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Influence of spraying magnesium, silicon and salicylic acid on improving growth, yield and fruit properties of grapevine

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Abstract

This study was carried out through two growing seasons of 2018 and 2019 in a private vineyard located at Aga district, Dakahlia Governorate, to study the effect of foliar spray with magnesium sulphate (MgS) at 0.3%, salicylic acid (SA) at 500 ppm and potassium silicate (KSi) at 2000 ppm individually or in combinations on yield, cluster and berry properties of Thompson Seedless grapes under clay soil conditions. All treatments under investigation improved the studied parameters comparing with the untreated vines (control). In this concern, spraying grapevines especially with the treatment included the three materials (MgS+SA+KSi) for three times (at full bloom, two weeks after setting and 45 days after setting) recorded the highest values of vegetative parameters, yield and fruit physical and chemical properties, also the same treatment recorded the highest leaf and berry content of N, P, Ca and chlorophyll, also carotenoids comparing with the untreated vines.

Keywords: yield; fruit properties; grapevine; magnesium; silicon; salicylic acid

1. Introduction

Grape (Vitis vinifera, L.) is regarded as the first yielding fruit crop in both regional and global production. In Egypt, it is the second most important fruit crop after citrus. The farmed area has developed fast in the last two decades due to its strong net return and reached 172.533 feddan that produced 1586342 tons [1]. Thompson Seedless is a popular cultivar of grape grown in Egypt. The berries are high in minerals and vitamins (B1, B2, and C). The berries are eaten fresh as a table fruit and processed as wine, raisins, and fresh juice. Thompson Seedless is becoming more popular as a table and raisin due to its high total soluble solids, thin skin, and ideal form.

Foliar fertilization (foliar feeding) is the application of nutrients, plant hormones, bio-stimulants, other beneficial substances and pesticides to the plant leaves and stems. The use of these substances would improve nutrient balance during growth and development, resulting in improving yield and quality, high disease and insect pest resistance and enhancing drought tolerance.

Salicylic acid (SA), a natural signal molecule, has been shown to play an important role in controlling various physiological processes in the plants. The exogenous application increased plant production under biotic and abiotic stress [2]. In this regard, Abdel-Salam [3] found that spraying SA improved cluster weight, berry weight, juice volume, total chlorophyll content, NPK in the leaves, T.S.S, acidity, total phenols, and β-carotene when compared to the control. El-Kenawy [4] observed that spraying SA increased shoot length, leaf surface area, total chlorophyll in the leaf, and total protein in the canes, as well as percentages of N, P, and K in the leaves, also increased the yield per vine, cluster weight, berry weight, soluble solids content, and total phenols, while decreased total acidity compared to the unsprayed vines.

Magnesium nutrient is important in activating the enzymes involved in respiration, photosynthesis, DNA and RNA synthesis. Magnesium is also a member of the ring structure of the chlorophyll molecule. According to research, the chlorophyll molecule is associated with 15 to 30% of total plant magnesium. Magnesium deficiency can have a serious impact on plant growth and development because it is directly related to photosynthesis [5]. Spraying trees with magnesium improved plant growth, yield, and quality, as well as chemical

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composition of mandarin [6], Washington Navel orange [7-9], and grapes [10].
Silicon as micro nutrient, at high transpiration levels reduces the biotic and abiotic stresses in the plants by maintaining plant water potential, photosynthetic activity, stomatal conductance, and leaf erectness [11, 12]. Spraying grapevine with silicon resulted in improving berry growth, yield, and quality, also showed a significant increase in berry weight and cluster coloration [13-15].
The aim of this study was to achieve high cluster yield with good berry quality using foliar spray with magnesium, salicylic acid and potassium silicate on Thompson Seedless grapevines under clay soil conditions.

2. Materials and methods

This study was carried out through two growing seasons of 2018 and 2019 in a private vineyard located at Aga district, Dakahlia Governorate, to study the effect of foliar spray with magnesium sulphate, salicylic acid and potassium silicate individually or in combinations on yield cluster and berry properties of Thompson Seedless grapes under clay soil conditions. Vines under investigation were 12 years old, planted at 2×2.5 m apart and selected as almost uniformed in vigor. The vines were trained to the yard pruning system and received the common horticultural practices such as fertilization, irrigation cultivation, diseases and insects control.

This experiment included eight treatments as follows:

1) Control (sprayed with water only)

2) Spraying magnesium sulphate (MgS) at 0.3 %

3) Spraying salicylic acid (SA) at 500 ppm

4) Spraying potassium silicate (KSi) at 2000 ppm

5) Spraying MgS+SA

6) Spraying MgS+KSi

7) Spraying SA+KSi

8) Spraying MgS+SA+KSi

These treatments were arranged in a randomized complete block design with four replications. Each replicate contained three vines. At full bloom, two weeks after setting, and 45 days after setting, all vines were sprayed three times with the above treatments. Each vine had received 2.5 L solution of MgS, SA and KSi individually, or in combinations using spreading agent (super film) for all treatments. The untreated vines were sprayed with water + spreading agent only.

The following determinations were recorded:

Vegetative growth: Leaf length and width in cm and leaf area in cm2 were recorded at May in each season. Average leaf fresh and dry weight (g) were determined, also moisture content was calculated.

Photosynthetic pigments: Leaf samples were collected and used to estimate both chlorophyll a and b as well as carotene pigments according to the methods described by Beckett et al. [16].

Mineral determinations: Samples of dry leaves and berries were finely grind and wet digested for N, P, K, Ca and Mg determinations. Total nitrogen, phosphorus and potassium were determined according to the methods described by Bremner and Mulvaney [17]; Olsen and Sommers [18]; Jackson [19], respectively. However, Mg and Ca in the leaves and berries were determined according to the method described by Gottelt et al. [20].

Yield/ vine and cluster properties: At August in each season, when the total soluble solids berry juice reached 16-17%, and the color covered all bunch berries, the yield was harvested, and number of clusters per vine were counted, then weighed to determine the total yield (kg) per vine.

Number of berries per cluster, also volume, length, width, girth, and weight of the cluster were measured.

Berry physical properties: Berry length and diameter (cm), fresh and dry weight of 100 berries as well as moisture percentage (%) in the berries were recorded, also juice volume of 100 berries (cm3) and juice volume of 100 g fruits were measured.

Berry chemical properties: The berry juice was extracted from 100 berries for each replicate. The total soluble solids (TSS) percentage of juice was determined using a hand refractometer. The juice acidity was determined by titration against sodium hydroxide (0.1 N) in presence of phenolphthalein as indicator. The total juice acidity was expressed as g tartaric acid per 100 ml of juice. Then TSS/acid ratio of each juice sample was calculated. Reducing, non-reducing and total sugars in berry juice were determined according to the method described by Francesca et al. [21].

Statistical analysis: The obtained data were tabulated and statistically tested for analysis of variance using MSTAT (1998) and the significant differences among the various treatments were compared using LSD values at probability of 0.05 according to Snedecor and Cochran [22].

3. Results and discussion

Leaf properties: The effect of spraying magnesium sulphate (MgS), salicylic acid (SA), and potassium silicate (KSi) on leaf length and width, leaf area, leaf fresh and dry weight, as well as moisture content, are shown in Table 1. The results show that all treatments had a positive effect on increasing length and width of grapevine leaves. In this regard, MgS+SA+KSi treatment scored the greatest leaf length and width in the first and second seasons, respectively, while the untreated vines (control) recorded the lowest values in the first and second seasons.

Table 1. Effect of MgS, SA, and KSi foliar sprays on leaf properties of grape during 2018 and 2019 seasons.

Treatments	Leaf length (cm)		Leaf width (cm)		Leaf area (cm^2)		Leaf fresh wt. (g)		Leaf dry wt. (g)		Leaf moisture content (%)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	10.25	11.16	8.55	10.33	82.44	98.27	23.18	24.93	6.18	7.18	2.8	2.5
MgS	10.97	11.78	9.01	10.47	89.17	103.24	23.90	24.49	6.89	7.49	2.5	2.3
SA	11.27	12.07	9.18	11.06	91.14	114.25	24.17	25.06	7.01	8.27	2.4	2.0
KSi	11.04	12.00	9.07	10.97	95.47	120.17	24.01	25.00	6.90	8.47	2.5	2.0
MgS+SA	12.19	12.78	10.47	11.90	100.24	121.17	25.01	25.70	7.45	8.90	2.4	1.9
Mg+KSi	11.49	12.17	11.01	11.87	97.27	117.28	25.24	25.97	7.44	8.79	2.4	2.0
SA+ KSi	12.27	13.01	11.04	12.07	118.27	131.45	25.75	26.10	7.80	9.01	2.3	1.9
MgS+SA+KSi	12.39	13.15	11.38	12.46	121.99	136.04	25.81	26.36	8.18	9.27	2.2	1.8
LSD at 0.05 level	0.56	0.64	0.71	0.68	8.97	11.22	0.74	0.46	1.36	1.12	0.04	0.07

MgS = magnesium sulphate at 0.3 %, SA = salicylic acid at 500 ppm, KSi = potassium silicate at 2000 ppm

Concerning leaf area, treatment included the three sprayed materials was the superior in this concern and recorded 121.99 and 136.04 cm2, while the control treatment recorded 82.44 and 98.27 cm2 in the first and second seasons, respectively.

Regarding leaf fresh and dry weight, it is clear that the combined treatments, particularly those included the three sprayed materials recorded the highest values in terms of both fresh and dry leaf weight, followed by the treatment that included both SA and KSi when compared to the other treatments including the control. This was true in both studied seasons.

As for moisture content, the obtained results showed that the untreated vines recorded the highest leaf moisture value in both studied seasons, while the lowest value was recorded when sprayed MgS+SA and KSi in the same solution.

Leaf pigments: Table (2) shows the effect of spraying MgS, SA and KSi on leaf pigment content. However, the obtained results show that both of chlorophyll a, b and carotenoids, also total chlorophyll recorded the maximum values with the treatments included the three sprayed materials. The results were gradually decreased with the treatments included two sprayed materials, followed by those included only one. The untreated vines gave the least values of all previous parameters. These results were observed in both studied seasons.

Table 2. Effect of MgS, SA, and KSi foliar sprays on leaf pigments of grape during 2018 and 2019 seasons.

Treatments	Chlorophyll a (mg/dec^2)		Chlorophyll b (mg/dec^2)		Total chlorophyll a+b (mg/dec^2)		Carotenoids (mg/dec^2)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	0.96	1.07	0.47	0.65	1.43	1.72	1.0	1.07
MgS	1.12	1.20	0.78	0.81	1.9	2.01	1.17	1.11
SA	1.48	1.65	0.89	0.84	2.37	2.49	1.24	1.29
KSi	1.41	1.50	0.80	0.85	2.21	2.35	1.25	1.10
MgS+SA	2.01	1.97	0.91	1.02	2.92	2.99	1.57	1.49
Mg+KSi	1.88	1.74	1.06	1.07	2.94	2.81	1.38	1.42
SA+ KSi	1.67	1.74	1.01	1.05	2.68	2.79	1.37	1.46
MgS+SA+KSi	2.18	2.07	1.24	1.18	3.42	3.25	1.74	1.67
LSD at 0.05 level	0.22	0.34	0.11	0.17	0.19	0.47	0.24	0.29

MgS = magnesium sulphate at 0.3 %, SA = salicylic acid at 500 ppm, KSi = potassium silicate at 2000 ppm

Leaf mineral contents: Results in Table (3) show the effect of the sprayed materials on leaf mineral contents. The obtained results show that the highest values of all determined minerals were detected when the vines sprayed with the three examined materials in the same solution. In this respect, the untreated vines recorded the lowest mineral content in the leaves. However, the other treatments gave intermediate values for the determined minerals. The obtained results were true for N, P, K, Mg and Ca leaf content in both studied seasons.

Table 3. Effect of MgS, SA, and KSi foliar sprays on leaf mineral content of grape during 2018 and 2019 seasons

Treatments	N (%)		P (%)		K (%)		Mg (%)		Ca (%)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	3.45	3.60	0.33	0.42	1.31	1.42	1.89	1.79	1.56	1.71
MgS	3.90	3.75	0.42	0.45	1.28	1.75	2.41	2.25	1.73	1.83
SA	4.25	4.25	0.45	0.46	1.56	1.72	2.14	2.01	1.90	2.04
KS	3.80	4.50	0.40	0.47	1.52	1.89	2.07	2.14	2.05	2.13
Mg+SA	4.46	4.38	0.52	0.51	1.68	1.79	2.31	2.46	2.17	2.18
Mg+KS	4.76	4.76	0.49	0.51	1.72	1.99	2.48	2.51	2.37	2.28
SA+ KS	4.80	4.89	0.55	0.49	1.98	2.11	2.20	2.18	2.25	2.26
MgS+SA+KS	4.82	4.92	0.61	0.47	2.11	2.23	2.54	2.67	2.45	2.35
LSD at 0.05 level	0.63	0.87	0.12	0.07	0.37	0.42	0.31	0.19	0.46	0.31

MgS = magnesium sulphate at 0.3 %, SA = salicylic acid at 500 ppm, KSi = potassium silicate at 2000 ppm

Berry mineral contents: Table (4) shows the effect of examined materials on berry mineral content. The results show that N,P ,K, Mg and Ca content in grape berry reached the maximum values when vines were sprayed with MgS+SA+KSi in combination except for P % in the first season since the highest value was recorded with the treatment of MgS+SA or MgS+KSi. On the other hand, the untreated vines recorded the minimum mineral content in the berries. The previous results were detected in the two studied seasons.

Table 4. Effect of MgS, SA, and KSi foliar sprays on berry mineral content of grape during 2018 and 2019 seasons

Treatments	N (%)		P (%)		K (%)		Mg (%)		Ca (%)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	0.52	0.54	0.25	0.32	0.98	1.07	0.47	0.45	0.32	0.43
MgS	0.59	0.56	0.32	0.34	0.96	1.31	0.60	0.56	0.43	0.46
SA	0.64	0.64	0.34	0.35	1.17	1.29	0.54	0.50	0.48	0.51
KS	0.57	0.68	0.30	0.35	1.14	1.42	0.52	0.54	0.51	0.53
Mg+SA	0.67	0.66	0.39	0.38	1.26	1.34	0.58	0.62	0.54	0.55
Mg+KS	0.71	0.71	0.37	0.38	1.29	1.49	0.62	0.63	0.59	0.57
SA+ KS	0.72	0.73	0.41	0.37	1.49	1.58	0.55	0.55	0.56	0.57
MgS+SA+KS	0.72	0.74	0.46	0.35	1.58	1.67	0.64	0.67	0.67	0.69
LSD at 0.05 level	0.09	0.11	NS	NS	0.16	0.23	0.09	0.12	0.08	0.06

MgS = magnesium sulphate at 0.3 %, SA = salicylic acid at 500 ppm, KSi = potassium silicate at 2000 ppm

Cluster properties: Table (5) includes the physical cluster characteristics such as number of berries / cluster and both volume, length, width, girth and weight of cluster, also yield per vine.

The obtained results reveal that the maximum values for all the previous parameters were recorded with the treatment included the three examined materials (MgS+SA+KSi) followed by the treatment included both SA+KSi. The lowest values for the above parameters were detected with the unsprayed vines. On the other side, when calculating the increment percentage of the total yield over the control due to applied treatments, the results show that all applied treatments increased the yield per vine than the control, the increment percentage ranged between 18.8-98.7 in the first season and 28.7-99.0 % in the second one among the applied treatments. The maximum increment of the yield over the control (98.7 and 99.00 %) was recorded by the treatment included the three examined materials

(MgS+SA+KSi) in the first and second seasons, respectively.

Table 5. Effect of MgS, SA, and KSi foliar sprays on cluster properties and yield of grape during 2018 and 2019 seasons

Treatments	No. of berries / cluster		Cluster vol. (cm^3)		Cluster length (cm)		Cluster width (cm)		Cluster girth (cm)		Cluster weight (g)		Yield/ vine (kg)		Yield increment % over the control	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	228.8	210.8	357.5	335.1	22.60	22.58	10.2	10.90	22.8	24.2	374.2	349.2	6.85	6.91	00.0	00.0
MgS	295.1	238.0	459.2	417.8	23.40	23.21	10.79	11.17	23.47	25.79	418.7	420.1	8.27	8.89	20.7	28.7
SA	333.5	248.5	491.7	471.8	25.10	26.48	11.40	11.79	23.47	26.18	467.2	434.2	8.17	9.24	30.9	33.7
KS	317.3	238.3	472.4	450.2	24.17	24.48	11.17	11.47	24.18	27.19	490.7	478.2	8.14	8.47	18.8	22.6
Mg+SA	352.4	365.7	498.2	475.7	26.01	26.78	12.01	11.92	25.78	28.17	512.7	479.4	9.37	10.47	36.8	51.5
Mg+KS	340.7	350.2	465.2	460.2	25.47	25.14	11.87	11.97	27.89	27.46	501.4	512.4	9.00	10.01	31.4	44.9
SA+ KS	362.7	372.4	500.8	480.2	26.47	26.75	12.27	12.45	32.47	31.78	540.7	537.2	11.24	11.79	64.1	70.6
MgS+SA+KS	390.8	398.7	551.7	499.7	26.75	27.18	12.80	12.65	35.7	34.17	567.1	554.7	13.61	13.75	98.7	99.0
LSD at 0.05 level	0.57	0.42	0.31	0.59	0.27	0.59	0.17	0.23	2.17	3.51	62.18	53.28	0.87	1.02	--	--

MgS = magnesium sulphate at 0.3 %, SA = salicylic acid at 500 ppm, KSi = potassium silicate at 2000 ppm

Berry physical and chemical properties:

Table (6) shows the berry properties, since the weight of 100 berries (g) recorded the highest value when the vines were sprayed with MgS+SA+KSi followed by the treatment included both SA+KSi. However, it is clear that the treatments included SA sprayed material enhanced 100 berry weight than those include KSi or MgS. The untreated vines were the lowest concerning the weight of 100 berries. This was true in both studied seasons. The same trend was obtained concerning the dry weight of 100 berries, since the treatment included the three sprayed materials gave the heaviest weight followed by that included SA+KSi, while the lowest value was detected with the control treatment.

Table 6. Effect of MgS, SA, and KSi foliar sprays on berry physical properties of grape during 2018 and 2019 seasons

Treatments	Wt. of 100 berries (g)		Dry wt. of 100 berries (g)		Berry moisture content (%)		Juice vol. of 100 berries (cm^3)		Juice vol. of 100 g fruits (cm^3)		Berry length (cm)		Berry diameter (cm)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	159.12	186.01	29.15	34.18	4.5	4.4	145.1	176.5	91.02	91.4	1.5	1.6	1.3	1.3
MgS	162.71	189.31	32.9	38.17	3.9	4.0	150.1	170.1	92.19	92.78	1.5	1.6	1.3	1.3
SA	170.14	192.19	33.18	39.21	4.1	3.9	159.4	173.2	92.17	93.19	1.5	1.7	1.4	1.4
KS	166.27	190.71	33.38	39.7	4.0	3.8	155.2	171.2	92.79	93.17	1.6	1.6	1.4	1.4
Mg+SA	180.17	199.71	36.2	39.1	4.0	4.1	170.2	185.4	91.27	91.9	1.6	1.7	1.4	1.3
Mg+KS	181.21	194.62	35.18	40.01	4.2	3.9	170.2	181.2	94.27	93.79	1.6	1.7	1.4	1.3
SA+ KS	188.17	198.71	38.14	42.21	3.9	3.7	176.3	183.2	93.27	94.19	1.5	1.7	1.5	1.5
MgS+SA+KS	192.17	202.54	40.11	44.18	3.8	3.6	185.3	188.8	95.72	95.51	1.7	1.8	1.5	1.5
LSD at 0.05 level	8.15	12.17	1.17	1.89	0.24	0.18	11.15	17.59	1.18	0.97	NS	NS	Ns	Ns

MgS = magnesium sulphate at 0.3 %, SA = salicylic acid at 500 ppm, KSi = potassium silicate at 2000 ppm

As for juice volume of 100 berries, the obtained results clear that the maximum value was recorded with the treatment included MgS+SA+KSi in both studied seasons, while the lowest volume was recorded with the control in the first season and spraying MgS solely in the second season.

Regarding length and diameter of the berry, the results show that both parameters had recorded the highest values when the vines sprayed with MgS+SA+KSi, the other treatments included the control show lower values. This was true for both parameters in the two studied seasons.

Results in Table (7) show the berries chemical properties as affected by different sprayed treatments. In this respect, total acidity in the berry juice was reduced due to the applied treatments than the control. The lowest value of acidity was obtained with the treatment included MgS+SA+KSi, while the control gave the highest value.

As for TSS and TSS/acid ratio, the obtained results clear that all treatments increased these parameters. The results of both parameters have the same trend since the treatment of MgS+SA+KSi gave the highest values, followed by the treatment of SA+KSi. The untreated vines gave the lowest values for both TSS and TSS/acid ratio in both studied seasons.

As for total sugars percentage, it is clear that presence of the three sprayed materials in the same solution recorded the highest values, followed by the treatment included both SA+KSi. The lowest value for this parameter was recorded by the control.

Table 7. Effect of MgS, SA, and KSi foliar sprays on berry chemical properties of grape during 2018 and 2019 seasons

Treatments	Total acidity (%)		TSS (%)		TSS/acid ratio		Reducing sugars (%)		Non-reducing sugars (%)		Total sugars (%)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	0.63	0.64	17.2	16.8	27.30	26.25	17.8	16.2	1.7	2.6	19.5	18.8
MgS	0.59	0.55	18.4	18.6	31.19	33.82	18.00	17.8	1.7	2	19.7	19.8
SA	0.54	0.56	18.00	18.6	33.33	33.21	19.2	18.9	1.2	1.8	20.4	20.7
KS	0.53	0.55	18.9	19.00	35.66	34.55	18.9	19.7	0.8	0	19.7	19.7
Mg+SA	0.57	0.57	18.9	19.0	33.16	33.33	19.8	19.7	1.9	2	21.7	21.7
Mg+KS	0.56	0.57	18.9	18.7	33.75	32.81	19.2	18.7	1.7	1.7	20.9	20.4
SA+ KS	0.55	0.55	19.2	19.6	34.91	35.64	20.0	20.1	0.7	0.9	20.7	21.00
MgS+SA+KS	0.50	0.52	19.9	20.1	39.80	38.65	21.90	22.2	0.9	0.7	22.8	22.9
LSD at 0.05 level	0.02	0.06	0.27	0.32	1.12	2.17	0.98	0.63	NS	NS	0.89	0.77

MgS = magnesium sulphate at 0.3 %, SA = salicylic acid at 500 ppm, KSi = potassium silicate at 2000 ppm

4. Discussion

The effects of spraying magnesium sulphate (MgS), salicylic acid (SA), and potassium silicate (KSi) have a positive effect on increasing the length and width of grapevine leaves, leaf area, leaf fresh and dry weight and decreased moisture content.

Such growth parameters increment values could be due to the effect of Mg on some physical functions such as synthesis of carbohydrates and activating several enzymes which in turn affecting the plant growth [5]. Magnesium is also the essential nutrient for plant growth and plays an important role in photosynthesis, activation of enzymes and metabolism of carbohydrates [23].

Regarding macro-nutrients content in the leaves [3] found that applications containing salicylic acid improved N, P and K in the leaves. Also, salicylic acid has been shown to regulate various aspects of vegetative growth and development, also play as a main signaling key in thermogenesis and disease resistance [4, 24].

As for chlorophyll content, Mg is a major component of chlorophyll, since chlorophyll contents about 15 to 20 % of the plant total Mg constitution. Consider ribosome granules also has a structural component, stabilizing them in the composition needed. Mg foliar spray increased the translocation of photosynthesis synthesis materials from the leaf into the grape fruit [25]. Salicylic acid (SA) treatment also increases the area of the plants, a corresponding rate of photosynthesis, total carbohydrates and photosynthetic pigments, thus increasing the bio-productivity of the crops [26]. Also, total chlorophyll content in grapevine was the highest with SA spray than the unsprayed ones [3]. The obtained results are agreed with those on Murcott mandarins regarding magnesium effect [9].

In the same line, foliar application of SA enhanced the content of N, P, K, Cu, Fe, Zn, Na and Mn and increased the level of proteins and nitrate reductive activity [27].

The effect of spraying different magnesium forms on mineral contents are in line with the findings by many researchers on orange [7, 8]. In this concern, spraying SA improved the percentages of N, P and K in the leaves of grapevine than the unsprayed vines [4].

The positive effects of Mg application on the yield of grapevine could be attributed to its role in enhancing plant metabolism that reflected on berry yield and berry quality. Therefore, the beneficial effect of Mg as a foliar fertilizer on yield and its components could be due to the fact that Mg plays a significant role in the formation of the organic compound such as carbohydrates, lipids etc., which translocate to the reproductive organs and consequently increasing the yield and its components [5]. Improving grape yield and certain quality that attributed as response to foliar spray of SA has been reported by many researchers [3, 14] on grapes. While, that attributed to Mg, has been reported by Ram [6] on mandarin.

The results concerning total sugars percentage have been supported by many studies [3] regarding SA, [10] on grapes as for magnesium and [15] on grapes concerning potassium silicate.

5. Conclusion

Generally, from the above mentioned results, it observed that spraying any of the examined materials solely gave better results than the control, while the results were more enhanced when the spraying solution included more than one of the spraying materials. However, the best results were detected when all the three examined materials were sprayed together. This was true in respect to all the parameters in this study. Finally, it could be concluded that the treatment included the three spray materials (MgS+SA+KSi) was the promising one under this study conditions.

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