Fruiting of Flame Seedless Grapevines as Affected by Spraying Silicon

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Abstract: During 2016 and 2017 seasons, Flame seedless grapevines grown under Luxcor conditions were subjected one, twice or thrice to potassium silicate at 0.05 to 0.2%. The merit was examining the effect of silicon on growth, vine nutritional status, yield, berries colouration % and quality of the berries. Treating the vines once, twice or thrice with potassium silicate at 0.05 to 0.2% was very effective in improving shoot length, leaf area, chlorophylls a & b, total carotenoids, N, P, K, Mg, Zn, Fe and Mn, berry setting %, yield, berries colouration % and quality of the berries relative to the control. The promotion was considerably related to the increase in concentrations and frequencies of applications. Carrying out two sprays at growth start and again just after berry setting of potassium silicate at 0.1% was responsible for promoting berries colouration, yield and berries quality of Flame seedless grapevines grown under Luxor region conditions.

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1. Introduction

Abiotic stress caused by higher temporarily on Flame seedless grapevines grown under Luxor environmental conditions resulted in poor yield and berries colouration. Many efforts were done for findings out the recent and non- traditional horticultural practices that are responsible for solving these defects. Out of these practices was the application of silicon as an essential antioxidant required for the trees grown under unfavourable environmental conditions.

Beneficial effects of Si are more prominent when plants were subjected to multiple stresses including biotic and abiotic stresses (**Aziz *et al.*, 2002; Rodrigues *et al.*, 2003; Ma, 2004 and Tahir, *et al.*, 2006**). Silicon is also known to increase drought tolerance in plants by maintaining plant water balance, photosynthetic activity, erectness of leaves and structure of xylem vessels under high transpiration rates (**Melo *et al.*, 2003 and Hattori *et al.*, 2005**). Silicon is responsible for improving water economy (**Gang *et al.*, 2003**) and leaf water potential under water stress conditions (**Matoh *et al.*, 1991**). The previous authors suggested that a silicon cuticle double layer formed on leaf epidermal tissue is responsible for this higher water potential. The results of **Lux *et al.*, (2003) and Hattori *et al.*, (2005)** suggested that Si plays an important role in water transport and root growth under drought conditions. **Bowen *et al.*, (1992)** stated that Si inhibits powder mildew in grapes.

Previous studies showed that silicon had an outstanding effect on growth and fruiting of different grapevine cvs (**El- Khawaga, 2014; Al- Wasfy, 2014; Nagy Dina, 2016; Hassan, 2017 and Metwally, 2017**).

The target of this study was examining the effect of different concentrations and frequencies of potassium silicate on growth characteristics, vine nutritional status, yield and berries quality of Flame seedless grapes.

2. Materials and Methods

This study was carried out during the two successive seasons of 2016 and 2017 on thirty 8-years old Flame seedless grapevines grown in a private vineyard located at El- Tode village – Luxor district, Luxor Governorate where the soil texture is sandy and well drained and water table is not less than two meters deep. Vines are spaced at 2.0 meters (between vine) x 3 meters (between rows) (700 vines per feddan). The selected vines (30 vines) were chosen as uniform in vigour as possible and devoted to achieve this study. The chosen vines were pruned during the first week of January in both seasons. Spur pruning system using gable shape supporting method was followed. Vine load for all the selected vines was adjusted to 72 eyes (on the basis of 15 fruiting spurs x four eyes plus six replacement spurs x two eyes). Drip irrigation system was followed using Nile water.

The target of this study was examining the effect of different concentrations and frequencies of application of potassium silicate on some vegetative growth characteristics, leaf chemical composition, yield, berries colouration % and quality of the berries of Flame seedless grapevines grown under Luxer region conditions.

Mechanical, physical and chemical analysis of the tested soil at 0.0 - 90.0 cm depth were carried out at the start of the experiment according to the procedures of **Chapman and Pratt (1965).**

Table (1): Analysis of the tested soil

Constituents	Values
Sand %	78.0
Silt %	12.0
Clay %	10.0
Texture %	Sandy
pH (1: 2.5 extract) ppm	7.5
E.C. (1: 2.5 extract) ppm	500
O.M. %	0.20
$CaCO_3$ %	2.25
Total N %	0.09
Available P (Olsen method, ppm)	2.1
Available K (ammonium acetate, ppm)	45.0
EDTA extractable micronutrients (ppm)	
Fe	1.0
Mn	0.9
Zn	1.0
Cu	0.4

Except those dealing with the present treatments (application of silicon – fertilizers), all the selected vines (30 vines) received the usual horticultural practices which are commonly used in the vineyard including the application of 20 m^3 / fed farmyard manure (F.Y.M.), 200 kg ammonium sulphate (20.6 % N), 150 kg calcium superphosphate (15.5 % P_2O_5) and 300 kg potassium sulphate (48 % K_2O) per one feddan. Farmyard manure (0.25 % N) was added once at the middle of January. Phosphate fertilizer was added once with F.Y.M. Potassium fertilizer was added three times a week at a rate of 4 kg/ fed. drip irrigation. Mineral N fertilizer was added at three times a week at a rate of 5 kg/ fed via drip irrigation till the start of berry setting then added at a rate of 2.5 kg/ fed till one month after harvesting. The other horticultural practice were carried out as usual.

This experiment included the following ten treatments from various concentrations and frequencies of application of potassium silicate:

1- Control.

2- Spraying potassium silicate once (growth start) at 0.05% (0.5 gL^{-1}).

3- Spraying potassium silicate twice (growth start and again just after berry setting) at 0.05% (0.5 gL^{-1}).

4- Spraying potassium silicate thrice (growth start just after berry setting and at one month later) at 0.05% (0.5 gL^{-1}).

5- Spraying potassium silicate once at 0.1 % (1.0 g L^{-1}).

6- Spraying potassium silicate twice at 0.1 % (1.0 g L^{-1}).

7- Spraying potassium silicate thrice at 0.1 % (1.0 g L^{-1}).

8- Spraying potassium silicate once at 0.2 % (2.0 g L^{-1}).

9- Spraying potassium silicate twice at 0.2 % (2.0 g L^{-1}).

10- Spraying potassium silicate thrice at 0.2 % (2.0 g L^{-1}).

Therefore, thus study involved ten treatments. Each treatment was replicated three times, one vine per beach. The total number of selected vines for achieving of this study was 30 uniform in vigour vines. Potassium silicate (25% Si +10 % K_2O) were sprayed once at growth start when the mean lengths of main shoot reached at least 30cm) mid of March), just after berry setting (2nd week of April) and at one month late (2nd of May) Triton B as wetting agent was applied at 0.05% to silicon solutions before spray. Control vines were sprayed with tap water containing triton B at 0.05%. Spraying was done till runoff (1-2 L vine solution according to the date of spraying).

The present experiment was set up in a randomized complete block design (RCBD) with three replicates each consisted from one Flame seedless grapevine.

The following, growth characteristics, leaf chemical composition, fruit setting, yield and both physical and chemical berries characteristics were recorded during the two seasons.

At the middle of May during both seasons, twenty mature leaves from the opposite side to the basal clusters on the shoots were picked for calculating the leaf area using the following equation outlined by **Ahmed and Morsy (1999).**

Leaf area $(cm)^2$ = 0.45 (0.79 x diameter ^{2}) + 17.77.

The average leaf area was recorded. Average main shoot length (cm) was recorded as a result of measuring the length of the ten shoots per vine (cm) and the average shoot length was recorded.

Plant pigments namely chlorophylls a & b and total carotenoids were determined as mg / 100 g F.W. The same fresh leaves chosen for measuring leaf area were out into small pieces and a known sample (0.5g) from each sample was taken, homogenized and extracted using 25% acetone with the assistance of little amounts of Na_2CO_3 and clean sand. Filtration was conducted and the residue was washed several times with acetone till the filtrate was colorless. Acetone was used as a blank. The optical density of the filtrate was determined using spectrophotometer at the wave length of 662, 644 and 440 nm to determine chlorophylls a and b and total carotenoids, respectively (**Fadl and Seri El-Deen, 1978 and Hiscox and Isralstam, 1979**). The following equations were used for determination of the three plant pigments (according to **Von-Wettestein, 1957**).

Chl. a= (9.784 - E 662) - (0.99 - E 644) = mg II

Chl. b= (21.426 - E 644) - (4.65 - E 662) = mg II

Total Carotenoids = (4.965 x E 440 - 0.268) chlorophyll a + chlorophyll b).

Where E= Optical density at a given wave length. These plant pigments were calculated as (mg / 100 g F.W.).

Twenty leaves picked from those opposite to the basal clusters (According to **Summer, 1985**) for each vine were taken at the middle of May in both seasons. Blades and petioles of leaves were separated where blades were discarded and petioles were saved for determination of N, P, K and Mg percentages and leaf content of Zn, Fe, Mn and Cu (as ppm). Petiols were oven dried at 70°C and grounded, then 0.5 g weight of each sample was digested using H_2SO_4 and H_2O_2 until clear solution (**Wilde *et al.,* 1985**). The digested solutions were quantitatively to 100 ml volumetric flask and completed to 100 ml by distilled water. Thereafter, leaf contents of N, P, K, Mg, Zn, Fe, Mn and Cu for each sample were determined as follows:

1- Nitrogen % was determined by the modified microkeldahl method as described by **Cottenie *et al.,* (1982).**

2- Phosphorus % was determined by using Olsen method as reported by **Carter, (1993).**

3- Potassium % was flame photometrically determined using the method outlined by **Peach and Tracey, (1968).**

4- Magnesium % was determined by using versene method as outlined by (**Evenhuis and Dewaard, 1980**).

5- Micronutrient namely, Zn, Fe, Mn and Cu were determined as ppm using atomic absorption spectrophotometry (**Wilde *et al.,* 1985**).

Percentage of berry setting was calculated by caging five clusters per each vine in perforated white paper bags before bloom. After set completed the bags were removed for counting:

a) The number of attached barriers.

b) The number of dropped berries.

c) The number of dropped flowers.

d) The number of total flowers (a + b + c) per cluster. Berry set % was estimated by diving number of attached berries by total number of flowers per cluster and multiplying the product by 100.

Harvesting took place when T.S.S./acid in the berries of the check treatment reached at least 25:1 (at the 2nd week of June in both seasons) (according to **Weaver, 1976**). The yield of each vine was recorded in terms of weight (in kg.) and number of clusters per vine, then the average weight of cluster (g) was recorded.

Five clusters from each vine were taken at random for determination of the following physical and chemical characteristics:

1- Cluster dimensions (length and shoulder in cm).

2- Berries colouration % was calculated by dividing number of red colour berries, cluster by total number of berries, cluster and multiplying the product x 100.

3- Average berry weight (g).

4- Average berry dimensions (longititudinal and equatorial in cm).

5- Percentage of total soluble solids in the juice by using handy refractometer.

6- Percentage of total sugars in the juice by using **Lane and Eynon (1965)** volumetric method as described in (**A.O.A.C, 2000**).

7- Percentage of total acidity (as g tartaric acid / 100 ml juice) by titration against 0.1 NaOH using phenolphthalein as an indicator **(A.O.A.C, 2000).**

8- The ratio between T.S.S. and acid.

9- Total anthocyanins (mg/100 ml juice) using Ethyl alcohol and HCL at 85:15 and the optical density was determined using spectrophotometer at wave length of 532 **(Fulcki and Francis, 1968).**

Statistical analysis:

All the obtained data were tabulated and statistically analyzed Using New L.S.D. at 5% for made all comparisons among the thirteen investigated treatment means (according to **Mead *et al.,* 1993**).

3. Results and Discussion

Main shoot length and leaf area:

Data in Table (3) show the effect of different concentrations and frequencies of application of potassium silicate on the main shoot length and leaf area of Flame seedless grapevines during 2016 and 2017 seasons.

It is clear from the obtained data that subjecting Flame seedless grapevines to potassium silicate once, twice or thrice at 0.05 to 0.2% significantly was accompanied with stimulating main shoot length and leaf area relative to the control. The promotion on such two parameters was in proportional to the increase in concentrations and frequencies of applications. Increasing concentrations of K- silicate from 0.1 to 0.2% and frequencies of application from twice to thrice had no significant promotion on such two parameters. The maximum values of main shoot length (117.5 and 118.0 cm) and leaf area (116.3 & 115.8 cm^2) were recorded on the vines that treated with K- silicate thrice at 0.2% during both seasons, respectively. The untreated vines produced the minimum values. These results were true during both seasons.

Leaf chemical components

Data in Tables (3 to 5) show the effect of different concentrations and frequencies of application of potassium silicate on chlorophylls a & b, total carotenoids, N, P, K, Mg, Zn, Fe and Mn in the leaves of Flame seedless during 2016 and 2017 seasons.

It is evident from the obtained data that all leaf chemical components namely chlorophylls a & b, total carotenoids, N, P, K, Mg, Zn, Fe and Mn were significantly varied among the ten silicon treatments. They were significantly increased with treating the vines once, twice, or thrice with K- silicate at 0.05 to 0.2% over the control. A progressive promotion on these pigments and nutrients was observed with increasing concentrations from 0.05 to 0.2 % and frequencies of applications from once to thrice. Increasing concentrations of K- silicate from 0.1 to 0.2% and frequencies of applications from twice to thrice had no significant promotion on these pigments and nutrients. The maximum values of chlorophyll a (6.5 & 6.8 mg/ g F.W.), b (2.7 & 2.7 mg/ g F.W.), total carotenoids (2.8 & 2.8 mg/ g F.W.), N (1.90 & 1.96 %), P (0.162 & 0.166 %), K (1.42 & 1.41 %), Mg (0.72 & 0.77 %), Zn (m 51.0 & 51.4 ppm) Mn (61.3 & 60.9 ppm) and Fe (61.4 & 61.5 ppm) were recorded on the vines that received K- silicate three times at 0.2% during both seasons, respectively. The lowest values were recorded on the untreated vines. Similar results were announced during both seasons.

The percentage of berry setting

Table (6) shows the effect of different concentrations and frequencies of application of potassium silicate on the percentage of berry setting of Flame seedless grapevines during 2016 and 2017.

It is noticed from the obtained data that exposing Flame seedless grapevines once, twice or thrice with K- silicate at 0.05 to 0.2% significantly improved the percentage of berry setting over the check treatment. The promotion on such parameter was associated with increasing concentrations and frequencies of applications of K- silicate. No significant promotion on such parameter was detected among the higher two concentrations (0.1 and 0.2%) and frequencies of applications (twice and thrice) The highest percentage of berry setting (18.7 & 21.1 %) was recorded on the vines treated three times with K- silicate at 0.2% during both seasons, respectively. The lowest values (12.9 & 13.0 %) were recorded on the untreated vines during both seasons, respectively. These results were true during both seasons.

Yield and cluster aspects

Data in Tables (6 & 7) show the effect of different concentrations and frequencies of application of potassium silicate on the yield expressed in number of clusters / vine and weight (kg.) as well as weight, length and shoulder of cluster of Flame seedless grapevines during 2016 and 2017.

Yield expressed in number of clusters/ vine and weight (kg.) as well as weight, length and shoulder of cluster significantly were improved in response to treating the vines one, twice or thrice with K- silicate at 0.05 to 0.2% relative to the control. Increasing concentrations and frequencies of application of K- silicate caused a gradual promotion on these parameters. Significant differences on these parameters were observed among all concentrations and frequencies of applications of K- silicate except among the higher two concentrations namely 0.1 to 0.2% and frequencies of application namely twice to thrice. Therefore, from economical point of view, it is concluded to spray Flame seedless grapevines twice with K- silicate at 0.1%. Under such promised treatment, yield per vine reached 9.6 and 12.5 kg during both seasons, respectively. The untreated vines produced 7.7 and 8.1 kg during both seasons, respectively. The percentage of increment on the yield due to using the previous promised treatment over the control reached 24.7 and 54.3 % during both seasons, respectively. Number of clusters per vine was unaffected by the present treatments. Similar trend was noticed during both seasons.

Percentage of berries colouration

Data in Table (7) show the effect of different concentrations and frequencies of application of potassium silicate on the percentage of berries colouration of Flame seedless grapevines during 2016 and 2017 seasons.

It is evident from the obtained data that subjecting the vines to K- silicate once, twice or thrice at 0.05 to 0.2% succeeded significantly in enhancing berries colouration % rather than non-application. The advancement in berries colouration was related to the increase in both concentrations and frequencies of application of K- silicate. Meaningless promotion on berries colouration% was recorded when concentration of K- silicate was increased from 0.1 to 0.2% and frequencies of application from twice to thrice. The maximum percentage of berries colouration (79.4 & 81.7 %)

was recorded on the vines that received three sprays of K- silicate at 0.2% during both seasons, respectively. The percentage of berries colouration reached 70.9 & 71.0 % in the untreated vines during 2016 and 2017 seasons, respectively. These results were true during both seasons.

Some physical and chemical characteristics of the berries

Data in Tables (7 to 9) show the effect of different concentrations and frequencies of application of potassium silicate on berry weight and dimensions (equatorial and longitudinal), T.S.S.%, reducing sugars %, total acidity % and total anthocyanins in the berries of Flame seedless grapevines during 2016 and 2017 seasons.

It is clear from the obtained data that supplying the vines with K- silicate once, twice or thrice at 0.05 to 0.2%, significantly was very effective in improving both physical and chemical characteristics of the berries in terms of increasing weight, equatorial and longitudinal of berry, T.S.S.%, reducing sugars % and total anthocyanins and decreasing total acidity % relative to the control. The promotion on quality of the berries was associated with increasing concentrations and frequencies of application of K- silicate. Increasing concentrations of K- silicate from 0.1 to 0.2% and frequencies of applications from twice to thrice failed to show significant promotion on fruit quality characteristics. Therefore, from economical point of view the best results were obtained due to treating the vines twice with K- silicate at 0.1%. The untreated vines produced unacceptable effect on fruit quality. These results were true during both seasons.

Table (2): Effect of different concentrations and frequencies of application of potassium silicate on main shoot length, leaf urea and chlorophylls a and b of Flame seedless grapevines during 2016 and 2017 seasons.

K- silicate treatments	Main shoot length (cm)		Leaf area (cm)^2		Chlorophyll a (mg/ g F.W.)		Chlorophyll b (mg/ g F.W.)	
	2016	2017	2016	2017	2016	2017	2016	2017
Control	111.0	109.4	109.0	108.9	4.4	4.5	1.1	1.6
K- silicate once at 0.05%	112.4	110.7	110.0	110.1	4.9	5.0	1.4	1.4
K- silicate twice at 0.05%	114.0	112.9	111.9	112.0	5.5	5.5	1.7	1.8
K- silicate thrice at 0.05%	114.2	113.2	112.0	112.1	5.6	5.6	1.8	1.9
K- silicate once at 0.1 %	116.0	115.5	114.0	113.9	6.0	6.1	2.2	2.2
K- silicate twice at 0.1 %	117.4	117.0	115.5	115.6	6.3	6.6	2.5	2.5
K- silicate thrice at 0.1 %	117.5	117.7	116.0	115.7	6.4	6.7	2.6	2.6
K- silicate once at 0.2 %	116.1	115.6	114.3	114.0	6.1	6.2	2.3	2.3
K- silicate twice at 0.2 %	117.5	117.2	115.6	115.7	6.4	6.7	2.6	2.6
K- silicate thrice at 0.2 %	117.6	118.0	116.3	115.8	6.5	6.8	2.7	2.7
New L.S.D. at 5%	1.0	1.1	1.0	0.9	0.3	0.4	0.2	0.3

Once = at growth start. Twice = at growth start and again just after berry setting.
Thrice = at the two previous dates and at one month later.

Table (3): Effect of different concentrations and frequencies of application of potassium silicate on total carotenoids and percentages of N, P, and K of Flame seedless grapevines during 2016 and 2017 seasons.

K- silicate treatments	Total carotenoids (mg/ g F.W.)		Leaf N %		Leaf P %		Leaf K %	
	2016	2017	2016	2017	2016	2017	2016	2017
Control	1.1	1.0	1.58	1.59	0.124	0.120	1.11	1.14
K- silicate once at 0.05%	1.4	1.3	1.66	1.68	0.134	0.130	1.17	1.19
K- silicate twice at 0.05%	1.7	1.7	1.72	1.74	0.141	0.140	1.23	1.25
K- silicate thrice at 0.05%	1.8	1.8	1.73	1.75	0.142	0.141	1.24	1.26
K- silicate once at 0.1 %	2.2	2.2	1.81	1.83	0.150	0.153	1.33	1.32
K- silicate twice at 0.1 %	2.6	2.6	1.88	1.94	0.159	0.163	1.40	1.39
K- silicate thrice at 0.1 %	2.7	2.7	1.89	1.95	0.160	0.164	1.41	1.40
K- silicate once at 0.2 %	2.3	2.4	1.82	1.84	0.151	0.155	1.34	1.33
K- silicate twice at 0.2 %	2.7	2.7	1.89	1.95	0.160	0.165	1.41	1.40
K- silicate thrice at 0.2 %	2.8	2.8	1.90	1.96	0.162	0.166	1.42	1.41
New L.S.D. at 5%	0.3	0.3	0.05	0.06	0.006	0.008	0.04	0.04

Once = at growth start. Twice = at growth start and again just after berry setting.
Thrice = at the two previous dates and at one month later.

Table (4): Effect of different concentrations and frequencies of application of potassium silicate on the leaf content of Mg (as %) and Zn, Mn and Fe (as ppm) of Flame seedless grapevines during 2016 and 2017 seasons.

K- silicate treatments	Leaf Mg %		Leaf Zn (ppm)		Leaf Mn (ppm)		Leaf Fe (ppm)	
	2016	2017	2016	2017	2016	2017	2016	2017
Control	0.51	0.49	40.3	41.0	48.3	48.0	50.1	50.0
K- silicate once at 0.05%	0.55	0.58	43.0	43.8	51.3	51.0	52.1	51.9
K- silicate twice at 0.05%	0.60	0.63	45.5	46.3	54.0	53.7	55.0	54.8
K- silicate thrice at 0.05%	0.61	0.64	46.0	46.5	54.5	53.8	55.4	54.9
K- silicate once at 0.1 %	0.66	0.70	48.0	48.9	57.9	57.6	58.0	58.3
K- silicate twice at 0.1 %	0.70	0.75	50.0	51.0	60.9	60.6	61.0	61.3
K- silicate thrice at 0.1 %	0.71	0.76	50.6	51.3	61.0	60.7	61.3	61.4
K- silicate once at 0.2 %	0.67	0.71	48.3	49.0	58.0	57.7	58.2	58.4
K- silicate twice at 0.2 %	0.71	0.76	50.2	51.1	61.0	60.7	61.3	61.4
K- silicate thrice at 0.2 %	0.72	0.77	51.0	51.4	61.3	60.9	61.4	61.5
New L.S.D. at 5%	0.02	0.02	1.9	1.8	1.9	2.1	1.7	1.8

Once = at growth start. Twice = at growth start and again just after berry setting.
Thrice = at the two previous dates and at one month later.

Table (5): Effect of different concentrations and frequencies of application of potassium silicate on the percentage of berry setting, yield and cluster weight of Flame seedless grapevines during 2016 and 2017 seasons.

K- silicate treatments	Berry setting %		No. of clusters / vine		Yield/ vine (kg.)		Av. Cluster weight (g.)	
	2016	2017	2016	2017	2016	2017	2016	2017
Control	12.9	13.0	22.0	23.0	7.7	8.1	350.0	351.0
K- silicate once at 0.05%	14.8	14.7	23.0	25.0	8.3	9.1	362.0	364.0
K- silicate twice at 0.05%	16.4	16.7	23.0	27.0	8.6	10.2	374.0	376.0
K- silicate thrice at 0.05%	16.5	16.8	23.0	27.0	8.6	10.2	375.0	377.0
K- silicate once at 0.1 %	17.0	18.9	24.0	29.0	9.3	11.3	386.0	390.0
K- silicate twice at 0.1 %	18.5	20.9	24.0	31.0	9.6	12.5	400.0	404.0
K- silicate thrice at 0.1 %	18.6	21.0	24.0	31.0	9.6	12.6	401.0	405.0
K- silicate once at 0.2 %	17.1	19.0	24.0	29.0	9.3	11.3	387.0	391.0
K- silicate twice at 0.2 %	18.6	21.0	24.0	31.0	9.6	12.6	401.0	405.0
K- silicate thrice at 0.2 %	18.7	21.1	24.0	31.0	9.6	12.6	402.0	406.0
New L.S.D. at 5%	1.4	1.6	NS	2.0	0.3	0.5	10.1	9.9

Once = at growth start. Twice = at growth start and again just after berry setting. Thrice = at the two previous dates and at one month later.

Table (6): Effect of different concentrations and frequencies of application of potassium silicate on cluster dimensions, berries colouration % and berry weight of Flame seedless grapevines during 2016 and 2017 seasons.

K- silicate treatments	Cluster length (cm)		Cluster shoulder (cm)		Berries colouration %		Berry weight (g.)	
	2016	2017	2016	2017	2016	2017	2016	2017
Control	15.7	14.9	11.0	10.9	70.9	71.0	4.00	4.05
K- silicate once at 0.05%	15.6	15.6	11.4	11.5	72.9	73.0	4.10	4.16
K- silicate twice at 0.05%	16.2	16.3	11.9	12.0	75.0	75.0	4.22	4.30
K- silicate thrice at 0.05%	16.2	16.4	12.0	12.1	75.1	75.3	4.23	4.31
K- silicate once at 0.1 %	16.7	17.0	12.5	12.6	77.1	79.0	4.26	4.39
K- silicate twice at 0.1 %	17.2	17.6	13.0	13.2	79.0	81.5	4.32	4.46
K- silicate thrice at 0.1 %	17.3	17.7	13.1	13.3	79.0	81.6	4.32	4.47
K- silicate once at 0.2 %	16.8	17.1	12.6	12.7	77.2	79.3	4.27	4.40
K- silicate twice at 0.2 %	17.3	17.7	13.1	13.3	79.2	81.6	4.32	4.47
K- silicate thrice at 0.2 %	17.4	17.8	13.2	13.4	79.4	81.7	4.33	4.48
New L.S.D. at 5%	0.4	0.5	0.4	0.4	1.4	1.3	0.06	0.07

Once = at growth start. Twice = at growth start and again just after berry setting. Thrice = at the two previous dates and at one month later.

Table (7): Effect of different concentrations and frequencies of application of potassium silicate on some physical and chemical characteristics of the berries of Flame seedless grapevines during 2016 and 2017 seasons.

K- silicate treatments	Berry longitudinal (cm)		Berry equatorial (cm)		T.S.S. %		Total acidity %	
	2016	2017	2016	2017	2016	2017	2016	2017
Control	1.55	1.58	1.24	1.23	17.5	17.0	0.701	0.699
K- silicate once at 0.05%	1.60	1.62	1.28	1.28	18.0	17.4	0.688	0.681
K- silicate twice at 0.05%	1.66	1.66	1.33	1.34	18.4	17.9	0.670	0.664
K- silicate thrice at 0.05%	1.67	1.66	1.34	1.35	18.5	18.0	0.669	0.662
K- silicate once at 0.1 %	1.74	1.75	1.38	1.40	19.0	18.7	0.650	0.648
K- silicate twice at 0.1 %	1.80	1.81	1.43	1.44	19.4	19.1	0.635	0.632
K- silicate thrice at 0.1 %	1.81	1.82	1.44	1.45	19.5	19.2	0.634	0.630
K- silicate once at 0.2 %	1.75	1.76	1.39	1.41	19.1	18.8	0.648	0.647
K- silicate twice at 0.2 %	1.81	1.82	1.44	1.45	19.5	19.2	0.632	0.631
K- silicate thrice at 0.2 %	1.82	1.83	1.45	1.46	19.6	19.3	0.630	0.629
New L.S.D. at 5%	0.04	0.03	0.03	0.04	0.4	0.3	0.011	0.012

Once = at growth start. Twice = at growth start and again just after berry setting. Thrice = at the two previous dates and at one month later.

Table (8): Effect of different concentrations and frequencies of application of potassium silicate on some chemical characteristics of the berries of Flame seedless grapevines during 2016 and 2017 seasons.

K- silicate treatments	T.S.S. / acid		Reducing sugars %		Total anthocyanins (mg/ 100 g F.W.)	
	2016	2017	2016	2017	2016	2017
Control	25.0	24.3	15.6	15.8	24.1	25.3
K- silicate once at 0.05%	26.2	25.6	15.9	16.2	25.2	26.4
K- silicate twice at 0.05%	27.5	27.0	16.4	16.6	26.4	27.6
K- silicate thrice at 0.05%	27.7	27.2	16.5	16.7	26.5	27.7
K- silicate once at 0.1 %	29.2	28.9	17.0	17.1	28.1	29.0
K- silicate twice at 0.1 %	30.6	30.2	17.5	17.6	29.4	30.0
K- silicate thrice at 0.1 %	30.8	30.5	17.6	17.7	29.5	30.1
K- silicate once at 0.2 %	29.4	29.1	17.1	17.2	29.3	29.1
K- silicate twice at 0.2 %	30.9	30.4	17.6	17.7	29.5	30.2
K- silicate thrice at 0.2 %	31.1	30.7	17.7	17.9	29.6	30.3
New L.S.D. at 5%	0.9	1.0	0.3	0.3	0.9	1.0

Once = at growth start. Twice = at growth start and again just after berry setting. Thrice = at the two previous dates and at one month later.

4. Discussion

Previous studies showed that the favourable effects of silicon on growth, nutritional status of trees and fruiting seem to originate from its positive action on enhancing the tolerance of plants to biotic and abiotic stresses and drought tolerance. This is attributed to its essential role in maintaining plant water balance (**Gang *et al.*, 2003**), photosynthetic activity, erecting the structure of xylem vessels. Previous studies explained these benefits to the formation of silica cuticle double layers formed on leaf epidermal tissue. Silicon also is responsible for water transport and root development as well as increasing the tolerance of plants to producing mildew. The mechanical strength provided by silicon to the plant tissues increases their resistance to diseases and insects and in responsible for reducing the adverse effects of heavy metal; toxicity (**Matoh *et al.*, 1991; Lux *et al.*, 2003; Rodrigues *et al.*, 2003; Ma, 2004; Hattori *et al.*, 2005 and Tahir *et al.*, 2006**).

These results are in agreement with those obtained by **El- Khawaga (2014), Al- Wasfy (2014), Nagy- Dina (2016), Hassan (2017) and Metwally (2017)** on different grapevines cvs, **Gad El- Kareem (2012); Abdelaal and Oraby- Mona (2013); Ahmed *et al.*, (2013b), Wassel *et al.*, (2015); Abd El- Wahab (2015) and Mohamed *et al.*, (2015)** on different mango cvs.

References

1. Ahmed, F. F. and Morsy, M. H. (1999): A new method for measuring leaf area in different fruit crops. Minia of Agric. Res. & Develop. Vol. (19) pp. 97-105.
2. Al-Wasfy, M.M. (2014): The synergistic effects of using silicon with some vitamins on growth and fruiting of Flame seedless grapevines. Stem Cell 5(1): 8-13.
3. Association of Official Agricultural Chemists (A.O.A.C.) (2000): Official Methods of Analysis (A.O.A.C), 12th Ed., Benjamin Franklin Station, Washington D.C., U.S.A. pp.490-510.
4. Aziz, T.; Gill, M.A. and Rahmatullah, A. (2002): Silicon nutrition and crop production. Pak. J. Agric. Sci. 39(3): 181-187.
5. Bowen, P.; Menzies, J. and Ehret, D. (1992): Soluble silica sprays inhibit powdery mildew development on grape leaves. J. Amer. Soc. Hort. Sci. 117(6): 906-912.
6. Carter, M. R. (1993): Soil Sampling and Methods of Analysis. Canadian Soc. Soil Sci. Lewis Publishers, London, Tokyo, ISBN-10 0873718615.
7. Chapman, H. D. and Pratt, P. P. (1965): Methods of Analysis for Soils, Plants and Water. Univ. of California. Division of Agric., Sci. 172-173.
8. Cottenie, A.; Cerloo, M.; Kiekens, L.; Velgle, G. and Amerlynuck, R. (1982): Chemical analysis of plant and soil. 34-51. Laboratory of Analytical and Agroch. State Univ. Belgium, Gent.
9. El-Khawaga, A.S. (2014): Impact of vitamins B and C, glutamic acid and silicon on fruiting of Superior grapevines. World Rural Observations. 6(4): 57-62.
10. Evenhuis, B. and Dewaard P.W. (1980): Principles and Practices in Plant Analysis. F.A.O., Soil Bull. 38: 172- 163.
11. Fadle, M.S. and Seri El- Deen, S.A. (1978): Effect of N Benzyl adenine on photosynthesis, pigments and total sugars on olive seedling grown under saline conditions, Res. Bull. No. 873, Fac. Agric., Ain Shams Univ.
12. Fulcki, T. and Francis, F.J. (1968): Quantitative methods for anthocyanins. I Extraction and determination for total anthocyanins in cranberries. J. Food Sci., 33:72-77.
13. Gang, H.J.K.; Chen, K.M.; Chen, G.C.; Wan, S.M. and Zhang, C.L. (2003): Effect of silicon on growth of wheat under drought. H. Plant. Nutr. 26(5):1055-1063.
14. Hassan, M.M.M. (2017): Effect of spraying potassium silicate on productivity of Superior grapes M. Sc. Thesis Fac. of Agric. Minia Univ. Egypt.
15. Hattori, T; Inanaga, S.; Araki, H.; An, P.; Martia, S.; Luxova, M. and Lux, A. (2005): Application of silicon enhanced drought tolerance in Sorgham bicolor. Physiologia Plantarum, 123:459-466.
16. Hiscox, A. and Isralstam B. (1979): Method for the extraction of chlorophyll from leaf tissue without maceration. Can. J. Bot. 57:1332-1334.
17. Lane, J. H. and Eynon, L. (1965): Determination of reducing sugars by means of Fehlings solution with methylene blue as indicator A.O.A.C. Washington D.C.U.S.A. pp.490-510.
18. Lux, A.; Luxova, M.; Abe, J. Tanmoto, E. and Inanaga, S. (2003): The dynamic of silicon deposition in the sorghum root endodermis. New Physiol. 158:437-441.
19. Ma, J.F. (2004): Role of silicon in enhancing the resistance of plants to biotic and abiotic stresses. Soil Scr. Plant Nutr. 50:11-18.
20. Matoh, T.; Murata, S. and Takahashi, E. (1991): Effect of silicate application on photosynthesis of rice plants. Japan. J. Soil Sci. Plant Nutr. 62:248-251.
21. Mead, R.; Currnow, R. N. and Harted, A. M. (1993): Statistical Methods in Agricultural and Experimental Biology. 2nd Ed. Chapman and Hall, London pp. 10- 44.
22. Melo, S.P.; Kordnarfer, G.H.; Korndarfer, C.M.; Lana, R.M.G. and Santaon, D.G. (2003): Silicon accumulation and water deficient tolerance in grasses. Scientia Agricola 60:755-759.
23. Metwally, M.A.M. (2017): Trials for improving the productivity and reducing shot berries in Superior grapevines by using silicon and glutathione M. Sc. Thesis Fac. of Agric. Al-Azhar Univ. Assiut branch.
24. Nagy-Dina, A.M. (2015): Response of Flame seedless grapevines to spraying silicon. M. Sc. Thesis Fac. of Agric. Minia Univ. Egypt.
25. Peach, K and Tracey, I.M.V. (1968): Modem Methods of Plant Analysis, Vol. lip. 37-38.
26. Rodrigues, F.A.; Vale, F.X.R.; Kerridorfar, G.H.; Prabhu, A.S.; Datnoff, L.E.; Oliveria,

A.M.A. and Zambalim, L. (2003): Influence of silicon on Shealth blight of rice in Brazil. Crop. Prot; 22: 23-29.

27. Summer, M.E. (1985): Diagnosis and Recommendation Integrated System (DRIS) as a guide to orchard fertilization. Hort. Abst. 55(8): 7502.
28. Tahir, M.A.; Rahmatullah, A.; Aziz, T.; Ashraf, M.; Kanwal, S. and Magsood, A. (2006): Beneficial effects of silicon in wheat (*Triticum aestivum* L.) under salinity stress. Pak. J. Bot. 38(5):1715-1727.
29. Wassel, A.M.M.; Gobara, A.A.; Mohamed, A.Y. and El- Sadek, M.A. (2015): Response of Ewaise mango trees to foliar application of boron and ilicon. J. Biol. Chem. Environ. Sci. 10 (4): 423-437.
30. Weaver, R.J. (1976): Grape growing A wiley Interscience Publication John Willey & Davis, New York, London, Sydney, Toronto pp. 160-175.
31. Von-Wettstein, D. (1957): Chlorophyll-letale und der submikroskopische Formwechsel der Plastiden. Experimental Cell Research, 12(3): 427-506.
32. Wilde, S. A.; Corey, R. B.; Layer, J. G. and Voigt, G. K. (1985): Soil and Plant Analysis for Tree Culture. 3rd Ed, Oxford and (BH publishing Co., New Delhi. India, pp. 1-218.

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