleared the highest internodes diameter without significant differences between them in both seasons. The lowest values of all these parameters were obtained with the control vines during the two seasons.

The positive effect of treatments on vine vigor characters can be considered as a result of enhancing different growth parameters as showed previously, which increased carbohydrates accumulation during growing seasons that enhanced vine vigor.

The interaction results were in harmony with the findings of **Abd El-All *et al.* (2013)**, **Ahmed *et al.* (2014)** and **Xiao-Feng and Bo (2008)** they reported that by transitory of water through a magnetic field, water structure molecule is converted to a simple structure.

Table 4. Effect of magnetic iron and antioxidants applications on vine vigor parameters of "Flame seedless" grapevine during 2016 and 2017 seasons

Treatments		Internodes diameter (cm)		Internodes length (cm)		Pruning weight (Kg)	
		2016	2017	2016	2017	2016	2017
M_0		1.51 c	1.49 d	6.96 d	7.89 d	2.10 d	1.93 d
M_1		1.60 b	1.69 c	7.62 c	8.87 c	2.35 c	2.54 c
M_2		1.63 b	1.84 b	8.24 b	9.82 b	3.05 b	2.86 b
M_3		1.98 a	2.23 a	9.42 a	10.29 a	3.54 a	3.35 a
S_0		1.33 c	1.36 c	7.24 d	8.50 d	2.45 b	2.26 c
S_1		1.61 b	1.69 b	7.78 c	9.02 c	2.72 ab	2.53 b
S_2		1.82 a	2.01a	8.29 b	9.39 b	2.85 ab	2.78 b
S_3		1.95 a	2.19 a	8. 92 a	9.96 a	3.03 a	3.12 a
M_0	S_0	1.23 g	1.14 h	6.32 i	7.25 i	1.92 h	1.20 h
	S_1	1.42 efg	1.23 gh	6.63 i	7.86 h	2.09 gh	1.72 g
	S_2	1.64 cde	1.74 de	7.24 gh	8.14gh	2.18 gh	2.33 ef
	S_3	1.75 bcd	1.85 de	7.65 fg	8.32 fgh	2.20 gh	2.47 def
M_1	S_0	1.32 fg	1.23 gh	6.76 hi	7.86 h	2.17 gh	2.17 f
	S_1	1.54 def	1.45 fg	7.54 fg	8.54 fg	2.31 fg	2.47 def
	S_2	1.70 bcd	1.84 de	7.84 ef	8.83 ef	2.40 fg	2.53 de
	S_3	1.82 bc	2.23 b	8.33 de	10.24 abc	2.53 f	2.97 bc
M_2	S_0	1.23 g	1.43 fg	7.24 gh	9.16 de	2.60 f	2.53 de
	S_1	1.64 cde	1.85 de	7.92 ef	9.47 d	3.02 e	2.77 cd
	S_2	1.72 bcd	1.92 cd	8.54 cd	10.15 bc	3.15 cde	2.97 bc
	S_3	1.91 b	2.15 bc	9.25 b	10.50 ab	3.42 bcd	3.17 b
M_3	S_0	1.54 def	1.62 ef	8.65 cd	9.72 cd	3.12 de	3.12 b
	S_1	1.83 bc	2.22 b	9.03 bc	10.21 abc	3.45 bc	3.17 b
	S_2	2.22 a	2.53 a	9.54 b	10.45 ab	3.65 b	3.27 b
	S_3	2.33 a	2.54 a	10.45 a	10.76 a	3.95 a	3.85 a

In a column under each category, numbers followed by the same litter had no significant difference at 0.05 levels by DMRT.

M_0, M_1, M_2 and M_3 = Magnetic iron applications at 0,150,250 and 350 g/vine, respectively. **S_0, S_1, S_2 and S_3** = Folia spray with tap water, Ascorbic acid (AsA) at 150 mg/ l, Salicylic acid (SA) at 100 mg/ l and AsA+ SA, respectively.

The water surface tension force is reduced and freedom of action, fluidity and increased wetting properties of the water molecules. So, the plants could absorb the magnetic water easily as compared with non-magnetic water which led to increased growth and productivity of vines through improving nutrient absorption and increase solubility of minerals in rhizosphere. Also, **Ali *et al.* (2013)** and **Khamis *et al.* (2016)** they reported that, magnetic iron application resulted in a significant increment in different growth parameters such as stem diameter, number of lateral shoots, number of leaves of two grapevine cultivars, "Crimson seedless" and "Superior". Moreover, **Gunes *et al.* (2008)** and **Ahmed *et al.* (2014)** they concluded that, SA applications significantly stimulated wood ripening coefficient, pruning's weight and cane thickness of "Superior "grapevines under hot climates over the check treatment.

2. Leaf chlorophyll content

Data of Table (5) showed that, "Flame seedless" vines treated with M_3 of magnetic levels showed the highest values of chlorophyll a, b and total content followed in deciding order by vines treated with M_2, and M_1, respectively. However, the lowest value was obtained with the control vines in booth seasons.

Concerning antioxidants, data of Table (5) cleared that, the combination between SA and AsA treatment (S_3) two times (after fruit set and at veraison) showed the highest values of chlorophyll a, b and total content followed S_1 foliar application, however control (S_0) treatment cleared the lowest values in both seasons.

Regarding interaction, data of the same Table (5) clearly showed that, "Flame seedless" grapevines received M_3 plus S_3 cleared the highest significant values of chlorophyll a, b and total chlorophyll content as compared with others however, the lowest value was noticed with control (S_0) vines, this trend was true during both seasons of the study. These results are in line with those of **Ashraf *et al.* (2013), Aly *et al.* (2015)** and **Taimourya et al. (2017)** summarized that, magnetic irrigation water increased leaf chlorophyll content of some horticultural crops compared with nonmagnetic irrigation water. The enhancement of chlorophyll pigments may due to the positive effect of magnetic iron on availability of soil mineral nutrients as N, Mg, etc. and elevation of salinity stress as previously mentioned.

Table 5. Effect of magnetic iron and antioxidants applications on leaf chlorophyll content and leaf proline content of "Flame seedless" grapevine during 2016 and 2017 seasons

Treatments		Chlorophyll (mg/100g FW)						Leaf proline content (mg/100g FW)	
		a		b		Total			
		2016	2017	2016	2017	2016	2017	2016	2017
M_0		14.35 ^{d}	15.04 ^{d}	3.57 ^{d}	4.26 ^{c}	17.92 ^{d}	19.30 ^{b}	3.88 ^{a}	3.58 ^{a}
M_1		15.03 ^{c}	15.83 ^{c}	4.00 ^{c}	4.49 ^{bc}	19.03 ^{c}	20.32 ^{ab}	3.35 ^{b}	3.37 ^{b}
M_2		15.56 ^{b}	16.15 ^{b}	4.49 ^{b}	4.77 ^{b}	20.05 ^{b}	20.92 ^{ab}	2.16 ^{c}	1.97 ^{c}
M_3		15.95 ^{a}	16.69 ^{a}	4.99 ^{a}	5.35 ^{a}	20.94 ^{a}	22.05 ^{a}	1.38 ^{d}	1.31 ^{d}
S_0		13.85 ^{d}	15.21 ^{d}	3.30 ^{d}	3.57 ^{d}	17.15 ^{d}	18.78 ^{d}	3.28 ^{a}	3.12 ^{a}
S_1		15.16 ^{c}	15.77 ^{c}	3.99 ^{c}	4.29 ^{c}	19.15 ^{c}	20.05 ^{c}	2.77 ^{b}	2.57 ^{b}
S_2		15.66 ^{b}	16.16 ^{b}	4.57 ^{b}	5.07 ^{b}	20.23 ^{b}	21.23 ^{b}	2.47 ^{bc}	2.42 ^{bc}
S_3		16.21 ^{a}	16.58 ^{a}	5.19 ^{a}	5.95 ^{a}	21.40 ^{a}	22.53 ^{a}	2.24 ^{c}	2.11 ^{c}
M_0	S_0	12.75 ^{h}	14.44 ^{g}	2.75 ^{g}	3.30 ^{j}	15.50 ^{j}	17.74 ^{j}	4.57 ^{a}	4.12 ^{a}
	S_1	14.55 ^{ef}	14.81 ^{gf}	3.33 ^{f}	3.74 ^{i}	17.88 ^{h}	18.55 ^{i}	4.15 ^{b}	3.71 ^{bc}
	S_2	14.75 ^{e}	15.22 ^{ef}	3.85 ^{e}	4.48 ^{eg}	18.60 ^{g}	19.70 ^{g}	3.58 ^{c}	3.39 ^{cd}
	S_3	15.33 ^{d}	15.69 ^{de}	4.33 ^{d}	5.53 ^{c}	19.66 ^{f}	21.22 ^{d}	3.20 ^{d}	3.08 ^{d}
M_1	S_0	13.55 ^{g}	15.06 ^{ef}	3.15 ^{f}	3.36 ^{j}	16.70 ^{i}	18.42 ^{i}	3.72 ^{c}	3.81 ^{ab}
	S_1	14.80 ^{e}	15.62 ^{de}	3.75 ^{e}	4.39 ^{fg}	18.55 ^{g}	20.01 ^{fg}	3.41 ^{cd}	3.39 ^{cd}
	S_2	15.55 ^{cd}	16.12 ^{cd}	4.33 ^{d}	4.58 ^{ef}	19.88 ^{ef}	20.70 ^{e}	3.19 ^{d}	3.27 ^{d}
	S_3	16.20 ^{b}	16.52 ^{bc}	4.75 ^{c}	5.61 ^{g}	20.95 ^{c}	22.13 ^{c}	3.06 ^{d}	3.00 ^{d}
M_2	S_0	14.33 ^{f}	15.23 ^{ef}	3.55 ^{ef}	3.99 ^{hi}	17.88 ^{h}	19.22 ^{h}	2.68 ^{e}	2.29 ^{e}
	S_1	15.55 ^{cd}	16.07 ^{cd}	4.33 ^{d}	4.18 ^{gh}	19.88 ^{ef}	20.25 ^{ef}	2.26 ^{f}	2.15 ^{e}
	S_2	15.80 ^{c}	16.47 ^{bc}	4.75 ^{c}	5.14 ^{d}	20.55 ^{cd}	21.61 ^{d}	2.04 ^{f}	2.00 ^{e}
	S_3	16.55 ^{a}b	16.82 ^{ab}	5.33 ^{b}	7.77 ^{bc}	21.88 ^{b}	22.59 ^{k}	1.64 ^{g}	1.43 ^{f}
M_3	S_0	14.75 ^{e}	16.12 ^{cd}	3.75 ^{e}	3.62 ^{ij}	18.50 ^{g}	19.74 ^{g}	2.16 ^{f}	2.25 ^{e}
	S_1	15.75 ^{c}	16.56 ^{bc}	4.55 ^{cd}	4.83 ^{de}	20.30 ^{de}	21.39 ^{d}	1.25 ^{h}	1.03 ^{g}
	S_2	16.55 ^{ab}	16.81 ^{ab}	5.33 ^{b}	6.09 ^{b}	21.88 ^{b}	22.90 ^{b}	1.05 ^{h}	1.02 ^{g}
	S_3	16.75 ^{a}	17.28 ^{a}	6.33 ^{a}	6.88 ^{a}	23.08 ^{a}	24.16 ^{a}	1.04 ^{h}	0.92 ^{g}

In a column under each category, numbers followed by the same litter had no significant difference at 0.05 levels by DMRT.
M_0, M_1, M_2 and M_3 = Magnetic iron applications at 0,150,250 and 350 g/vine, respectively. **S_0, S_1, S_2 and S_3** = Folia spray with tap water, Ascorbic acid (AsA) at 150 mg/ l, Salicylic acid (SA) at 100 mg/ l and AsA+ SA, respectively.

3. Leaf proline content

Data of Table (5) showed that magnetic iron applications (M_1, M_2 and M_3) and antioxidants (S_1, S_2 and S_3) foliar applications reduced leaf proline content as compared to control. Leaf proline content was reduced as magnetic iron application rate increased since the lowest value was obtained with the highest magnetic application level (M_3) however, control vines showed the highest values in both seasons.

Moreover, the data of antioxidant treatments cleared that, leaf proline content was severely affected by antioxidant treatments, since the lowest concentration noticed with the mix between SA and AsA (S_3) treatment however, the highest value was observed with control during both seasons.

Regarding interaction, data in Table (5) showed that, leaf proline concentration are affected by the combination between magnetic iron application and antioxidant substances, where the lowest values were noticed with M_3 companies with all antioxidants (S_1, S_2 and S_3) treatments without significant differences among them however, the maximum values were recorded with control vines (M_0 + S_0) in both seasons. The positive effect of treatments on the availability of soil water, mineral nutrients were effective in reducing leaf proline content. Moreover, the main role of antioxidants (SA and AsA) in mitigates the environmental stress as soil salinity, drought, etc. are discussed by several articles **(Kassem *et al.*, 2011; Abdel-Salam, 2016; EL-Sayed, 2014 and Abobatta, 2015).**

4. Leaf nutrients content

Data presented in Table (6 and 7) show that, all magnetic iron treatments enhanced the nutritional status of "Flame seedless" grapevines as compared with control. Improvements in leaf nutrition status are directly proportional to magnetic iron concentration, where, magnetic iron application at 350g/vine (M_3) showed the highest significant values of leaf nutrients lick N, P, K, Ca, Mg and Fe, however it reduced leaf Na and Cl to the lowest values as compared with the other treatments during both seasons of the study.

Table 6. Effect of magnetic iron and antioxidants applications on leaf nutrients content of "Flame seedless" grapevine during 2016 and 2017 seasons

Treatments		N %		P %		K %		Ca %	
		2016	2017	2016	2017	2016	2017	2016	2017
M_0		1.61 ^{c}	1.68 ^{c}	0.29 ^{c}	0.25 ^{b}	1.28 ^{b}	1.30 ^{c}	1.83 ^{c}	1.92 ^{c}
M_1		1.67 ^{bc}	1.72 ^{bc}	0.36 ^{ab}	0.31 ^{ab}	1.38 ^{ab}	1.43 ^{bc}	2.11 ^{b}	2.07 ^{bc}
M_2		1.78 ^{b}	1.82 ^{b}	0.43 ^{ab}	0.34 ^{ab}	1.45 ^{ab}	1.54 ^{ab}	2.30 ^{ab}	2.22 ^{b}
M_3		2.12 ^{a}	2.26 ^{a}	0.56 ^{a}	0.49 ^{a}	1.53 ^{a}	1.70 ^{a}	2.53 ^{a}	2.52 ^{a}
S_0		1.52 ^{c}	1.55 ^{d}	0.34 ^{b}	0.28 ^{b}	1.28 ^{b}	1.35 ^{b}	1.76 ^{c}	1.82 ^{c}
S_1		1.76 ^{b}	1.78 ^{c}	0.38 ^{ab}	0.35 ^{ab}	1.38 ^{ab}	1.48 ^{ab}	2.19 ^{b}	2.13 ^{b}
S_2		1.90 ^{a}	1.95 ^{b}	0.46 ^{a}	0.36 ^{ab}	1.46 ^{ab}	1.54 ^{ab}	2.33 ^{ab}	2.38 ^{ab}
S_3		2.00 ^{a}	2.19 ^{a}	0.47 ^{a}	0.41 ^{a}	1.51 ^{a}	1.61 ^{a}	2.49 ^{a}	2.45 ^{a}
M_0	S_0	1.21 ^{h}	1.35 ^{h}	0.20 ^{e}	0.19 ^{c}	1.16 ^{f}	1.10 ^{i}	1.42 ^{f}	1.55 ^{d}
	S_1	1.57 ^{fg}	1.62 ^{f}	0.26 ^{de}	0.24 ^{bc}	1.21 ^{ef}	1.27 ^{h}	1.70 ^{e}	1.77 ^{cd}
	S_2	1.77 ^{de}	1.82 ^{de}	0.30 ^{cde}	0.26 ^{bc}	1.33 $^{c-f}$	1.37 ^{fgh}	1.89 ^{de}	2.05 ^{bc}
	S_3	1.87 ^{cd}	1.93 ^{cd}	0.38 $^{a-e}$	0.32 ^{bc}	1.41 $^{a-d}$	1.44 $^{c-h}$	2.30 ^{bd}	2.29 ^{ab}
M_1	S_0	1.43 ^{g}	1.48 ^{g}	0.30 ^{cde}	0.25 ^{bc}	1.22 ^{ef}	1.31 ^{gh}	1.62 ^{ef}	1.62 ^{cd}
	S_1	1.62 ^{fg}	1.58 ^{fg}	0.30 ^{cde}	0.30 ^{bc}	1.36 ^{b}e	1.38 $^{e-h}$	2.12 ^{cd}	1.85 ^{cd}
	S_2	1.76 ^{de}	1.82 ^{de}	0.42 $^{a-d}$	0.30 ^{bc}	1.45 $^{a-d}$	1.45 $^{c-g}$	2.28 ^{bc}	2.32 ^{ab}
	S_3	1.89 ^{cd}	1.98 ^{c}	0.42 $^{a-d}$	0.39 ^{ab}	1.48 ^{abc}	1.57 ^{bcd}	2.42 ^{ab}	2.50 ^{ab}
M_2	S_0	1.56 ^{fg}	1.59 ^{fg}	0.35 $^{b-e}$	0.30 ^{bc}	1.30 ^{def}	1.42 $^{d-h}$	1.87 ^{de}	1.77 ^{cd}
	S_1	1.73 ^{de}	1.68 ^{ef}	0.41 $^{a-d}$	0.32 ^{bc}	1.40 $^{a-d}$	1.50 $^{b-f}$	2.29 ^{bc}	2.32 ^{ab}
	S_2	1.84 ^{cd}	1.72 ^{ef}	0.48 ^{abc}	0.35 ^{abc}	1.52 ^{ab}	1.60 ^{abc}	2.46 ^{ab}	2.37 ^{ab}
	S_3	2.00 ^{bc}	2.30 ^{b}	0.50 ^{ab}	0.39 ^{ab}	1.52 ^{ab}	1.65 ^{ab}	2.56 ^{ab}	2.41 ^{ab}
M_3	S_0	1.88 ^{cd}	1.77 ^{e}	0.50 ^{ab}	0.37 ^{abc}	1.45 $^{a-d}$	1.55 $^{b-e}$	2.11 ^{cd}	2.32 ^{ab}
	S_1	2.12 ^{ab}	2.25 ^{b}	0.56 ^{a}	0.46 ^{a}	1.54 ^{a}	1.76 ^{a}	2.64 ^{a}	2.58 ^{a}
	S_2	2.23 ^{a}	2.45 ^{a}	0.57 ^{a}	0.46 ^{a}	1.55 ^{a}	1.74 ^{a}	2.67 ^{a}	2.59 ^{a}
	S_3	2.25 ^{a}	2.55 ^{a}	0.57 ^{a}	0.47 ^{a}	1.56 ^{a}	1.76 ^{a}	2.68 ^{a}	2.58 ^{a}

In a column under each category, numbers followed by the same litter had no significant difference at 0.05 levels by DMRT.
M_0, M_1, M_2 and M_3 = Magnetic iron applications at 0,150,250 and 350 g/vine, respectively. **S_0, S_1, S_2 and S_3** = Folia spray with tap water, Ascorbic acid (AsA) at 150 mg/ l, Salicylic acid (SA) at 100 mg/ l and AsA+ SA, respectively.

Also, antioxidant treatments (S_1, S_2 and S_3) were improved leaf nutrients in relative to the control treatment. Foliar application of the two antioxidants (S_3), as well as S_1 treatments, resulted in the highest significant values of leaf N and P without significant differences between them in the first season, but by the second one, the application of S_3 showed the highest values. Also, this combination (S_3) treatment cleared the highest significant leaf content of K, Ca, Mg and Fe in both seasons.

However, the lowest values were obtained with control treatment. On the other hand, vines sprayed by S_3 and S_2 showed the lowest significant values of leaf Na and Cl without significant differences between them and the highest values of these elements were cleared with control treatment in both seasons of the study.

The Interaction between the two tested factors (magnetic iron and antioxidants) improved leaf nutritional status as compared to control, especially the combination between the high level of magnetic iron (M_3) and both salicylic acid and ascorbic acid. The combination ($M_3 + S_2$ and $M_3 + S_3$) treatments showed the highest percent of leaf N without significant differences between them. Moreover, all foliar spray treatments (S_1, S_2 and S_3) combined with magnetic iron at 350g/vine (M_3) cleared the highest leaf content of P, K, and Ca. However, the lowest values of these nutrients were found with control. This trend was true during both seasons. In the contrary, the above-mentioned combinations (M_3+ S_1, M_3+ S_2 and M_3+ S_3) treatments showed the lowest leaf Na and Cl contents as compared to the others, however the highest values was showed by control vines during both seasons. Also, the M_3+ S_3 treatment cleared the highest significant concentration of Mg and Fe of leaf as compared with the others. Control treatment showed the lowest values of these elements in both seasons. These results could be explained according to those of **Selim (2008)** and **Fathi *et al.* (2006)** they concluded that, magnetized water have a three main effects on soil: i) lowering soil pH, ii) increasing the leaching of excess soil soluble salts and iii) dissolving slightly soluble salts as phosphates, sulfates and carbonates. In this respect, **Taia *et al.* (2007)** and **Hilal *et al.* (2013)** stated that, magnetized water applied to salty soil breaks down the salt crystals twice as fast as non-magnetized water and allow the salts to be leached from soil resulted in enhancing plant growth through increasing N, P, K, Mg and Fe nutrients uptake. Also, decreased Na in leaves of broad bean plant **EL-Sayed (2014)** it may show the role of magnetic water in reducing the negative effects of salinity through solubilizing and leaching NaCl salt out of the root zone. Hence, the plants were not uptake higher amounts of either Na or Cl. Moreover, antioxidants as salicylic acid and ascorbic acid were very effective in stimulating chlorophyll, N, P, K, Ca, Mg and Fe percentages in "Flame seedless" and White banaty seedless grapevine leaves and increased total carbohydrates of the canes as showed by **Elsayed *et al.* (2000)** and **Wassel *et al.* (2007).** Also, foliar spray of SA strongly inhibited Na^+ and Cl^- accumulation, however stimulated N, Mn, Fe, Mg, and Cu concentrations in leaves of some fruit crops under salt stress conditions. These suggest that SA could be used as a growth regulator to enhancing plant resistance for salinity stress **(Gunes *et al.* 2008 & Ahmed and Mahdi, 2012)**.

Table 7. Effect of magnetic iron and antioxidants applications on leaf nutrients content of "Flame seedless" grapevine during 2016 and 2017 seasons

Treatments		Na %		Cl %		Mg %		Fe ppm	
		2016	2017	2016	2017	2016	2017	2016	2017
M_0		0.58 ^{a}	0.50 ^{a}	0.82 ^{a}	0.74 ^{a}	0.28 ^{c}	0.35 ^{c}	54.71 ^{d}	58.03 ^{d}
M_1		0.49 ^{ab}	0.39 ^{ab}	0.71 ^{ab}	0.60 ^{b}	0.43 ^{b}	0.40 ^{bc}	59.81 ^{c}	62.69 ^{c}
M_2		0.42 ^{bc}	0.32 ^{bc}	0.62 ^{b}	0.48 ^{b}	0.46 ^{b}	0.44 ^{b}	64.14 ^{b}	65.71 ^{b}
M_3		0.35 ^{c}	0.23 ^{c}	0.46 ^{c}	0.31 ^{c}	0.57 ^{a}	0.55 ^{a}	68.97 ^{a}	72.01 ^{a}
S_0		0.58 ^{a}	0.47 ^{a}	0.78 ^{a}	0.65 ^{a}	0.35 ^{b}	0.35 ^{b}	56.31 ^{d}	57.51 ^{d}
S_1		0.46 ^{b}	0.38 ^{b}	0.68 ^{ab}	0.57 ^{ab}	0.41 ^{ab}	0.46 ^{ab}	60.04 ^{c}	61.43 ^{c}
S_2		0.40 ^{c}	0.31 ^{c}	0.58 ^{b}	0.49 ^{b}	0.47 ^{ab}	0.45 ^{ab}	63.38 ^{b}	66.14 ^{b}
S_3		0.39 ^{c}	0.29 ^{c}	0.57 ^{b}	0.43 ^{b}	0.52 ^{a}	0.54 ^{a}	67.89 ^{a}	73.35 ^{a}
M_0	S_0	0.71 ^{a}	0.60 ^{a}	0.97 ^{a}	0.92 ^{a}	0.20 ^{g}	0.25 ^{f}	50.83 ^{i}	52.57 ^{i}
	S_1	0.59 ^{abc}	0.48 ^{abc}	0.85 ^{b}	0.81 ^{b}	0.25 ^{fg}	0.30 ^{ef}	53.32 ^{h}	54.68 ^{hi}
	S_2	0.50 ^{abc}	0.45 $^{a-d}$	0.73 ^{cd}	0.68 ^{c}	0.31 ^{efg}	0.38 $^{b-f}$	54.42 ^{h}	57.35 ^{g}
	S_3	0.50 ^{abc}	0.40 $^{a-d}$	0.71 ^{cd}	0.55 ^{ef}	0.36 $^{d-g}$	0.45 $^{b-e}$	60.27 ^{ef}	67.50 ^{d}
M_1	S_0	0.66 ^{ab}	0.55 ^{ab}	0.86 ^{b}	0.69 ^{c}	0.35 $^{d-g}$	0.35 ^{def}	54.58 ^{h}	56.46 ^{gh}
	S_1	0.52 ^{abc}	0.41 $^{a-d}$	0.75 ^{c}	0.63 ^{cd}	0.40 $^{c-f}$	0.38 $^{b-f}$	57.56 ^{g}	60.29 ^{f}
	S_2	0.40 ^{bc}	0.33 ^{bcd}	0.67 ^{de}	0.57 ^{de}	0.48 $^{b-e}$	0.41 $^{b-f}$	62.36 ^{e}	63.43 ^{e}
	S_3	0.37 ^{bc}	0.26 ^{cd}	0.64 ^{e}	0.50 ^{f}	0.50 $^{a-d}$	0.46 $^{b-e}$	64.73 ^{d}	70.57 ^{c}
M_2	S_0	0.53 ^{abc}	0.42 $^{a-d}$	0.72 ^{cd}	0.63 ^{cd}	0.37 $^{c-g}$	0.36 ^{def}	58.25 ^{fg}	57.58 ^{g}
	S_1	0.43 ^{abc}	0.32 ^{bcd}	0.68 ^{de}	0.51 ^{ef}	0.43 $^{b-e}$	0.37 $^{c-f}$	61.46 ^{e}	62.34 ^{ef}
	S_2	0.37 ^{bc}	0.26 ^{cd}	0.53 ^{f}	0.42 ^{g}	0.50 $^{a-d}$	0.45 $^{b-e}$	65.48 ^{d}	68.27 ^{d}
	S_3	0.38 ^{bc}	0.27 ^{cd}	0.54 ^{f}	0.35 ^{h}	0.55 ^{abc}	0.56 ^{ab}	71.35 ^{b}	74.63 ^{b}
M_3	S_0	0.41 ^{ab}	0.30 ^{bcd}	0.57 ^{f}	0.34 ^{h}	0.48 $^{b-e}$	0.43 $^{b-f}$	61.57 ^{e}	63.42 ^{e}
	S_1	0.31 ^{c}	0.20 ^{d}	0.43 ^{g}	0.31 ^{h}	0.55 ^{abc}	0.52 $^{a-d}$	67.82 ^{c}	68.41 ^{d}
	S_2	0.34 ^{c}	0.23 ^{d}	0.42 ^{g}	0.29 ^{h}	0.59 ^{ab}	0.55 ^{abc}	71.27 ^{b}	75.51 ^{b}
	S_3	0.33 ^{c}	0.22 ^{d}	0.43 ^{g}	0.30 ^{h}	0.66 ^{a}	0.68 ^{a}	75.21 ^{a}	80.71 ^{a}

In a column under each category, numbers followed by the same litter had no significant difference at 0.05 levels by DMRT.
M_0, M_1, M_2 and M_3 = Magnetic iron applications at 0,150,250 and 350 g/vine, respectively. **S_0, S_1, S_2 and S_3** = Folia spray with tap water, Ascorbic acid (AsA) at 150 mg/ l, Salicylic acid (SA) at 100 mg/ l and AsA+ SA, respectively.

5. Yield and cluster quality

Data established in Table (8) showed that, all magnetic iron applications enhanced cluster physical quality characters and yield per vine, especially magnetic iron application at 350g/vine (M_3) which produced the highest significant values of cluster weight, length and yield per vine as compared with the chick treatment during the two study seasons. However, the vines received M_2 and M_3 produced the highest number of clusters without significant differences among them in both seasons.

Concerning the main effect of antioxidants substances, it could be noticed that, all foliar spray applications were effective in increasing clusters weight, length and yield per vine as compared with control. Application of S_3 was more effective in this respect, where it resulted in the highest significant increase in these parameters. On the other hand, the lowest values were noticed with control and cluster number per vine did not show significant differences in both seasons.

Table 8. Effect of magnetic iron and antioxidants applications on yield, clusters weight, number and length of "Flame seedless" grape during 2016 and 2017 seasons

Treatments		Yield/ vine (Kg)		Cluster weight (g)		Cluster number (No.)		Cluster length (cm)	
		2016	2017	2016	2017	2016	2017	2016	2017
M_0		7.52^{d}	8.35^{d}	303.59^{d}	316.36^{d}	24.77^{c}	26.35^{b}	17.88^{d}	16.63^{d}
M_1		9.73^{c}	10.30^{c}	363.71^{c}	380.74^{c}	26.73^{b}	27.07^{b}	20.54^{c}	20.30^{c}
M_2		10.55^{b}	11.80^{b}	376.37^{b}	412.73^{b}	28.06^{a}	28.58^{a}	22.79^{b}	23.32^{b}
M_3		11.86^{a}	12.72^{a}	408.78^{a}	436.41^{a}	29.03^{a}	29.16^{a}	25.25^{a}	25.02^{a}
S_0		8.39^{c}	9.54^{c}	314.99^{d}	347.05^{d}	26.62^{a}	27.45^{a}	19.88^{c}	19.28^{c}
S_1		9.45^{bc}	10.56^{b}	347.95^{c}	377.30^{c}	27.10^{a}	27.94^{a}	21.13^{bc}	21.11^{b}
S_2		10.52^{ab}	10.92^{b}	383.35^{b}	393.06^{b}	27.42^{a}	27.74^{a}	22.25^{ab}	22.01^{ab}
S_3		11.14^{a}	12.02^{a}	406.16^{a}	428.82^{a}	27.46^{a}	28.03^{a}	23.21^{a}	22.86^{a}
M_0	S_0	5.95^{d}	6.01^{d}	210.45^{k}	237.08^{k}	23.52^{e}	25.35^{c}	15.83^{h}	15.33^{i}
	S_1	6.81^{cd}	8.15^{cd}	275.63^{j}	304.60^{j}	24.71^{de}	26.76^{bc}	17.67^{gh}	16.12^{hi}
	S_2	8.95^{a-d}	8.85^{bcd}	350.53^{h}	333.43^{i}	25.53^{cde}	26.54^{bc}	18.83^{fg}	17.20^{ghi}
	S_3	9.56^{abc}	10.44^{abc}	377.75^{e}	390.33^{f}	25.31^{cde}	26.75^{bc}	19.17^{fg}	17.88^{fgh}
M_1	S_0	8.74^{bcd}	9.33^{bcd}	330.22^{i}	347.50^{h}	26.47^{a-d}	26.85^{abc}	19.00^{fg}	18.55^{efg}
	S_1	9.41^{abc}	10.26^{abc}	357.55^{fgh}	375.43^{g}	26.32^{bcd}	27.33^{abc}	20.17^{ef}	19.75^{ef}
	S_2	9.94^{abc}	10.39^{abc}	374.44^{e}	386.98^{f}	26.55^{a-d}	26.85^{abc}	21.00^{def}	20.55^{de}
	S_3	10.83^{abc}	11.26^{abc}	392.64^{cd}	413.03^{de}	27.58^{abc}	27.26^{abc}	22.00^{cd}	22.33^{cd}
M_2	S_0	9.87^{abc}	11.15^{abc}	355.74^{gh}	387.68^{f}	27.74^{abc}	28.76^{ab}	21.00^{def}	20.55^{de}
	S_1	10.35^{abc}	11.63^{abc}	365.33^{f}	405.37^{e}	28.33^{ab}	28.69^{ab}	22.17^{cd}	23.35^{bc}
	S_2	10.97^{abc}	11.69^{abc}	385.85^{d}	412.67^{de}	28.43^{ab}	28.33^{ab}	23.00^{bc}	24.45^{ab}
	S_3	11.06^{abc}	12.71^{ab}	398.55^{c}	445.20^{b}	27.75^{abc}	28.55^{ab}	25.00^{ab}	24.91^{ab}
M_3	S_0	10.45^{abc}	12.00^{abc}	363.56^{fg}	415.95^{cd}	28.74^{ab}	28.85^{ab}	23.67^{bc}	22.70^{c}
	S_1	11.42^{ab}	12.29^{abc}	393.28^{cd}	423.80^{c}	29.04^{ab}	29.00^{ab}	24.50^{ab}	25.20^{ab}
	S_2	12.32^{ab}	12.85^{ab}	422.59^{b}	439.17^{b}	29.15^{ab}	29.26^{ab}	26.17^{a}	25.85^{a}
	S_3	13.30^{a}	13.79^{a}	455.68^{a}	466.73^{a}	29.19^{a}	29.55^{a}	26.67^{a}	26.31^{a}

In a column under each category, numbers followed by the same litter had no significant difference at 0.05 levels by DMRT.
M_0, M_1, M_2 and M_3 = Magnetic iron applications at 0,150,250 and 350 g/vine, respectively. S_0, S_1, S_2 and S_3 = Folia spray with tap water, Ascorbic acid (AsA) at 150 mg/ l, Salicylic acid (SA) at 100 mg/ l and AsA+ SA, respectively.

Data of Table (8) cleared that, the interaction among all treatments (magnetic applications and antioxidants as foliar sprays) showed a significant increase in cluster characters in terms of weight, length, number and yield/vine during both seasons. The "Flame seedless" vines treated with magnetic iron at M_3 level plus S_3 produced the highest significant values of cluster weight, number and yield per vine as compared with the others in both seasons. However, vines treated with the same magnetic iron level (M_3) combined with both S_1 and S_3 showed the highest cluster length without significant differences between them during the two seasons. The enhancement of treatments on yield and cluster characters may do to the beneficial effects on vegetative growth, especially leaf area and chlorophyll pigments content which reflect on vine vigor and carbohydrates accumulation, that enhanced plant activity throughout activating antioxidants enzymes which encourage growth and productivity plants **Gunes *et al.* (2008)**. Irrigation with magnetic water enhanced all berry physical characteristics, improved cluster weight and yield of "Thompson Seedless" grapevines. Moreover, it prevents from forming white salty deposits around the plant **Ali *et al.* (2013)**.Also, **Abdel-Salam (2016)** on Bez El-

Naka grapevines and **Kassem *et al.* (2011)** on "Flame seedless" reported that, spraying salicylic acid (SA) at different concentrations enhanced yield and berry quality of the two grapevine cultivars.

6. Berries physical quality

Data of Table (9) explain that, magnetic iron applications enhanced different berries quality parameters. Vines received magnetic iron at M_3 level showed the highest significant values of berry length, diameter and volume as compared with the others; however control vines showed the lowest values of these parameters during the two seasons.

As for foliar sprays, data of Table (9) clear that, vines treated with the combination of the two antioxidants (S_3) produced the highest significant values of the above-mentioned berries parameters. However, control vines showed the lowest values in both seasons.

Table 9. Effect of magnetic iron and antioxidants applications on berry length, diameter, and volume of "Flame seedless" grape during 2016 and 2017 seasons

Treatments		Berry length (cm)		Berry diameter (cm)		Berry volume (ml)	
		2016	2017	2016	2017	2016	2017
M_0		1.55 c	1.60 c	1.57 b	1.66 b	241.5d	226.2d
M_1		1.69 bc	1.76 bc	1.68 ab	1.78 ab	254.3c	245.7c
M_2		1.79 b	1.90 b	1.78 ab	1.82 ab	264.5b	257.0b
M_3		2.22 a	2.18 a	1.91 a	1.98 a	273.0a	268.7a
S_0		1.67 b	1.68 c	1.59 c	1.64 b	236.3d	226.7d
S_1		1.70 b	1.78 bc	1.67 bc	1.74 bc	249.8c	241. 8c
S_2		1.89 ab	1.91 ab	1.79 ab	1.84 b	266.7b	258.7b
S_3		1.98 a	2.07 a	1.89 a	2.02 a	280.7a	270.4a
M_0	S_0	1.37 h	1.43 h	1.45 f	1.51 f	217.5l	197.5l
	S_1	1.42 h	1.55 gh	1.52 ef	1.63 def	231.3k	220.4k
	S_2	1.67 fg	1.66 fg	1.62 ef	1.72 cde	250.4h	235.7j
	S_3	1.75 efg	1.74 efg	1.70 cde	1.79 b-e	266.6e	251.3fg
M_1	S_0	1.52 gh	1.60 gh	1.53 ef	1.60 ef	234.4j	222.4k
	S_1	1.68 fg	1.73 efg	1.61 ef	1.73 cde	245.6i	239.8i
	S_2	1.74 efg	1.81 def	1.72 cde	1.82 bcd	261.5f	253.8f
	S_3	1.80 def	1.91 de	1.85 bc	1.95 b	275.4c	266.7d
M_2	S_0	1.65 fg	1.73 efg	1.63 def	1.69 c-f	243.4i	237.5ij
	S_1	1.71 fg	1.82 def	1.71 cde	1.77 b-e	257.6g	248.2h
	S_2	1.83 def	1.93 cd	1.84 bcd	1.87 bc	271.5d	267.3d
	S_3	1.95 cde	2.11 bc	1.95 ab	1.96 b	285.4b	274.8c
M_3	S_0	2.15 bc	1.97 cd	1.73 cde	1.75 b-e	250.4h	249.5gh
	S_1	1.98 cd	2.00 cd	1.85 bc	1.84 bcd	262.6f	258.7e
	S_2	2.33 ab	2.25 b	1.97 ab	1.96 b	283.5b	277.9b
	S_3	2.42 a	2.50 a	2.07 a	2.36 a	295.4a	288.6a

In a column under each category, numbers followed by the same litter had no significant difference at 0.05 levels by DMRT.
M_0, M_1, M_2 and M_3 = Magnetic iron applications at 0,150,250 and 350 g/vine, respectively. **S_0, S_1, S_2 and S_3** = Folia spray with tap water, Ascorbic acid (AsA) at 150 mg/ l, Salicylic acid (SA) at 100 mg/ l and AsA+ SA, respectively.

Interaction between the two tested factors (Magnetic iron and antioxidants) reached a significant increase in berry physical characters (length, diameter and volume) during both seasons. Magnetic iron as a soil drench at 350g/ vine (M_3) plus S_3 treatment showed the highest significant values of the above-mentioned berry properties during the two seasons. However, the lowest values were noticed with control. Similar results were found by **Aladjadjiyan (2010)** who reported that, Magnetic water improved the plant growth characteristics, root functions and nutrients uptake which reflected in yield per plant and yield properties in several crops **and Ali *et al.* (2013)** demonstrated that, magnetic water enhanced different berry physical characteristics as berry firmness, berry weight and berry adherence of "Thompson Seedless" grapevines. Moreover, foliar application of ascorbic acid showed a positive effect on berry weight, dimensions, cluster weight and yield of "Flame seedless" grape, these due to the enhancement of cell division and cell enlargement which related with the leaf area **(Kassem *et al.*, 2011** and **Abdel-Salam, 2016)**.

7. Berries chemical quality

Data presented in Table (10) show the effect of magnetic iron as anti-salinity and antioxidant substances (salicylic acid and ascorbic acid) treatments on berry chemical quality parameters of "Flame seedless" grape. Magnetic iron at M_3 level produced the highest significant values of SSC% in relative to control (M_0) and M_1 treatments which showed the lowest percent without significant differences between them in both seasons. Also, the same treatment (M_3) showed the highest significant values of SSC/acid ratio and berries anthocyanine pigments in both seasons and lowest berry titratable acidity percent in the first season. However, the lowest values of SSC/acid ratio and berries anthocyanin were noticed with control (M_0) during the two seasons. Data of the same Table (10) clear that foliar spray of SA and AsA alone or in combination (S_1, S_3 and S_3) enhanced berries chemical quality in terms of SSC%, SSC/acid ratio and anthocyanine pigments. All foliar spray treatments reached a significant as compared to control (S_0). The application of S_3 was more effective in this respect since it reached the highest significant values of the above mentioned parameters. On the contrary, vines of control (S_0) showed the lowest values during both seasons. However, vines sprayed by S_3 showed the lowest titratable acidity in both seasons.

Table 10. Effect of magnetic iron and antioxidants applications on berry chemical quality properties of "Flame seedless" grape during 2016 and 2017 seasons.

Treatments		SSC %		Titratable acidity %		SSC/ Acid Ratio		Anthocyanine (mg/100g FW)	
		2016	**2017**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**
M_0		15.09^{c}	15.87^{c}	0.81^{a}	0.69	18.81^{d}	23.10^{d}	34.67^{d}	31.22^{d}
M_1		15.30^{c}	16.00^{c}	0.73^{ab}	0.66^{a}	21.08^{c}	24.59^{c}	37.92^{c}	34.72^{c}
M_2		16.61^{b}	17.18^{b}	0.73^{ab}	0.64^{a}	23.18^{b}	26.96^{b}	41.50^{b}	38.60^{b}
M_3		16.99^{a}	17.82^{a}	0.67^{b}	0.63^{a}	25.86^{a}	28.62^{a}	43.42^{a}	41.88^{a}
S_0		15.06^{d}	15.93^{d}	0.81^{a}	0.71^{a}	18.70^{d}	22.42^{d}	31.25^{d}	28.10^{d}
S_1		15.54^{c}	16.43^{c}	0.76^{ab}	0.67^{ab}	20.66^{c}	24.82^{c}	36.50^{c}	34.41^{c}
S_2		16.34^{b}	16.83^{b}	0.70^{ab}	0.64^{ab}	23.66^{b}	26.52^{b}	43.33^{b}	39.82^{b}
S_3		17.05^{a}	17.70^{a}	0.66^{b}	0.60^{b}	25.92^{a}	29.51^{a}	46.42^{a}	44.08^{a}
M_0	**S_0**	14.43^{i}	15.40^{g}	0.86^{a}	0.75^{a}	16.78^{e}	20.53^{e}	26.67^{j}	22.45^{m}
	S_1	14.73^{h}	15.60^{fg}	0.84^{a}	0.72^{a}	17.54^{e}	21.67^{e}	32.33^{h}	28.33^{k}
	S_2	15.20^{g}	15.80^{ef}	0.80^{ab}	0.69^{ab}	19.00^{de}	22.90^{de}	38.33^{e}	34.55^{gh}
	S_3	16.00^{e}	16.66^{d}	0.73^{bcd}	0.61^{de}	21.92^{bcd}	27.31^{c}	41.33^{d}	39.55^{ef}
M_1	**S_0**	14.23^{i}	15.60^{fg}	0.80^{ab}	0.72^{ab}	17.79^{e}	21.67^{e}	30.33^{i}	25.55^{l}
	S_1	15.07^{g}	15.67^{efg}	0.77^{abc}	0.67^{bcd}	19.57^{cde}	23.39^{de}	35.33^{f}	32.44^{ij}
	S_2	15.70^{f}	15.88^{e}	0.70^{cde}	0.63^{cde}	22.43^{bc}	25.21^{cd}	41.67^{d}	38.33^{f}
	S_3	16.20^{de}	16.86^{d}	0.66^{de}	0.60^{e}	24.55^{b}	28.10^{bc}	44.33^{c}	42.55^{c}
M_2	**S_0**	15.57^{f}	15.85^{ef}	0.80^{ab}	0.71^{ab}	19.46^{de}	22.32^{de}	33.33^{gh}	30.75^{j}
	S_1	16.07^{de}	16.88^{d}	0.77^{abc}	0.64^{cde}	20.87^{cd}	26.38^{c}	38.67^{e}	36.33^{g}
	S_2	16.80^{c}	17.40^{c}	0.68^{cde}	0.63^{cde}	24.71^{b}	27.62^{bc}	45.67^{c}	41.75^{cd}
	S_3	18.00^{a}	18.60^{a}	0.65^{de}	0.59^{e}	27.69^{a}	31.53^{a}	48.33^{b}	45.55^{b}
M_3	**S_0**	16.00^{e}	16.85^{d}	0.77^{abc}	0.67^{bcd}	20.78^{cd}	25.15^{cd}	34.67^{fg}	33.65^{hi}
	S_1	16.27^{d}	17.55^{c}	0.66^{de}	0.63^{cde}	24.65^{b}	27.86^{bc}	39.67^{e}	40.55^{de}
	S_2	17.67^{b}	18.22^{b}	0.62^{e}	0.60^{e}	28.50^{a}	30.37^{a}	47.67^{b}	44.65^{b}
	S_3	18.00^{a}	18.66^{a}	0.61^{e}	0.60^{e}	29.51^{a}	31.10^{a}	51.67^{a}	48.66^{a}

In a column under each category, numbers followed by the same litter had no significant difference at 0.05 levels by DMRT.
M_0, M_1, M_2 and M_3 = Magnetic iron applications at 0,150,250 and 350 g/vine, respectively. **S_0, S_1, S_2 and S_3** = Folia spray with tap water, Ascorbic acid (AsA) at 150 mg/ l, Salicylic acid (SA) at 100 mg/ l and AsA+ SA, respectively.

The interaction treatments showed a positive effect on berries chemical quality parameters of "Flame seedless" grape. Application of the two antioxidants (S_3) combined with magnetic iron at both M_2 and M_3 levels were more effective. These treatments produced the highest percent of berry SSC without significant differences between them and the lowest values were noticed with control in both seasons. Also, vines treated by $M_3 + S_3$ and $M_3 + S_2$ as well as $M_2 + S_3$ showed the highest SSC/acid ratio without significant differences among them and the lowest value was observed with control during both seasons. On the other hand, the least berry juice titratable acidity% was found with $M_3 + S_2$ and $M_3 + S_3$ treatments however, the highest percent was noticed with control ($M_0 + S_0$) and ($M_0 + S_1$) in both seasons. The interaction ($M_3 + S_3$) treatment resulted in the highest concentration of berries Anthocyanin pigments in both seasons. These results explained the role of magnetic water in dissolving of soil fertilizers and enhancing water absorption rate which increased plant photosynthesis, carbohydrates content, growth, yield and fruit quality. Magnetic fields may cause a variation in the ionic currents across the cellular membrane that leads to change in the osmotic pressure (**Carbonell *et al*., 2004).** In this respect, **Ali *et al*. (2013)** reported that magnetic water was effective in enhancing SSC%, SSC/acid ratio of "Thompson seedless" grape berries. Moreover, **Maksoud *et al.* (2009)** cleared the important role of ascorbic acid and salicylic acid in plants, where it conceder as antioxidant and enzyme cofactors. These substances are participating in different biological processes as cell expansion, cell wall growth, photosynthesis and synthesis of some vital compounds as gibberellins and anthocyanine. Also, it plays an important role in stability of cell membrane, transporter enzymes activity and carbohydrates translocation. In the same trend, **Abdel-Salam (2016)** reported that, application of Ascorbic acid at 2000 ppm as foliar spray gave the best effectiveness on berries quality of "Ruby Seedless" grape.

8. Soil chemical properties

It is obvious from Table (11) that, it can be noticed that the soil texture is sandy, also, soil had high pH value (8.4 and 8.6), under such high alkaline conditions and low of organic matter content, macro and micro-nutrients are usually unavailable, low and inadequate levels for vines. Moreover, the average of electric conductivity EC was 4.20 and 4.60 dSm^{-1}, so the soil salinity classification as moderately saline according to **(Abrol *et al.*, 1988)**. Such soil condition leads to a loss of soil fertility and a reduction in the abundance and diversity of soil microorganisms, moreover, these factors limiting the growth and productivity of grapevines. The results in Table (11) clearly showed that soil salinity (EC dSm^{-1}), sodium absorption ratio (SAR) and pH were positively affected by different treatments. Magnetic iron as soil amendment was decreased soil salinity (EC dSm^{-1}), sodium absorption ratio (SAR) and pH at the end of the experiment as compared with soil analysis before applying treatments. This decreased was proportional to the application rates of magnetic iron.

Also, the decreasing of soil salinity (EC dSm^{-1}), sodium absorption ratio (SAR) and pH were much pronounced in soil surface (0-30 cm). It is also, noted that, magnetic iron treatments increased soil macronutrients as N, P, K^+, Ca^{++}, Mg^{++}, and micronutrients as Fe, Mn, and Zn, and decreased Na^+ and Cl^- especially in soil layer at 0-30 cm. These findings are in line with those of **Abualamaim (2012)** and **Amer (2016)**. In this respect, **Mohamed *et al.* (2013)** reported that, magnetic iron application improved saline soil as decreased the electrical conductivity (EC), pH value and Na^+, increased K^+ and Mg^{++}. Similar results were reported by **Ali *et al.* (2013)** they found that, magnetic iron application at a rate of 150kg/feddan led to reduced soil salinity.

Table 11. Soil chemical properties of vineyard after magnetic iron application conducted as mean of the two study seasons.

Soil depth and characters	Average of both seasons after study conducted							
Soil depth	**0 - 30 cm**				**30 - 60 cm**			
Magnetic applications	**0**	**150**	**250**	**350**	**0**	**150**	**250**	**350**
Soil chemical properties								
EC (dS/m)	4.43	3.22	2.82	2.41	4.70	3.32	3.37	3.10
pH (1:2.5)	8.40	8.00	7.63	7.54	8.50	8.00	8.10	8.00
OM %	0.44	0.42	0.43	o.42	0.37	o.40	0.39	0.40
Cations (meq/L)								
K^+	1.87	1.97	1.84	1.55	1.65	1.29	1.50	1.53
Na^+	13.23	8.27	5.86	4.13	19.40	10.94	9.35	6.42
Ca^{++}	15.50	12.24	11.70	10.07	13.14	10.13	10.40	11.47
Mg^{++}	13.92	10.58	10.13	8.66	14.11	11.13	11.88	12.23
Anions (meq/L)								
Cl^{--}	18.04	13.15	7.23	5.48	22.18	15.98	16.74	15.26
CO_3^{--}	--	--	--	--	--	--	--	--
HCO_3^-	8.87	6.54	5.20	4.37	8.11	6.02	6.23	5.86
SO_4^{--}	17.61	13.37	17.09	14.56	18.01	11.38	10.16	10.53
(SAR)	3.45	2.45	1.77	1.35	5.26	3.36	2.80	1.87
Available nutrients (ppm)								
N	12.41	14.22	16.42	18.75	10.50	12.65	15.82	17.65
P	4.91	5.16	5.41	5.76	2.97	3.41	3.81	3.87
Fe	2.82	3.45	3.72	4.52	3.51	4.32	5.61	5.83
Mn	1.32	1.65	1.93	2.30	1.45	1.50	1.72	1.94
Zn	1.30	1.52	1.75	2.22	1.38	1.44	1.62	1.85

Conclusion

From our results, it could be summarized that, soil application of magnetic iron, as well as the foliar spray with salicylic acid and ascorbic acid used either individually or in combination form, are very effective in enhancing different growth and vigor characters of "Flame seedless" grapevine as well as yield and large scale of chemical and physical properties of berries. Soil chemical properties were positively affected as a result of magnetic iron treatments, especially at 350g/ vine. The combination between magnetic iron at 350g/vine applied after winter pruning plus foliar application with salicylic acid and ascorbic acid at 100 and 150 mg/l, respectively two times: after fruit set and at veraison was achieved the best enhancement of growth and production of vines under salt-affected soil. In addition, the materials used are natural, safe, and reduce environmental pollution.

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تأثير اضافة الحديد المغناطيسي والرش ببعض مضادات الاكسدة على نمو وانتاجية عنب الفلايم سيدلس في الاراضى المتاثرة بالاملاح

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أجريت هذه الدراسة خلال موسمى 2016 و 2017 على كرمات عنب الفليم عديم البذور عمرها ثمان سنوات نامية فى تربة رملية بمنطقة ابوغالب بالجيزة وذلك لدراسة تأثير اضافة الحديد المغناطيسى كمحسن للتربة بتركيزات 0 و150 و250 و350 جم \الكرمة وذلك عقب التقليم الشتوى مباشرة دفعة واحدة والرش بكل من حامض السيليلك بتركيز 100 مجم و حامض الاسكوربك بتركيز 150 مجم \اللتر منفردين او مجتمعين كمضادات اكسدة بالاضافة الى معاملة القياس وذلك مرتين (الاولى بعد عقد الثمار والثانية عند بداية تلوين الثمار(veraison) كذا التداخل بين الحديد المغناطيسى ومضادت الاكسدة على النمو والمحصول وجودة الثمار وبعض خصاص التربة الكيميائية.

ويمكن تلخيص اهم النتائج على النحو التالي:

- اضافة الحديد المغناطيسى بالمستوى الاعلى (350جم \الكرمة) و كذلك الرش بمضادات الاكسدة كانت الاكثرتاثيرا فى تحسين مختلف قياسات النمو الخضرى والمحصول وجودة الثمار.
- المعاملة بالحديد المغناطبسى بالمستوى الاعلى (350جم \الكرمة) مشتركة مع الرش بحامض السيلسيلك بتركيز 100 + حامض الاسكوربك بتركيز 150 مجم \اللتر اظهرت أعلى قيم لقياسات النمو الخضرى ممثلة فى الطول الكلى للقصبات – المساحة الورقية – تركيز الكلوروفيل بالاوراق وقياسات قوة الكرمة مثل وطول وقطر السلميات– وزن خشب التقليم– نسبة الكربوهيدرات الكلية بالقصبات– معامل نضج الخشب. كما اظهرت ذيادة معنوية فى محتوى الاوراق من عناصر النيتروجين– الفسفور– البوتاسيوم – الكالسيوم – المغنسيوم – الحديد وعلى العكس اقل تركيزات لعنصرى الصوديوم و الكلور وكذا اقل محتوى من البرولين بالاوراق. ايضا انتجت اعلى محصول للكرمة و صفات الجودة الفيزيائية ممثلة فى وزن العنقود – طول العنقود – طول وقطر الحبات – صلابة الحبات و القوة اللزمة لنزعها من العنقود والصفات الكيميائية مثل نسبة المواد الصلبة الكلية الذائبة بعصير الحبات– التركيزالكلى لصبغة الانثوسيانين بالحبات. كما ادت كافة معاملات الحديد المغناطيسى الى خفض ملوحة التربة ورقم الحموضة و تركيز عنصررى الصوديوم و الكلور وكذا نسبة الصوديوم المدمص بالتربة .