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Effect of Silicon Foliar Sprays Combined with Moringa Leaves Extract on Yield and Fruit Quality of "Flame Seedless" Grape (*Vitis vinifera* L.)

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ABSTRACT

This study was conducted during two seasons 2014 and 2015 to evaluate the effects of spraying natural moringa leaf extract, silicon and their combination on vine vigor, yield and fruit quality of "Flame seedless" (*Vitis vinifera* L.) grapevine grown in a private vineyard located at El-Beheira Governorate. Seven treatments were done, control (spraying with water), silicon at 0.1%, moringa extract at 2%, and silicon at 0.1% plus moringa extract at 2%. All treatments were sprayed in two ways (2 times only and every 2 weeks) starting at 15-20 cm of shoot length. The obtained results revealed that the suggested treatments were effective in stimulating different growth parameters, yield, and fruit quality parameters. Moringa leaves extract at 2% combined with silicon at 0.1% every two weeks significantly enhanced vegetative growth parameters in terms of leaf area, total chlorophyll, average shoot length, cane internodes length, and their diameter, and removed pruning weight, leaf nutrients content as N, P, K, Fe, Zn and Mn. Also cluster physical quality parameters in terms of weight, length, width, berry physical parameters as weight and volume of 100 berries, firmness, berry removal force, berry length and diameter consequently and juice chemicals in terms of SSC, SSC/acid ratio, anthocyanins and total sugars contents are also increased. Sequently, it increased the total yield per vine and reduced titratable acidity.

Keywords: *Silicon, Moringa extract, fruit quality, yield and Flame seedless grapevines.*

INTRODUCTION

Grape (*Vitis vinifera* L.) is one of the most popular and common fruits in the world. In Egypt, the area of grape vine increased recently specially in the newly reclaimed land. Flame seedless is considered as an important cultivar as table grapes for Egyptian market, as well as for the export market. It has many nutritive values as a major source of nutrients, organic acids, vitamins and many antioxidants such as phenols and β carotene (Fuleki and Ricardo-da-Silva, 2003). Flame seedless grape marketing value depends upon its desirable appearance, berry, cluster size, and shape. Therefore, any horticulture applications that could be done to enhancing these characteristics would be very important as like growth regulators and nutritional elements. Recently, public health and environmental safety encourage the use of natural extracts as an alternative to different chemicals for enhancing production of fruit crops. Nowadays, there is a widespread use of both silicon and moringa extracts.

Silicon is the second most abundant soil element after oxygen, comprising 29% of the Earth's crust. The use of Si as fertilizer began in the 1950s in Japan and is now widespread (Guntzer *et al*., 2012 and Haynes, 2014). It is an important secondary metabolite in grape berries and plays an essential role in determining berry quality such as color, flavor, astringency, and bitterness. Moreover, it prevents fruit softening by affecting activities of major cell wall degrading enzymes such as cellulase, polygalacturonase, and xylanase (Zhang and Ervin, 2008). Si is considered to be quasi-essential element, due to its benefits confers on plants, that enhanced growth, yield and crop quality, photosynthesis, N_2 fixation, particularly in response to abiotic and biotic stresses as metal toxicity, high and low temperature, nutrient deficiency, drought, and salinity (Epstein and Bloom, 2005 and Van Bockhaven *et al*., 2013). Using silicon in fruit orchards grown under unsuitable conditions was accompanied with alleviating the adverse effects of these conditions on fruiting of fruit crops. This is happened by maintaining plant water balance, photosynthesis activity, water transport and organic foods (Aziz *et al*., 2002 and Epstein and Bloom, 2005). In this respect, Al-Wasfy (2014) reported that applications of silicon resulted in improving growth, yield and quality of Flame seedless berries and remarkable promotion on both berry weight and cluster coloration.

Fresh Moringa oleifera leaves have high zeatin concentrations (up to 200 mcg/g of leaves), antioxidants and macro–micro nutrients (Fuglie, 2000 and Azra *et al*., 2013). Moreover, moringa leaves are a potential source of vitamin A and C, iron, calcium and b-carotene (Nambiar *et al*., 2005, and Siddhuraju and Becker 2003). It is rich in purine and adenine as derivatives of plant hormone group of cytokinin. Zeatin enhances the antioxidant properties of many enzymes and protects the cells from aging effects ofdifferent reactive oxygen species (Zhang and Ervin 2004).

Since the major fraction of plant hormones in moringa leaf extract is cytokinin, it was assessed with growth enhancement, it is mainly attributed to cytokinins or its a cumulative effect on plant hormones and mineral nutrients present in moringa leaf (Wahid *et al*., 2007). This natural plant hormone has increased the yield of many crops even when applied in small concentration. This fact was revealed by Foidle *et al*., (2001) who reported that foliar spray with the moringa leaf extract showed a significant enhancement in yield despite the fact that it was applied in very small amounts. Also, Fuglie (2000) reported that leaf extracts of moringa accelerated the growth of young plants, improved plant resistance, increased leaf area, the number of roots, produced more and larger pear fruits and generally increased yield by 20 to 35%.

The objective of the current study is to improve the growth, yield, fruit quality, and marketing tolerance of Flame seedless (*Vitis vinifera*) grape cv. grown under EL-Nobaria region conditions by using new natural and safe substrates as moringa leaves extract and silicon.

MATERIALS AND METHODS

This study was carried out during two successive seasons of 2014 and 2015 on seven years old, Flame seedless grapevine (*Vitis vinifera* L.), grown in a private vineyard located at El-Nobaria region, El-Beheira Governorate. The vines were planted in sandy soil (soil texture was: sand 88, silt 7, clay 5, pH 8.2 and Ec 2.1 dSm^{-1}) at 1.5 meters in a row and 3 meters between rows under drip irrigation system. A spur pruning system was adopted during winter pruning with bud load 68 eyes/ vine (12 fruiting spurs × 5 eyes and four replacement spurs × 2 eyes) with wire trills supporting system. Normal cultural practices were done as recommended by the ministry of agriculture and land reclamation for grapevines. Sixty-three vines were selected to be healthy and as uniform as possible and arranged in a randomized complete block design with seven treatments, replicated three times with three vines. The treatments were arranged as follows:

1. Control (spray with water)
2. Silicon 0.1% spray two times
3. Silicon 0.1% spray every 2 weeks
4. Moringa extracts 2 % spray two times
5. Moringa extracts 2 % spray every 2 weeks
6. Silicon 0.1% + Moringa extract 2% spray two times
7. Silicon 0.1% + Moringa extract 2% spray every 2 weeks

Foliar spraying was applied in two ways: the first, (two times) when shoot length reached 15-20 cm, and once again two weeks after fruit set. The second, also started at 15-20 cm of shoot length and continued (every 2 weeks) till veraison stage.

Preparation of moringa extract:

The moringa leaves extract at 2% was prepared by blending 20g of young moringa leaves with 675 ml of 80% ethanol as suggested by (Makker and Becker, 1996). The obtained suspension homogenized and filtered by wringing using a mutton cloth. Finally, the solution re-filtered using No.2 Whatman filter paper and rose to one liter.

Preparation of silicon solution:

It was prepared as suggested by (Alexand *et al*., 1954) by solvating 1g of SiO_2 (Silicon dioxide, Mol.weight.60.08) in 100 ml of KOH 0.1 N (potassium hydroxide, 5.6 g/l) for 24 h. then diluted to 1 liter.

The following data was recorded:

A. Vegetative growth and vine vigor:

1. Leaf surface area and shoot length were measured using five shoots per vine (fruiting shoot) which were labeled for measuring the average shoot length (cm) and total surface area of the leaves per vines (cm^2/vine) which calculated as average leaf area multiplied by the number of leaves/shoot by number of shoots per vine.
2. Total leaf chlorophyll content (as mg/100 g F.W) was measured in ten mature leaves which were collected from (5-7th leaves from shoot top) opposite to basal clusters according to Wettstein, (1957).
3. Internodes length and diameter (cm) was measured in the mid of August and calculated as the mean length and diameter of the first six basal internodes of five cans per vine.
4. The weights of removed pruning wood /vine (kg): pruning weights of the selected vines was weighed in winter pruning time (middle January).
5. Vine biomass was calculated as yield/ vine (kg) plus the weights of removed pruning wood produced by the same vine.

B. Leaf mineral content:

Nitrogen % was determined in dried mature leaves (5-7th leaves from shoot top) using the modified micro-Kjeldahl method according to Pregl (1945). Phosphorus % was determined colorimetrically according to Snell and Snell (1967). Also, Potassium % was estimated photometrically according to Jackson (1967). Leaf content of Fe, Mn, and Zn (as ppm) was determined according to (Chapman and Pratt, 1965 and Balo *et al*., 1988).

C. Yield and Fruit Quality:

The cluster weight was recorded in gram and cluster number/ vine was counted in field at harvest date then yield/ vine was expressed as average weight of cluster (kg) x number of cluster/ vine, also the cluster length and width were measured in (cm) and cluster shape index was estimated by dividing cluster length by its width.

1-Berry physical quality characteristics:

Shot berries/cluster (%) was expressed as percent of cluster weight. The length and diameter of berries were determined as the average of ten berries per cluster as mm by using a digital vernal clipper, also berry shape index was calculated by dividing berry length by its width. Berry firmness and berry removal force were measured in ten berries per bunch by using hand dynamometer model FDP1000 with a thump (1mm) for berry firmness and another tool of the same apparatus for berries removal force in gf (gram-force). Data of berry firmness and removal force was transformed into Newton units using standard factor (1 gram-force = 0.00980665 Newton). Also, the weight of 100 berries as g was determined by using digital balance and volume of 100 berries as ml was determined by using the water displacement method.

2-Berry chemical quality characteristics:

The soluble solid contents (SSC) % was measured using hand refractometer apparatus and the titratable acidity (%) was determined as mg of tartaric acid equivalent to NaOH (0.1N) in 100 ml of berries juice (A.O.A.C., 1985)**.** SSC: Acid ratio was calculated using data of SSC % and that of titratable acidity, also the juice pH was determined using Micro Computer pH version 6071 in the juice berries. In addition, total sugars (%) was determined using 80% ethyl alcohol as recommended by Dubois *et al*. (1956) and anthocyanin pigment of the berry skin (mg/100 g fresh weight) was determined according to (Hsia *et al*., 1965).

D. Fruit quality score:

Evaluation system for calculating the total score of fruit quality from each treatment was done according to Mansour *et al*. (1981) using the ranking system in which, the highest SSC % treatment received 7 points, the second best 6 points and so on. The same was done

for SSC/acid ratio, berry firmness, and berry removal force. With acidity percent and shot berries, the lowest value received 7 points, the second best 6 points and so on. The treatment of the highest general score was considered the optimum one. This evaluation system was done at harvest date.

E. Statistical analysis:

The data collected were statistically analysis using the MSTATC computer program as randomized complete block design and differences among means were compared using Duncan's multiple range test Duncan (1955).

RESULTS AND DISCUSSION

A. Vegetative growth, vine vigor, and leaf chlorophyll content:

Data in Tables 1 and 2 clearly showed that silicon at 0.1% and moringa leaves extract at 2% foliar applications alone or combined with the other at two times and every two weeks were significantly effective in improving the vegetative growth and vine vigor parameters in terms of leaf area, average shoot length, internodes length, internodes diameter, as well as totally removed pruning weight, vine biomass, and leaf chlorophyll content of Flame seedless vines compared to control treatment.

Table 1. Effect of moringa leaves extract and silicon spray treatments on some vegetative growth parameters of Flame seedless grapevines during 2014 & 2015 seasons.

Treatments	Leaf area (cm^2)		Average shoot length (cm)		Internodes length (cm)	
	2014	2015	2014	2015	2014	2015
Control	105.2 e	98.4 e	93.4 e	94.7 e	4.0 f	4.1 e
Si. two times	107.8 d	108.9 d	96.5 d	96.4 d	4.6 d	4.5 d
Si. every 2 weeks	109.5cd	110.6 c	96.2 d	97.6 d	4.2 e	4.5 d
Mo. two times	111.0 bc	112.2 b	101.1 c	101.7 c	4.8 c	5.0 c
Mo. every 2 weeks	112.4 bc	113.4 b	108.7 b	107.6 b	5.1 b	5.4 b
Si. + Mo. two times	115.1 ab	116.2 ab	109.7 b	110.7 b	4.2 e	4.4 d
Si. + Mo. every 2 weeks	117.6 a	118.2 a	115.7 a	126.3 a	5.5 a	6.2 a
Significance	**	**	**	**	**	**

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Spraying of silicon 0.1% + moringa extracts 2 % every 2 weeks was more effective in enhancing vegetative growth parameters than that of silicon at 0.1% or moringa leaves extract at 2% alone at two times and every two weeks. Vines sprayed with combined treatment had the highest significant values of all vegetative growth parameters and total leaf chlorophyll content in both seasons. However, the maximum leaf area (117.6 and 118.2 cm^2), average shoot length (115.7 and 126.3 cm), Internodes length (5.5 and 6.2 cm), Internodes diameter (2.3 and 2.7cm), removed pruning weight (2.0 and 2.1 kg), vine biomass (11.71 and 13.06 kg), and total chlorophylls (16.2 and 15.9 mg/ 100 g F.W) were observed on the vines that received Silicon at 0.1% plus moringa extract at 2 % every two weeks in both seasons, respectively. In contrary, vines sprayed with tap water (control) gave the minimum values in this respect in both seasons.

Table 2. Effect of moringa extract and silicon spray treatments on some vine vigor parameters and leaf chlorophyll content of Flame seedless grapevines during 2014 & 2015 seasons.

Treatments	Internodes diameter (cm)		Removed pruning (kg)		Vine Biomass(kg)		Total chlorophyll (mg/100 g FW)	
	2014	2015	2014	2015	2014	2015	2014	2015
Control	1.5 d	1.7 d	1.4 c	1.5 c	9.14 f	9.83 f	10.6 e	10.3 e
Si. two times	1.8 c	2.1 c	1.6 b	1.8 b	10.71 e	11.01 e	12.1 d	11.9 d
Si. every 2 weeks	1.8 c	2.2 c	1.9 ab	1.7 b	11.22 d	11.45 c	13.7 c	13.0 c
Mo. two times	1.9 c	2.4 bc	1.9 ab	1.7 b	10.60 ef	11.49 c	12.7 d	12.9 c
Mo. every 2 weeks	2.1 b	2.5 b	2.0 a	1.8 b	11.59 b	12.67 b	14.9 b	14.3 b
Si. + Mo. two times	2.2 ab	2.5 b	2.1 a	1.8 b	11.29 cd	11.32 d	14.5 b	15.5 a
Si. + Mo. every 2 weeks	2.3 a	2.7 a	2.0 a	2.1 a	11.71 a	13.06 a	16.2 a	15.9 a
Significance	*	*	**	**	**	*	*	**

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

The obtained vegetative growth and vine vigor results could be expressed as reported by Qin *et al*., (2016) who cleared that, silicon is possible to play an important role in protecting photosynthetic machinery from damage and improving the stress-tolerance of the grapevine by increasing the concentration of soluble sugars and starch. In addition, Ling *et al*., (2016) reported that the addition of Si under salt stress improved all growth parameters and increased the pigments and photosynthetic rates. Also, Rafi *et al*., (1997) reported that Silicon increases crop productivity and improves crop quality while the lack of this element can reduce the plant's biological ability to withstand adverse environmental conditions. The positive effects of silicon on plant growth, biomass, yield, and nutrition have been reported by several workers (Guntzer *et al*., 2012 and Meena *et al*., 2014).

Also, the obtained results could be explained the important role of moringa extract which contains vitamins, β carotene, amino acids and some phenolic compounds rich in zeatin, protein, vitamins such as, A, B_1, B_2, B_3, ascorbic acid, sugars, minerals (calcium, magnesium, sodium, iron, phosphorus and potassium) and flavonoid pigments. Moreover, moringa leaves extract has the potential role to promote plant growth; hence, it is used as a natural plant growth enhancer, (Nagar *et al*., 2006, Siddhuraju and Becker, 2003 and Anwar *et al*., 2007). Also, Azra (2011) found that spraying different crops with the *Moringa oleifera* leaves extract at 3.5% increased all growth parameters.

B. Leaf nutrients content:

The results presented in Table 3 show the effect of silicon and moringa leaf extract as stimulants treatments on leaf macro and micronutrients of Flame seedless grapevine. The data of Table 3 show that silicon and moringa leaf extract alone or combined with other significantly increased N, P, K, Mn, Zn, and Fe in the leaves in relative to the control treatment. Foliar application of silicon 0.1% + moringa extracts at 2 % every 2 weeks was superior in increasing these macro and micro nutrients than using silicon or moringa alone. The beneficial effects of the combined treatment on leaf macro and micronutrients were significantly enhanced. The maximum leaf N (2.34 and 2.30 %), P (0.37 and 0.42%), K (1.71 and 1.73%), Zn (75.3 and 74.2 ppm) Mn (72.4 and 74.3 ppm), Fe (70.4 and 71.5 ppm) were recorded for the vines that received the combined treatment (Silicon 0.1% + Moringa extract 2 % every 2 weeks) in both seasons, respectively. On the contrary, the untreated vines recorded the minimum values during both seasons.

Table 3. Effect of moringa leaves extract and silicon spray treatments on some macro and micro- nutrients in leaves of Flame seedless grapevines during 2014 & 2015 seasons.

Treatments	N %		P %		K %		Zn ppm		Mn ppm		Fe ppm	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Control	1.57 e	1.47 d	0.22 c	0.20c	1.22 d	1.20f	48.2c	50.0e	50.1e	53.1e	45.3 e	40.3f
Si. two times	1.72 d	1.65 c	0.25 c	0.27 b	1.43 c	1.47e	51.4c	52.3d	58.1d	59.6d	50.3 e	53.4e
Si. every 2 weeks	1.94 c	1.88 b	0.28 bc	0.30ab	1.66 a	1.58d	60.8d	63.3c	62.4c	65.2c	60.3 c	65.3c
Mo. two times	2.19 b	2.22 a	0.34 ab	0.30ab	1.51 bc	1.64c	63.2cd	65.2c	63.2bc	64.8c	55.3 d	60.2d
Mo. every 2 weeks	2.24ab	2.26 a	0.35 a	0.39 a	1.61 ab	1.65c	67.5bc	69.8b	67.1b	69.4b	61.6 c	64.8c
Si.+ Mo. two times	2.30ab	2.24 a	0.35 a	0.40 a	1.68 a	1.69b	69.2ab	72.4ab	65.4bc	68.2b	66.1 b	68.2b
Si.+ Mo. every 2 weeks	2.34 a	2.30 a	0.37 a	0.42 a	1.71 a	1.73a	75.3 a	74.2a	72.4a	74.3a	70.4 a	71.5a
Significance	**	**	*	*	**	**	**	**	*	**	**	**

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

The enhancement of leaf macro and micronutrients content could be explained as reported by Apaolaza, (2014) that the physiological role of Si in relation to micronutrients deficiency symptoms has been assessed in several plant species in hydroponics. In cucumber, Si supply mitigated the symptoms of Fe deficiency. The main factor controlling this beneficial effect seems to be the Si contribution to the formation of metal deposits in the root and/or leaves apoplast and its role in their following remobilization when required. Also, Jia *et al*., (2011) summarized that silicon led to an improvement of micro-nutrient supply, coordination of nutrition supply and enhancement of resistance to stressful conditions. In addition Meunier *et al*., (2011) reported that the addition of this element to particular crop species benefits the plant through enhancement of nutrient uptake and mitigation of biotic and abiotic stresses. Also, Singh *et al*., (2006) reported that 180kg/hectare of potassium silicate increases nitrogen and phosphorus contents in leaves of some crops.

As for the role of moringa extract, in this respect, Mona (2013) found that fertilization of rocket (Eruca vesicaria subsp. sativa) plants with *Moringa oleifera* at rates 2% extracts potentially increased the content of, N, P, and K in leaves. Also, it has the potential to promote plant growth since it contained several minerals such as (calcium, magnesium, sodium, iron, phosphorus and potassium) and several flavonoid pigments (Anwar *et al*., 2007).

C. Yield and Fruit Quality:

1. Cluster physical quality characters:

Concerning cluster quality as shown in Table 4, it could be noticed that all applied spray treatments (Silicon 0.1% and Moringa extract 2 % each of them as single spray two times or every two weeks as well as the combination of them) enhanced most cluster physical quality parameters as cluster weight (g), cluster length (cm), cluster width (cm) and cluster shape index (L/D) of Flame seedless vines as compared to control treatment.

Moreover, Flame seedless grapevines which sprayed with the combination treatment (Silicon 0.1% + Moringa extract 2 % every 2 weeks) gave the higher cluster weight, cluster length and cluster width as compared with control. As for cluster shape index, the higher values were recorded for control in the first season, while in the second one, control, and silicon treatment spray two times gave the highest values without significant differences between them. However, the lowest value was belonged to the vines sprayed with combined (Silicon 0.1% + Moringa extract 2 % every 2 weeks) treatment. Clusters numbers per vine were reached to the significant value with moringa extract and combined treatments every 2 weeks in the second season only.

The maximum values (393.3 and 401.2 g) for cluster weight, (20.7 and 22.1 cm) for cluster length, and (19.9 and 20.0 cm) for cluster width were observed

on the vines that received silicon at0.1% plus moringa extract at 2 % every two weeks during both seasons, respectively. The untreated vines produced the minimum values of these parameters. However, the maximum value of cluster shape index (1.30 and 1.29) was noticed with vines of control during both seasons, respectively.

Table 4. Effect of moringa leaves extract and silicon spray treatments on some cluster . quality parameters of Flame seedless grapevines during 2014 & 2015 seasons.

Treatments	Cluster Weight (g)		Cluster length (cm)		Cluster width (cm)		Cluster shape index		Clusters/vine (No)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Control	322.6 f	329.3 e	16.7 e	17.3 f	12.8 f	13.4 d	1.30 a	1.29 a	24.0 a	25.3 b
Si. two times	356.0 e	364.0 d	17.5 de	18.3 e	13.9 e	13.3 d	1.26 ab	1.28 a	25.6 a	25.3 b
Si. every 2 weeks	364.2 d	370.6 c	18.8 bc	18.9 d	15.6 d	16.5 c	1.21 b	1.15 b	25.6 a	26.3 ab
Mo. two times	362.7 d	376.7 b	18.3 cd	18.4 e	17.5 c	16.1 c	1.05 c	1.14 bc	24.0 a	26.0 ab
Mo. every 2 weeks	383.4 b	398.0 a	19.7 b	20.1 b	18.3 b	17.8 b	1.08 c	1.13 bc	25.0 a	27.3 a
Si. + Mo. two times	378.2 c	376.3 b	18.8 bc	19.9 c	18.1 b	17.5 b	1.04 c	1.14 bc	24.3 a	25.3 b
Si. + Mo. every 2weeks	393.3 a	401.2 a	20.7 a	22.1 a	19.9 a	20.0 a	1.0 4 c	1.11 c	24.7 a	27.3 a
Significance	**	**	*	**	*	*	*	*	ns	*

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

2. Berry physical quality characters:

Data in Tables 5 and 6 showed that single applications of silicon at 0.1% or moringa leaves extract at 2% two times or every two weeks improved several berry quality parameters. However, combined applications of silicon and moringa leaves extract two times or every two weeks were more effective in enhancing these characters since, it showed significantly increase in weight of 100 berries (g), volume of 100 berries (ml) and berry firmness (Newton) as compared to the all of other treatments, except berry removal force which showed no significant difference between vines sprayed with moringa extract 2 % alone every 2 weeks and that of combined treatment every two weeks. However, vines of control showed the lowest values of these parameters in both seasons.

In this respect the maximum weight of 100 berries (375.3 and 372.3g), volume of 100 berries (298.7 and 311.3 ml), berry firmness (3.8 and 3.8 Newton) and berry removal force (4.6 and 4.6 Newton) were recorded for the vines that received Silicon at 0.1% plus moringa extract at 2% every two weeks during both seasons, respectively. The untreated vines exhibited the minimum values. These results were true in the both study seasons.

Concerning data of Table 6, it could be noticed that the highest berry length and diameter were obtained in Flame seedless grapevines sprayed with moringa leaves extract in combined with Silicon every two weeks. However, the lowest value of berry length was obtained in vines that sprayed by moringa leaves extract at 2% two times treatment, but as for berry diameter, the lowest value was obtained with control and vines treated with silicon two times alone without significant deference between them in both seasons.

Table 5. Effect of moringa leaves extract and silicon spray treatments on some berry physical quality parameters of Flame seedless grapevines during 2014 & 2015 seasons.

Treatments	Weight of 100 berries (g)		Vol. of 100 berries (ml)		Berry removal force (Newton)		Berry firmness (Newton)	
	2014	2015	2014	2015	2014	2015	2014	2015
Control	221.0 f	231.6 e	212.3 f	195.7 f	3.3 e	3.6 e	2.1 g	2.3 e
Si. two times	235.0 e	242.7 d	233.7 e	245.6 e	3.7 d	3.8 d	2.5 f	2.2 e
Si. every 2 weeks	274.3 d	287.8 c	272.7 d	263.3 d	3.9 c	4.0 c	2.7 e	2.7 d
Mo. two times	295.0 c	288.8 c	284.7 c	278.0 c	4.2 b	4.1 c	2.8 d	2.9 c
Mo. every 2 weeks	364.7 b	360.5 b	291.0 d	275.6 c	4.5 a	4.6 a	3.2 c	3.5 b
Si. + Mo. two times	361.0 b	366.8 b	276.0 b	298.7 b	4.3 b	4.2 b	3.4 b	3.5 b
Si. + Mo. every 2 weeks	375.3 a	372.3 a	298.7 a	311.3 a	4.6 a	4.6 a	3.8 a	3.8 a
Significance	**	**	*	**	*	*	**	*

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Table 6. Effect of moringa leaves extract and silicon spray treatments on berry physical quality parameters and vine yield of Flame seedless grapevines during 2014 & 2015 seasons.

Treatments	Berry length (mm)		Berry diameter (mm)		Berry shape index		Shot berries (%)		Yield/vine (Kg)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Control	18.7 cd	18.4 d	17.4 f	17.8 e	1.1 a	1.0 a	4.5 a	2.8 a	7.74 f	8.33 e
Si. two times	18.3 d	18.6 cd	17.8 f	17.9 e	1.0 b	1.0 a	2.5 b	1.6 b	9.11 d	9.21 d
Si. every 2 weeks	18.9 c	18.8 c	18.4 e	18.9 d	1.0 b	1.0 a	0.2 c	0.2 c	9.32 c	9.75 b
Mo. two times	17.4 e	17.2 e	19.5 d	19.5 c	0.9 e	0.9 b	0.5 c	0.5 c	8.70 e	9.79 b
Mo. every 2 weeks	19.6 b	19.0 c	21.7 b	21.7 b	0.9 e	0.8 c	0.2 c	0.1 c	9.59 b	10.87 a
Si. + Mo. two times	19.8 b	20.3 b	20.0 c	20.0 c	1.0 c	1.0 a	0.6 c	0.7 c	9.19 d	9.52 c
Si. + Mo. every 2 weeks	21.2 a	21.5 a	22.6 a	22.6 a	0.9 d	0.9 b	0.0 c	0.0 c	9.71 a	10.96 a
Significance	**	**	*	**	*	**	**	**	**	**

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

As for berry shape index, the highest value was noticed with vines of control in the first season, while in the second one, there was no significant difference between control and vines treated with silicon alone. However, the lowest values were obtained with vines treated with silicon in combined with moringa leaves extract every two weeks in both seasons, this result revealed that the combination treatment was produced the more round berries than the other treatments. Concerning shot berries, all spray treatments except silicon alone were produced significantly the lower percent as compared to control, vines sprayed with silicon 0.1% + moringa leaves extract at 2% every 2 weeks was more effective in this respect.

3. Yield per vine (kg):

Generally, data of Table 6 cleared the total yield per vine was enhanced by using moringa leaves extract, silicon and the combination between them. The total yield per vines sprayed with moringa leaves extract in combined with silicon every two weeks (Silicon 0.1% + Moringa extract 2 % every 2 weeks) showed significantly the higher yield per vine in the first season, but by the second season the higher yield per vine was obtained with vines that sprayed with moringa leaves extract alone and in combined with silicon every two weeks (Moringa extracts 2 % two times and Silicon 0.1% + Moringa extract 2 % every 2 weeks) treatments without significant difference between them. However, vines of control showed the lowest yield / vine in both seasons.

The enhancing effect of spraying with silicon and moringa leaves extract on physical quality of clusters (cluster weight, length, width, cluster number per vine and shape index), berries (weight of 100 berries, volume of 100 berries, berries removal force and shot berries) characteristics and yield per vine of Flame seedless grape could be interpreted in view of that role of Silicon as an endogenous plant growth regulator of phenolic nature and classified as a growth promoter, (Hayat *et al*., 2010). In addition, Epstein and Bloom (2005) reported that Si is considered to be a quasi-essential element due to its benefits for same plants, including enhanced yield and crop quality. Applications of silicon improved growth, yield and quality of Flame seedless (Al-Wasfy, 2014). Moreover, Stamatakis *et al*., (2003) reported that use of potassium silicate in hydroponic culture significantly increased beta-carotene, lutein and lycopene contents of the tomato fruits and silicon also enhanced fruit firmness. In addition Jia *et al*., (2011) reported that silicon fertilizer could enhance hardness and stress-resistance of apple, grape, and tomato.

The positive effect of moringa extract attributed to the known role of cytokinins which moringa leaves extract contend in stimulating both cell division and cell enlargement which by their turn are reflected on fruit weight increase and consequently yield Rizk-Alla *et al*., (2011). Moreover, Siddhuraju and Becker, (2003) and Anwar *et al*., (2007) summarized that, the positive influence of moringa leaves extract may be due to its content proteins, vitamins, β carotene, amino acids and various phenolics and rare combination of zeatin, protein, vitamins as (A, B_1, B_2, B_3, ascorbic acid and E) phenolic compounds, sugars, minerals and several flavonoid pigments.

Generally, these results are in agreement with those of Fuglie (2000) who found that the moringa leaves extract accelerated growth of young plants and produced larger pear fruits.

4. Berry chemical quality characters

Data of Table 7 and 8 showed that vines sprayed with moringa leaves extract in combined with silicon every two weeks (Silicon 0.1% + Moringa extract 2 % every 2 weeks) showed significantly the higher berry juice SSC, and SSC: Acid ratio and the least values were recorded with vines of control. However, significantly the higher berry juice titratable acidity was observed in vines of the control. The lowest value was obtained in vines sprayed with moringa leaves extract every two weeks alone and moringa leaves extract in combined with silicon every two weeks treatments without significant difference between them. This trend was clear in both seasons.

Berry juice pH (Table 8) had no clear trend during the two seasons but, vines of control showed significantly the lower berries juice pH in both season. However, all treatments showed an increase in berries anthocyanin and total sugars, especially the combined treatment (Silicon 0.1% + Moringa extract 2 % every 2 weeks) which recorded significantly the highest concentrations. The lowest values were noticed with vines of control in the first season, but by the second one, there was no significant difference between vines sprayed with silicon two times only and that of control. This trend was noticed as for berries anthocyanin and total sugars.

The positive effect of moringa leaves extract and silicon on berry chemical quality characters (SSC, acidity, SSC/acid ratio, juice pH, berries anthocyanin) could be explained according to the results of Jia *et al*., (2011) who reported that, after application of silicon fertilizers, the soluble solids of strawberry, and some crops were increased, and Chowdhury *et al*., (2007) found that silicon improved TSS of mango trees. As for moringa leaf juice, the enhancing effect on berry quality could be attributed to the fact that, it is rich in numerous growth hormones, particularly zeatin and that has been reported to increase the crops yield in the range of 10-45% it also contains micronutrients in sufficient quantities and suitable proportions that increase the growth, yield components and yield of several crops (Iqbal, 2014). In this respect, calcium and potassium in moringa leaves play essential roles in plant growth and development through osmoregulation, enzyme activation, photosynthesis enhancement, and through other physiological processes (Hasegawa *et al*., 2000)., (Epstein and Bloom 2005). Moreover, Abd El–Hamied and El-Amary (2015) concluded that moringa leaf extracts at 4% improved chemical fruit characteristics of Pear trees, so it can be recommended to be used effectively as natural plant extracts for various crops.

Table 7. Effect of moringa leaves extract and silicon spray treatments on some berry chemical quality parameters of Flame seedless grapevines during 2014 & 2015 seasons.

Treatments	SSC (%)		Titratable acidity (%)		SSC/Acid ratio	
	2014	2015	2014	2015	2014	2015
Control	17.4 e	16.8 d	0.75 a	0.72 a	23.3 f	23.5 f
Si. two times	17.9 cd	17.4 c	0.71 b	0.69 b	25.3 e	25.1 e
Si. every 2 weeks	18.3 bc	18.0 bc	0.66 c	0.62 c	27.7 d	28.9 d
Mo. two times	17.6 de	17.6 c	0.62 d	0.63 c	28.3 d	27.7 d
Mo. every 2 weeks	18.8 ab	18.7 b	0.60 d	0.63 c	30.9 c	30.7 c
Si. + Mo. two times	18.3 c	18.5 b	0.53 e	0.55 d	34.3 b	33.8 b
Si. + Mo. every 2 weeks	19.3 a	19.4 a	0.52 e	0.54 d	37.2 a	36.1 a
Significance	**	**	**	**	*	**

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Table 8. Effect of moringa leaves extract and silicon spray treatments on some berry chemical quality parameters of Flame seedless grapevines during 2014 & 2015 seasons.

Treatments	Juice pH		Anthocyanin (mg/g fruit)		Total sugars (%)	
	2014	2015	2014	2015	2014	2015
Control	3.5 a	3.2 c	0.234 e	0.265 c	16.5 d	16.3 d
Si. two times	3.6 a	3.4 bc	0.253 d	0.275 c	16.9 c	16.3 d
Si. every 2 weeks	3.6 a	3.4 bc	0.273 c	0.259 c	17.2 bc	16.8 bc
Mo. two times	3.6 a	3.5 a	0.292 b	0.288 b	16.9 cd	16.8 bc
Mo. every 2 weeks	3.7 a	3.4 bc	0.256 d	0.263 c	17.3 bc	17.0 b
Si. + Mo. two times	3.6 a	3.5 a	0.283 bc	0.280 b	17.6 ab	17.2 b
Si. + Mo. every 2 weeks	3.6 a	3.5 a	0.345 a	0.355 a	17.9 a	17.8 a
Significance	ns	*	**	**	**	**

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

D. Total fruit quality score

Fruit quality score is the ranking system suggested by (Mansour *et al*., 1981) for helping us to determine which treatment produced the best berries quality (as explained in materials and methods). Data of the total fruit quality score established in Table 9 showed that, Flame seedless vines sprayed with silicon in combined with moringa leaves extract was more effective in enhancing both chemical (SSC, acidity, SSC/acid ratio, and berries anthocyanins pigments) and physical fruit quality (berry firmness, berry removal force, and shot berries) of "Flame seedless" vines than the other treatments in both seasons of the study.

Vines of the combination (Moringa leaves extract at % + silicon at 0.1% every 2 weeks) treatment gave the highest score, where it gained 49 and 49 degrees in the two seasons out of 49 degrees, respectively. This was followed by vines sprayed with the same combination two times only. These vines achieved 41 and 42 degrees in the two seasons, respectively.

Table 9. Total score quality of Flame seedless as affected by spraying with moringa leaves extract and silicon during 2014 and 2015 seasons

Quality parameter	SSC %	SSC/Acid ratio	Acidity %	Berry removal force	Berry firmness	Shot berries %	Berry anthocyanins	Total score
					2014			
Control	4	1	3	2	3	3	2	18
Silicon two times	5	2	4	3	4	4	3	25
Silicon every 2 weeks	6	3	6	3	5	6	4	33
Moringa two times	5	4	5	4	6	5	6	35
Moringa every 2 weeks	6	5	5	5	7	6	3	37
Silicon + Moringa two times	6	6	7	6	6	5	5	41
Silicon + Moringa every 2 weeks	7	7	7	7	7	7	7	49
					2015			
Control	3	1	4	3	4	3	5	23
Silicon two times	4	2	6	4	4	4	5	29
Silicon every 2 weeks	5	4	5	4	5	6	5	34
Moringa two times	4	3	5	5	5	5	6	33
Moringa every 2 weeks	6	5	5	6	7	6	5	40
Silicon + Moringa two times	6	6	7	6	6	5	6	42
Silicon + Moringa every 2 weeks	7	7	7	7	7	7	7	49

The total score is out of 49 degrees, i. e 7 parameters x7 degrees/parameter.

However, vines that sprayed with moringa leaves extract every 2 weeks only came in the third degree in this respect, where it gained 37 and 40 degrees of the quality score in both seasons, respectively. However, the lowest fruit quality score was noticed in vines of control since it gained only 18 and 23 degrees of the quality score during the two seasons, respectively.

CONCLUSION

From the above-mentioned results, it can be concluded, that moringa leaf extracts at 2% or silicon at 0.1% alone as well as a combination of them at two times or every two weeks improved most parameters of Flame seedless grapevines. Combination treatment (Silicon at 0.1% plus Moringa extract at 2% every two weeks) was the most effective in this respect. Generally, the above combination treatment could be recommended as natural materials to be used effectively for enhancing vegetative growth, vine vigor, yield, physical and chemical fruit quality of Flame seedless grape due to its high nutritive value, antioxidant effect, easy preparation and environmentally friendly nature.

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تأثير الرش بالسيلكون و مستخلص المورينجا على المحصول وجودة الثمار في صنف العنب الفليم سيدلس

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أجريت هذه الدراسة خلال موسمي ٢٠١٤ و ٢٠١٥ وذلك لدراسة تأثير الرش بمستخلص أوراق المورينجا و السيلكون وكذا كلاهما معا على قوة الكرامات والمحصول وجودة الثمار لصنف عنب الفليم سيدلس كرمات بعمر ٧ سنوات المنزرعة في مزرعة خاصة بمنطقة النوبارية محافظة البحيرة ،حيث تم فيها دراسة تأثير الرش بمستخلص أوراق المورينجا بتركيز ٢ % منفرد والرش بمحلول السيلكون بتركيز ٠.١% منفرد وكذا الرش بكلاهما معا. طبقت هذه المعاملات مرتين بفارق أسبوعين أو كل أسبوعين طوال موسم النمو وذلك عند وصول طول النموات من ١٥ إلى ٢٠ سم . أوضحت النتائج أن كل المعاملات كان لها تأثير ايجابي على مختلف قياسات النمو والمحصول وجودة الثمار خاصة معاملة الرش بكل من مستخلص المورينجا ٢% مع السيلكون ٠.١% كل أسبوعين على مدار الموسم حيث أدت إلى حدوث زيادة معنوية في كل من قياسات النمو الخضري (المساحة الورقية – الكلوروفيل الكلى – متوسط طول القصبات – طول و قطر السلاميات ووزن خشب التقليم للكرمة) و القياسات الفيزيائية لجودة العناقيد (وزن وطول وعرض العناقيد) والصفات الفيزيائية للحبات (وزن وحجم ١٠٠ حبة – الصلابة – القوة اللازمة لنزع الحبات – طول وعرض الحبات) و الصفات الكيميائية للعصير (نسبة المواد الصلبة الذائبة– النسبة بين المواد الصلبة والحموضة – تركيز صبغة الانثوسيانين ونسبة السكريات الكلية فى الثمار) كما أدت لحدوث زيادة معنوية في محصول الكرمة. وتوصى الدراسة باستخدام معاملة الرش المشترك (مستخلص المورينجا ٢% + السيلكون ٠.١% كل أسبوعين) مع صنف العنب الفلايم سيدلس.