Zagazig J. Agric. Res., Vol. 51 No. (1) 2024 31-45

Plant Production Science

Available online at http://zjar.journals.ekb.eg
http:/www.journals.zu.edu.eg/journalDisplay.aspx?Journalld=1&queryType=Master

EFFECT OF FOLIAR SPRAYING SOME NANO-FERTILIZERS OR POTASSIUM SILICATE IN REDUCING THE USE OF TRADITIONAL FERTILIZERS ON GROWTH, YIELD AND BUNCH CHARACTERISTICS OF FLAME SEEDLESS GRAPES

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Received: 03/01/2024; Accepted: 14/02/2024

ABSTRACT: This study carried out throughout two successive seasons 2017 and 2018, on 4 years-old Flame seedless grapevines grown in sandy soil at 2x3 m apart under drip irrigation system and vines were trellised with Y- shape system in a private vineyard at Belbies District, Sharkia Governorate, Egypt. The experiment included 8 treatments as follow: T1-Control (spraying water) vines will be fertilized according to the used fertilization program followed in the vineyard (60 N, 40 P2O5 and 80 K_2O g/vine/year). T2-Spraying vines with mixture of a nano fertilizer containing potassium (36%), amino acid (5%), total nitrogen (5%), total phosphorus (2%) and micronutrient (2%) [Potacrystal at 3 cm/L] (except potassium and 1/5 nitrogen). T3-Spraying vines with mixture of a nano fertilizer containing calcium (15%), magnesium (2%), boron (1.5%) with amino acid (2%) and nitrogen (10%) [Kalmagbor at 3 cm/L] (except 1/10 nitrogen). T4-Spraying vines with mixture of a nano fertilizer containing phosphorus (40%), potassium (28%), amino acid (5%) and nitrogen (5%) [Phospho one at 3 cm/L] (except potassium and phosphor and 1/5 nitrogen). T5-Spraying vines with mixture of nano micro nutrient + citric acid (Magro nano mix at 1 g/L) + (60 N, 40 P_2O_5 and 80 K_2O g/vine/year). T6-Spraying vines with normal chelated iron at 2 g/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year). T7-Spraying vines with nano chelated iron at 3 cm/L + (60 N, 40 P_2O_5 and 80 K_2O g/vine/year). T8-Spraying vines with normal potassium silicate at 5g/L+(60 N, 40 P_2O_5 and 80 K_2O g/vine/year). All spraying treatments carried out three times a year at monthly intervals i.e., the first week of each of March, April and May. The results showed that total yield/feddan (ton) significantly increased by application of all treatments compared with control in both seasons. The uppermost values of total yield per feddan (ton) recorded for treatments T4 (15.59 and 19.94 ton) and T7 (17.20 and 22.11ton) in the first and second season, respectively. The shortest bunches were from treatments control and Normal potassium silicate in the first and second season, respectively, while, other treatments recorded higher values of bunch length in the two seasons without significant differences between them. Leaf surface area (cm^2) and leaf fresh and dry weight were significantly increased by the tested treatments compared with control (T1) in the two seasons. However, leaves of T7 treatment (Nano chelated iron) contained the highest chlorophyll a (1.133 and 1.233 mg/100 mg FW), b (0.933 and 0.920 mg/100 mg FW), total chlorophyll (2.033 and 2.153 mg/100 mg FW) and carotenoids (0.950 and1.077 mg/100 mg FW).

Key words: Flame seedless, potassium silicate, micronutrients, nano fertilizer, yield, bunch, leaf area, photosynthetic pigments.

INTRODUCTION

The grape (*Vitis vinifera* L.) considered one of the most popular and common fruit crops in the world, it ranks first in the world and fourth after citrus, mango and olive in Egypt. In Egypt the cultivated area with grape reached 187358 feddans out of them 133811feddans are fruitful

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producing about 1183968 tons with an average of 8.85 ton/feddan **(Statistics of Ministry of Agriculture, 2020)**.

Flame Seedless is a popular table grape cultivar that previously introduced in Egypt and consider as a promising variety because its good qualities for local market and export **(Hegazi and Sallam, 2003).** The market value of 'Flame seedless grape cv. is depending upon its desirable appearance, especially homogeneity of the berries red color and cluster size and shape.

Potassium silicate provides the plant a 100% available source of silicon (Si) and potassium that are essential for optimum plant growth and health. Increasing silicon content in plant tissues enhances their resistance to various stresses. The presence of silicon in the cell walls of plants increases their strength, as silicon increases resistance to salinity, drought tolerance, and photosynthetic activity, and promotes active growth of roots and foliage. The entry of silicon to plant tissues leads to inhibition of the oxidative destruction processes that is accompanied with increasing activity of some antioxidant enzymes that neutralize reaction oxygen species (ROS) induced by drought, salinity, toxic metals. Also, Si could be used as a potential growth regulator to improve plant growth and resistance under stress conditions. This may be a promising new strategy for improvement of soil properties in agriculture **(Balakhnina and Borkowska, 2013; Kim *et al*., 2014; Shi *et al*., 2014; Yin *et al*., 2014; Sahebi *et al*., 2015; Xie *et al*., 2015)**.

Nanotechnology helps to improve agricultural production by increasing the efficiency of inputs and minimizing relevant losses. Nanomaterials offer a wider specific surface area to fertilizers and pesticides **(Shang *et al*., 2009)**. Nanotechnology is a means useful for the development of agricultural, especially in fertilization programs, as Nano fertilizers are an effective alternative to traditional fertilizers, as they achieve many advantages due to their use with lower chemicals and the speed of absorption by the plant and their high stability under different conditions, which increases the ability to store them for longer periods. Nanotechnology can also be used to detect and treat diseases, by increasing crop production, improving their quality and ensuring crop sustainability **(Al-Hchami and Alrawi, 2020)**. Green revolution had led to the increased consumption of chemical fertilizers which resulted in the higher productivity on one hand, whereas on the other hand it also caused environmental hazards. Nutrient use efficiency of conventional fertilizers is very low. To overcome all these drawbacks in a better way, nanotechnology can be a ray of hope. Nano fertilizer is an important tool in agriculture to improve crop growth, yield and quality parameters with increased nutrient use efficiency, reduction in wastage of fertilizers and cost of cultivation. Nanofertilizers are applied either to soil and/ or leaves. Foliar application can be done during unfavourable soil and weather conditions. In addition to this, it promotes the direct entry of nutrients into the plant system, thus reduce the wastage of fertilizer. Hence, foliar application of nanofertilizer leads to higher nutrient use efficiency (NUE) and has given a rapid response to the growth of crops. Nanofertilizers are more reactive and can penetrate through cuticle, ensuring controlled release and targeted delivery **(Mahil and Kumar, 2019; Mandal and Lalrinchhani, 2021)**, due to the fact that nanofertilizer has unique properties due to its small surface area with high absorption, which causes an increase in photosynthesis and leaves area **(Sekhon, 2014)**.

Iron is an essential element for growth of plants, lack of iron causes young leaves to yellow and photosynthesis activity to reduce significantly and consequently biomass is produced **(Briat *et al*., 2007).** Iron is a particularly crucial micronutrient in agricultural crops **(George *et al*., 2008)**. Micronutrients can improve plant growth characteristics and also increase plants resistance to the negative effects of toxic ions. Specifically, higher concentrations of iron in nutritional solutions can compensate for salinity impacts **(Uauy *et al*., 2006)**. Application of iron nano-fertilizer in plants can increase the plant resistance to salinity stress by simultaneously increasing the permeability of the root's selective plasma membrane and decreasing the absorption and accumulation of sodium, which improves the ratio of potassium to sodium in the shoot **(Taiz *et al*., 2015).**

The aim of this study is to investigate the effect of some nano fertilizers or potassium silicate treatments on growth, yield and bunch characteristics of Flame Seedless grapevine in comparison with the traditional used fertilizers.

MATERIALS AND METHODS

This study carried out throughout two successive seasons of 2017 and 2018 seasons on 4 years old of Flame Seedless cv. grapevines grown in sandy soil and cultivated at 2x3 m apart under drip irrigation system and vines were trellised with Y- shape system in a private vineyard at Belbies District, Sharkia Governorate, Egypt. This work conducted on 48 vines, 8 treatments x 6 vine (3 replicates x 2 vine/ replicate).

The experiment included 8 treatments as follows:

T1. Control vines fertilized according to the used commercial fertilization program followed in the vineyard (60,40and 80 g N, P2O5 and K_2O, respectively, per vine/year).

T2. Spraying vines with mixture of a nano fertilizer containing potassium (36%), amino acid (5%), total nitrogen (5%), total phosphorus (2%) and micronutrient (2%) [Potacrystal at 3cm/L] (except potassium and 1/5 nitrogen).

T3. Spraying vines with mixture of a nano fertilizer containing calcium (15%), magnesium (2%), boron (1.5%) with amino acid (2%) and nitrogen (10%) [Kalmagbor at 3 cm/L] (except 1/10 nitrogen).

T4. Spraying vines with mixture of a nano fertilizer containing phosphorus (40%), potassium (28%), amino acid (5%) and nitrogen (5%) [Phospho one at 3 cm/L] (except potassium and phosphor and 1/5 nitrogen).

T5. Spraying vines with mixture of nano micro nutrient + citric acid (Magro nano mix at 1 g/L) + (60 N, 40 P2O5 and 80 K2O g/vine/ year).

T6. Spraying vines with normal chelated iron (EDDTA13%) at 2g/L+ (60 N, 40 P2O5 and 80 K2O g/vine/year).

T7. Spraying vines with nano chelated iron at 3cm/L+ (60 N, 40 P2O5 and 80 K2O g/ vine/year).

T8. Spraying vines with normal potassium silicate at 5g/L+ (60 N, 40 P2O5 and 80 K2O g/vine/year).

All spraying treatments carried out three times a year at monthly intervals i.e., the first week of each of March, April and May. Whereas, fertigation treatments conducted at the same times of fertigation was followed in the vineyard. Moreover, vines treated with potassium silicate and chelated iron spraying treatments received the same fertigation program followed in the vineyard except T2 (zero K and 48 N), T3 (54 N) and T4 (zero K, zero P_2O_5 and 48 N).

Nano chelated iron was prepared according to the methods used by **Vafaee and Ghamsari (2007); Labuayai *et al*. (2009) and Manna (2012).** Transmission electron microscope micrograph of iron nanoparticles (from 0.5 to 200 nm) (Figs. 1 and 2).

In both seasons, bunches from each tested vine harvested after most (60%) of the fruits were considered to have exceeded the minimum market requirements of 16.5- 18% TSS and full red berry color.

At every harvest date all harvested bunches counted and weighed. The average harvest period (days after first to final harvest) and dates for every treatment were recorded. The harvested bunches transported immediately to the fruit laboratory of the Horticulture Department, Fac. Agric., Zagazig University to determine the bunch and berries physical and chemical characteristics as follow:

1. Total yield and some bunch characteristics: yield/vine (kg) determined as number of bunches/vine x average bunch weight (g) and calculated per feddan (ton). A sample of 5 bunches for each replicate randomly collected in both seasons for estimating average bunch weight (g), bunch dimensions (cm), number of berries per bunch and number laterals per bunch.
2. Vegetative growth: Vegetative growth of the tested vines evaluated through the following parameters:

2.1. Average number of the vegetative shoots / vine.

2.2. Leaf characteristics: Twenty-five leaf samples randomly collected from the medium position of non-fruiting shoots to determine the following leaf characteristics:

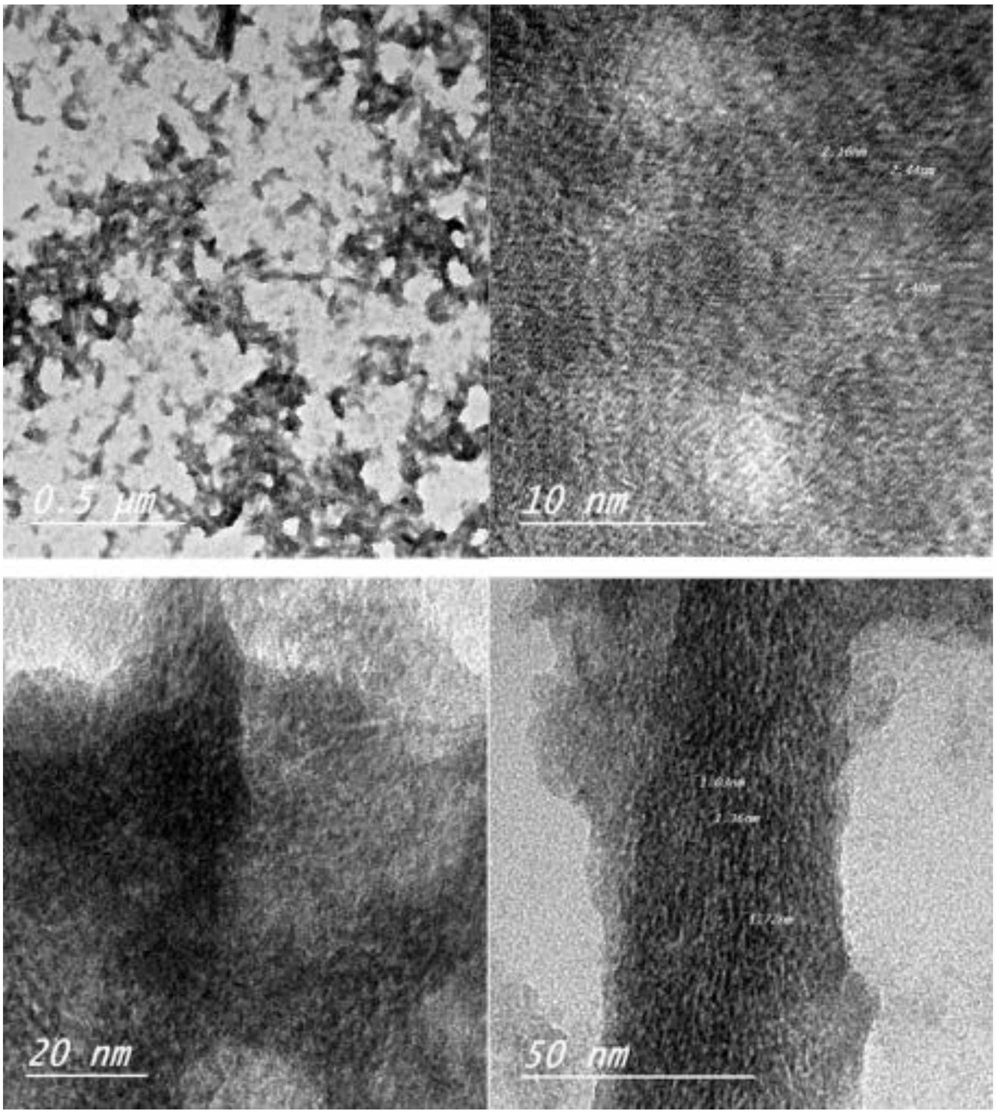

Fig. 1. Transmission electron microscope micrograph of iron manoparticles (0.5, 10, 20 and 50 nm)

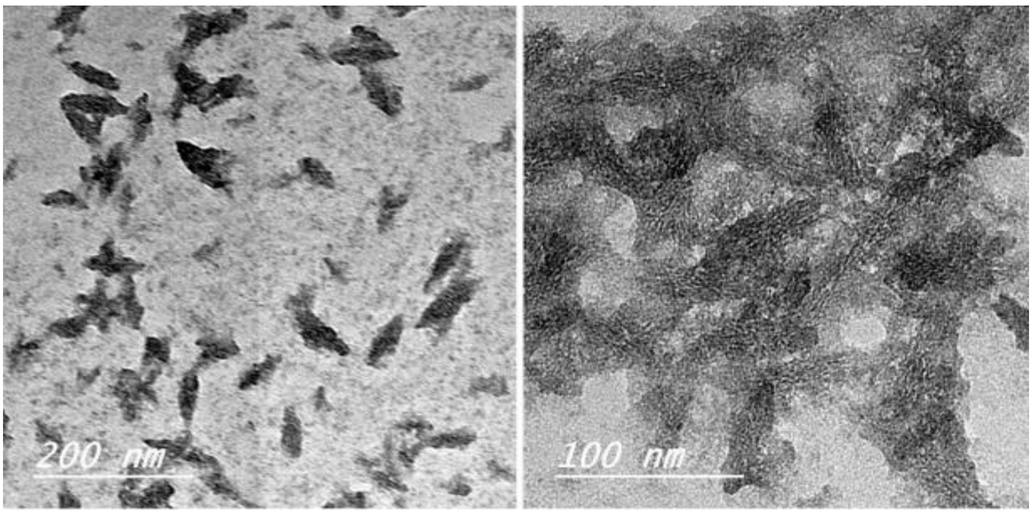

Fig. 2. Transmission electron microscope micrograph of Fe manoparticles (100 and 200nm)

- Average leaf fresh and dry weights (g) twenty leaves / replicate before and by weighing after being dried at 70ºC until constant weight.
- Average leaf surface area (cm^2) measured by using the Planimeter.
- Photosynthetic pigments contents: Five leaves from the previous collected leaf samples used for determining photosynthetic pigments contents. About 0.1 g from each fresh leaf sample taken for estimating both chlorophyll a and b as well as carotenoids pigment contents (mg/100 mg fresh weight) according to the method described by **Wettestein (1957).**

Statistical Analysis

The obtained data tested by the one-way analysis of variance (ANOVA) technique, according to **Snedecor and Cochran (1989)**. The treatments arranged in randomized complete block design with three replications. Treatments means separated and compared using **Duncan (1958)** test at 0.05 level of significance.

RESULTS

Yield Per (ton/feddan)

The concerned results in Table 1 indicated that total yield per feddan (ton) significantly increased by application of all treatments (from T2 to T8) compared with T1 (Control) in both seasons. The uppermost values of total yield/ feddan recorded for treatments T4 (Phospho one at 3 cm/L) and T7 (Nano chelated iron at 3 cm/L) (15.59 and 19.94 and 17.20 and 22.11ton) in the first and second season, respectively, as well as T2 (Potacrystal nano at 3cm/L) (15.53 ton), T3 (Kalmagbor at 3 cm/L) (16.33 ton), T5 (Magro nano mix at 1g/L) (16.03 ton) and T8 (Normal potassium silicate at 5 g/L) (15.08 ton) without significant differences between them in the first season only. The least values of total yield per feddan (ton) were for control T1 (11.95 and 13.50 ton) in the two experimental seasons, respectively. The other tested treatments recorded intermediate values of total yield per feddan (ton) in the two seasons.

Number of Bunches Per Vine

Results in Table 1 revealed that T2 (Potacrystal at 3 cm/L), T3 (Kalmagbor at 3 cm/L), T5 (Magro nano mix at 1g/L) and T7 (Nano chelated iron at 3 cm/L) significantly increased values of bunches number per vine at harvest date (36.67 and 38.33 , 34.33 and 37.67, 34.67 and 36.67 and 33.67 and 38.33) in the first and second season, respectively, as well as T8 (Normal potassium silicate at 5 g/L) in the first season only when compared with the other treatments. the lowest values of bunches number per vine were for T1(Control) (29.67 and 31.33) in the two seasons, respectively, and T4 (Phospho one nano at 3 cm/L) in the first season only. The other tested treatments recorded intermediate values of bunches number per vine in the two seasons.

Characteristics of Bunch

Data in Tables 1, 2 and 3 show the significant effect of the treatments on bunch weight (g), bunch dimensions (cm), total number berries per bunch and number laterals per bunch of "Flame Seedless" grapes in both seasons.

Bunch weight (g)

As indicated in Table 1 it is clear that the treatment T4 (Phospho one at 3 cm/L) recorded heaviest bunch weight (786.67 and 832.00 g) in the first and second season, respectively, as well as T7 (Nano chelated iron at 3 cm/L) in the second season (823.33g). Whereas the lowest bunch weight (573.33 and 613.67 g) was recorded by the control in the first and second season, respectively. The other tested treatments produced middle values of bunch weight (gm) in both seasons. Generally, bunch weight was from 573.33 to 786.67 g and from 613.67 to 823.33g in the first and second season, respectively.

Bunch dimensions (cm)

Data presented in Table 2 showed that T1 (Control) and T8 (Normal potassium silicate at 5 g/L) tabulated the shortest bunch (19.00 and 19.67 and 20.00 and 20.17cm) in the first and second season, respectively. The other treatments recorded higher values of bunch length in the two seasons without significant differences between them.

The treatments were significant effect on bunch width in both seasons (Table 2). Treatment T7 (Nano chelated iron at 3cm/L) gave the highest values of bunch width (20.33

Table 1. Effect of spraying some nano fertilizers and potassium silicate on total yield per feddan, bunch weight and number bunches per vine of Flame Seedless grapes (2017 and 2018 seasons)

Treatments	Yield/feddan (ton)		No. bunches / vine		Bunch weight (g)	
	First season	Second season	First season	Second season	First season	Second season
T1- Control (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	11.95 b	13.50 d	29.67 c	31.33 c	573.33 f	613.67 c
T2- mix a nano K 36%+ N 5%+ P 2% + amino acid 5 % (Potacrystal at 3cm/L) + (zero potassium and except 1/5 nitrogen)	15.53 a	15.70 cd	36.67 a	38.33 a	605.00 ef	646.67 bc
T3- mix a nano Ca15 %+ Mg2 %+ B1.5%+ N10 % + amino acid10 % (Kalmagbor at 3cm/L) + (except 1/10 nitrogen)	16.33 a	17.86 bc	34.33 ab	37.67 a	680.33 c	689.00 b
T4- mix a nano P 40 %+ K 28 %+ N 5%+ amino acid5 % (Phospho one at 3cm/L) + (zero potassium and phosphor and except 1/5 nitrogen)	15.59 a	19.94 ab	28.33 c	34.33 b	786.67 a	832.00 a
T5- mix a nano micro nutrient+ citric acid (Magro nano mix at 1g/L) + (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	16.03 a	17.86 bc	34.67 a	36.67 ab	654.00 cd	695.33 b
T6 - Normal chelated iron at 2g/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	12.75 b	15.49 cd	31.00 bc	34.00 bc	607.33 def	650.00 bc
T7- Nano chelated iron at 3cm/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	17.20 a	22.11 a	33.67 ab	38.33 a	729.00 b	823.33 a
T8- Normal potassium silicate at 5g/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/ year)	15.08 a	16.32 cd	33.33 ab	34.00 bc	646.00cde	683.33 b

Table 2. Effect of spraying some nano fertilizers and potassium silicate on bunch dimension (cm) of Flame Seedless grapes (2017 and 2018 seasons)

Treatments	Bunch length (cm)		Bunch width (cm)	
	First season	Second season	First season	Second season
T1- Control (115 N, 57 P_2O_5 and 170 K_2O g/vine/year)	19.00 c	19.67 b	16.33 c	15.60 d
T2- mix a nano K 36%+ N 5%+ P 2% + amino acid 5% (Potacrystal at 3cm/L)+(zero potassium and except 1/5 nitrogen)	21.40 abc	22.60 a	18.00 b	21.00 ab
T3- mix a nano Ca15 %+ Mg2 %+ B1.5%+ N10 % + amino acid10 % (Kalmagbor at 3cm/L) + (except 1/10 nitrogen)	21.40 abc	22.67 a	16.73 c	19.47 bc
T4- mix a nano P 40 %+ K 28 %+ N 5%+ amino acid5 % (Phospho one at 3cm/L) + (zero potassium and phosphor and except 1/5 nitrogen)	22.67 a	23.33 a	18.00 b	19.00 c
T5- mix a nano micro nutrient+ citric acid (Magro nano mix at 1g/L) + (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	21.80 ab	23.13 a	16.23 c	16.67 d
T6- Normal chelated iron at 2g/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	21.40 abc	22.37 a	16.33 c	16.83 d
T7- Nano chelated iron at 3cm/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	22.53 a	24.00 a	20.33 a	22.00 a
T8- Normal potassium silicate at 5g/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	20.00 bc	20.17 b	15.93 c	16.80 d

Table 3. Effect of spraying some nano fertilizers and potassium silicate on number laterals/ bunch and number berries/ bunch of Flame Seedless grapes (2017 and 2018 seasons)

Treatments	No. of berries / bunch		No. of laterals/ bunch	
	First season	Second season	First season	Second season
T1- Control (115 N, 57 P_2O_5 and 170 K_2O g/vine/year)	173.47 bcd	177.83 cd	17.80 b	19.30 c
T2- mix a nano K 36%+ N 5%+ P 2% + amino acid 5 % (Potacrystal at 3cm/L) + (zero potassium and except 1/5 nitrogen)	185.33 b	198.80 b	19.00 b	19.60 c
T3- mix a nano Ca15 %+ Mg2 %+ B1.5%+ N10 % + amino acid10 % (Kalmagbor at 3cm/L) + (except 1/10 nitrogen)	185.33 b	191.33 bc	20.60 ab	22.47 ab
T4- mix a nano P 40 %+ K 28 %+ N 5%+ amino acid5 % (Phospho one at 3cm/L) + (zero potassium and phosphor and except 1/5 nitrogen)	182.87 bc	189.40 bc	22.93 a	24.40 a
T5- mix a nano micro nutrient+ citric acid (Magro nano mix at 1g/L) + (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	183.20 bc	189.53 bc	20.03 b	20.60 bc
T6 - Normal chelated iron at 2g/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	163.87 d	170.00 d	18.87 b	19.97 c
T7- Nano chelated iron at 3cm/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	205.70 a	216.93 a	23.10 a	24.57 a
T8- Normal potassium silicate at 5g/L+ (60 N, 40 P_2O_5 and 80 K2O g/vine/year)	165.87 cd	171.67 d	18.87 b	19.87 c

and 22.00 cm) in the first and second season, respectively and also T2 (*Potacrystal nano* at 3 cm/L) in the second season (21.00 cm). The other tested treatments gave mid values of bunch width (cm) in both seasons.

Total number of berries per bunch and number of laterals per bunch

Data presented in Table 3 indicated that the treatment T7 (Nano chelated iron) recorded uppermost number of berries per bunch (205.70 and 216.93) in the first and second season, respectively. While, T1 (Control), T6 (Normal chelated iron at 3 cm/L) and T8 (Normal potassium silicate 5 g /L) produced lowest number of berries per bunch (173.47 and 177.83, 163.87 and 170.00 and 165.87 and 171.67) in the first and second season, respectively, without significant differences between them. The other tested treatments produced intermediate number laterals per bunch in the two seasons.

The highest values of number of laterals per bunch were from the treatments T3 (Kalmagbor at 3 cm/L), T4 (Phospho one nano at 3 cm/L) and T7 (Nano chelated iron at 3cm/L) (20.60 and 22.47, 22.93 and 24.40 and 23.10 and 24.57) in the first and second season, respectively (Table 3).

Vegetative Growth

Average number of shoots/vines

As shown in Table 4, number of shoots per vine was significantly affected by the tested treatments in the two seasons. However, the highest number of shoots/vine was recorded for T4 (Phospho one at 3 cm/L), T5 (*Magro nano* mix1 g/L) and T7 (Nano chelated iron at 3 cm/ L) (37.33 and 41.67, 37.33 and 40.00 and 38.00 and 40.00) in the first and second seasons, respectively, as well as T3 (Kalmagbor at 3 cm/L) (38.33) in the first season. The lowest number of shoots/vines was recorded for control T1 (28.33 and 31.00) in the two seasons, respectively. The other treatments induced intermediate number of shoots/vine in the two seasons.

Leaf characteristics

Leaf surface area (cm^2)

Data in Table 4 clearly show that leaf surface area (cm^2) was significantly affected by the tested treatments in the two seasons. However, the largest leaf surface area (cm^2) was recorded for T2 (Potacrystal at 3 cm/L) and T5 {Magro nano mix at 1 g/L) (184.67 and 199.47 and 178.87 and 201.83cm^2) in the first and second seasons, respectively, followed by T3 (Kalmagbor at 3 cm/L) and T4 (Phospho one at 3 cm/L) (171.03 and 176.47cm^2) in the first season, respectively. Control treatment (T1) produced the smallest leaf area (144.13 and 151.33 cm^2) in the first and second seasons, respectively. The other treatments induced intermediate leaf area values in the two seasons. Flame Seedless grapes leaf area ranged between 144.13 -184.67 cm^2in the first season and 151.33 -201.83 cm^2 in the second.

Leaf fresh and dry weight (g)

As shown in Table 5 leaf fresh and dry weight were significantly affected by the tested treatments in the two seasons. The highest leaf fresh was recorded for treatments T2 (Potacrystal at 3 cm/L), T5 (Magro nano mix at 1g/L) and T7 (Nano chelated iron at 3 cm/L) in the two seasons without significant differences between them and also treatments T3, T4 and T8 in the first season. The treatment T5 (Magro nano mix at 1 g/L) recorded highest leaf dry weight values (3.775 and 4.008 g) in the two seasons, respectively. While, T1 (Control) produced the lowest leaf fresh (4.160 and 4.233 g) and dry weight (3.187 and 3.348 g) in the first and second seasons, respectively, the other treatments induced intermediate leaf fresh and dry weight values in the two seasons.

Leaf water content (%)

Data in Table 5 showed that the tested treatments significantly affected leaf water percentage in the two seasons. The leaves of treatment T4 (Phospho one at 3 cm/L) recorded highest leaf water percentage (32.30 and 28.66%) in the two seasons, followed by T6 (Normal chelated iron at 3 cm/L) in the first season and T3, T7 and T7 in the second season. The other treatments showed non-significant values of leaf water percentages in the two seasons. Generally, leaf water content ranged between 21.78 – 32.30% and 18.50 – 28.66% in the first and second seasons, respectively.

Photosynthetic pigments contents

Data presented in Tables 6 and 7, revealed that the studied treatments significantly affected leaf photosynthetic pigments, i.e. chlorophyll a, b, total chlorophyll and carotene contents in the two seasons. However, leaves of treatment of T7 (Nano chelated iron at 3 cm/L) contained the highest chlorophyll a (1.133 and 1.233 mg/100 mg FW), b (0.933 and 0.920 mg/100 mg FW), total chlorophyll (2.033 and 2.153 mg/100 mg FW) in the first and second seasons, respectively, without significant differences with T2 (Potacrystal at 3cm/L) for chlorophyll b in the two seasons and with T8 (Normal potassium silicate 5 g/l) for chlorophyll a and b in the second season and also with T8 (Normal potassium silicate at 5 g/L) for total chlorophyll in the second season . In regard to leaf carotene content, the obtained data (Table 7) show that leaves of the treatments T2 (Potacrystal at 3 cm/L), T4 (Phospho one at 3 cm/L) and T7 (Nano chelated iron at 3 cm/L) contained the highest carotene contents (0.907 and 1.043, 0.920 and 1.083 and 0.950 and 1.077 mg/100 mg FW) in the first and second seasons, respectively, without significant differences with treatments T6 (Normal chelated iron at 2 g/L) in the first season and also with T3 {Kalmagbor at 3 cm/L) and T5 (Magro nano mix at1g/L) in the second season. The lowest values of leafy chlorophyll a (0.577 and 0.710 mg/100 mg FW), b (0.557 and 0.573 mg/100 mg FW), total chlorophyll (1.133 and 1.283 mg/100 mg FW) and carotene (0.667 and 0.767 mg/100 mg FW) contents were for control (T1) in the first and second seasons, respectively. Leaves of the other fertilization treatments contained significantly different intermediate chlorophyll a, b, and total chlorophyll and carotene contents.

DISCUSSION

The obtained results of nano-fertilizers (Potacrystal, Kalmagbor, Phospho one, Magro nano mix and Nano iron) had a positive effect in increasing yield, leaf area and chlorophyll content, agreeing with those stated by **Abdelaziz *et al*. (2019); Ahmed *et al*. (2019); Doaa *et al.* (2019); El-Said *et al*. (2019); El-Gioushy *et al*. (2021); Mosa *et al*. (2021) and Rahemi *et al*. (2020).**

Table 4. Effect of spraying some nano fertilizers and potassium silicate on number of shoots per vine and leaf surface area of Flame Seedless grapes (2017 and 2018 seasons)

Treatments	No of shoots / vine		leaf surface area (cm^2)	
	First season	Second season	First season	Second season
T1- Control (115 N, 57 P_2O_5 and 170 K_2O g/vine/year)	28.33 d	31.00 d	144.13 e	151.33 f
T2- mix a nano K 36%+ N 5%+ P 2% + amino acid 5% (Potacrystal at 3cm/L) + (zero potassium and except 1/5 nitrogen)	31.33 cd	35.33 bc	184.67 a	199.47 ab
T3- mix a nano Ca15 %+ Mg 2 %+ B 1.5%+ N 10% + amino acid10% (Kalmagbor at 3cm/L) + (except 1/10 nitrogen)	33.33 bc	38.33 ab	171.03 abc	179.80 cd
T4- mix a nano P 40 %+ K 28 %+ N 5%+ amino acid5 % (Phospho one at 3cm/L) + (zero potassium and phosphor and except 1/5 nitrogen)	37.33 ab	41.67 a	176.47 abc	187.43 bc
T5- mix a nano micro nutrient+ citric acid (Magro nano mix at 1g/L) + (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	37.33 ab	40.00 a	178.87 ab	201.83 a
T6 - Normal chelated iron at 2g/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	32.33 cd	34.00 cd	152.83 de	157.00 ef
T7- Nano chelated iron at 3cm/L+ (60 N, 40 P_2O_5 and 80 K2O g/vine/year)	38.00 a	40.00 a	166.27 bcd	187.83 bc
T8- Normal potassium silicate at 5g/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	30.67 cd	32.33 cd	159.90 cde	168.43 de

Table 5. Effect of spraying some nano fertilizers and potassium silicate on leaf fresh and dry weights (g) and leaf water content (%) of Flame Seedless grapes (2017 and 2018 seasons)

Treatments	Leaf fresh weight (g)		Leaf dry weight (g)		Leaf water content (%)	
	First season	Second season	First season	Second season	First season	Second season
T1-Control (115 N, 57 P_2O_5 and 170 K_2O g/vine/ year)	4.160 b	4.233 c	3.187 cd	3.348 e	24.03 b	19.68 bc
T2- mix a nano K 36%+ N 5%+ P 2% + amino acid 5% (Potacrystal at 3 cm/L) + (zero potassium and except 1/5 nitrogen)	4.498 ab	4.732 ab	3.377 bc	3.630 b	25.92 b	22.84 bc
T3- mix a nano Ca1 5%+ Mg2 %+ B1.5%+ N 10% + amino acid10 % (Kalmagbor at 3cm/L) + (except 1/10 nitrogen)	4.350 b	4.655 ab	3.235 cd	3.460 cde	21.78 b	24.39 ab
T4- mix a nano P 40%+ K 28 %+ N 5%+ amino acid5 % (Phospho one at 3 cm/L) + (zero potassium and phosphor and except 1/5 nitrogen)	4.460 b	4.603 abc	3.055 d	3.302 e	32.30 a	28.66 a
T5- mix a nano micro nutrient+ citric acid (Magro nano mix at 1g/L) + (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	4.858 a	4.927 a	3.775 a	4.008 a	22.77 b	18.50 c
T6- Normal chelated iron at 2g/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	4.380 b	4.473 bc	3.238 cd	3.437 de	26.80 ab	22.75 bc
T7- Nano chelated iron at 3cm/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	4.532 ab	4.732 ab	3.502 b	3.612 bc	23.89 b	24.10 ab
T8- Normal potassium silicate at 5g/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	4.390 b	4.705 ab	3.277 c	3.537 bcd	25.41 b	24.92 ab

Table 6. Effect of spraying some nano fertilizers and potassium silicate on Chlorophyll a and b of leaves Flame Seedless grapes (2017 and 2018 seasons)

Treatments	Chlorophyll a (mg/100 mg fresh weight)		Chlorophyll b (mg/100 mg fresh weight)	
	First season	Second season	First season	Second season
T1- Control (115 N, 57 P_2O_5 and 170 K_2O g/vine/year)	0.577 d	0.710 c	0.557 e	0.573 d
T2- mix a nano K 36%+ N 5%+ P 2% + amino acid 5 % (Potacrystal at 3cm/L) + (zero potassium and except 1/5 nitrogen)	1.033 b	1.033 b	0.833 ab	0.863 ab
T3- mix a nano Ca15%+ Mg 2%+ B1.5%+ N10 % + amino acid10 % (Kalmagbor at 3 cm/L) + (except 1/10 nitrogen)	0.950 bc	1.020 b	0.767 bc	0.827 bc
T4- mix a nano P 40 %+ K 28 %+ N 5%+ amino acid 5% (Phospho one at 3cm/L) + (zero potassium and phosphor and except 1/5 nitrogen)	0.967 b	1.017 b	0.733 cd	0.817 bc
T5- mix a nano micro nutrient+ citric acid (Magro nano mix at 1g/L) + (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	0.867 c	1.017 b	0.680 d	0.767 c
T6- Normal chelated iron at 2g/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	0.967 b	1.033 b	0.767 bc	0.777 c
T7- Nano chelated iron at 3cm/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	1.133 a	1.233 a	0.900 a	0.920 a
T8- Normal potassium silicate at 5g/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	1.000 b	1.100 ab	0.767 bc	0.877 ab

Table 7. Effect of spraying some nano fertilizers and potassium silicate on total chlorophyll and carotenoids of leaves Flame Seedless grapes (2017 and 2018 seasons)

Treatments	Total chlorophyll (mg/ 100 mg fresh weight)		Carotenoids (mg/ 100 mg fresh weight)	
	First season	Second season	First season	Second season
T1- Control (115 N, 57 P_2O_5 and 170 K_2O g/vine/year)	1.133 e	1.283 d	0.667 d	0.767 d
T2- mix a nano K 36%+ N 5%+ P 2% + amino acid 5 % (Potacrystal at 3cm/L) + (zero potassium and except 1/5 nitrogen)	1.867 b	1.897 bc	0.907 a	1.043 ab
T3- mix a nano Ca15 %+ Mg2 %+ B1.5%+ N10 % + amino acid10 % (Kalmagbor at 3cm/L) + (except 1/10 nitrogen)	1.717 c	1.847 bc	0.797 bc	0.977 abc
T4- mix a nano P 40 %+ K 28 %+ N 5%+ amino acid5 % (Phospho one at 3cm/L) + (zero potassium and phosphor and except 1/5 nitrogen)	1.700 c	1.833 bc	0.920 a	1.083 a
T5- mix a nano micro nutrient+ citric acid (Magro nano mix at 1 g/L) + (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	1.547 d	1.783 c	0.767 c	1.030 abc
T6 - Normal chelated iron at 2g/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	1.733 c	1.810 bc	0.867 ab	0.910 c
T7- Nano chelated iron at 3cm/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	2.033 a	2.153 a	0.950 a	1.077 a
T8- Normal potassium silicate at 5g/L+ (60 N, 40 P_2O_5 and 80 K_2O g/vine/year)	1.767 bc	1.977 ab	0.807 bc	0.923 bc

Spraying grape vines with nano-zinc increased significantly some vegetative parameters, leaf area and fresh weight, No. of clusters, cluster weight and yield compared with the control. Also, nano-zinc at 0.4, 0.8 and 1.2 ppm of had a significant increase on yield compared with conventional fertilizer **(El-Said *et al*., 2019)**. **Mohamed (2020)** revealed that using zinc, iron and manganese bulk or nano significantly increased yield of Thompson seedless grape cultivar, and improved the cluster and berry traits, and also improved leaf area, leaf total chlorophyll as well as leaf nutrient composition compared to control.

The effect of nanoparticles in plants varies according to their composition, size, physical and chemical properties, as well as the plant species since the nanoparticles interact through enhancing production or inhibitory effects on plant growth in the different developmental stages **(Ma *et al.*, 2010).**

Furthermore, because iron is a prosthetic group constituent of many enzymes such as cytochromes in the electron transport chain; it is required for many biological tasks **(Liu *et al*., 2014)**. It also participates in chlorophyll synthesis, so it is required for the chloroplast's structure and function. This could be attributed to Fe interfering with the structural and catalytic components of proteins and enzymes, which are required for the normal development of pigment biosynthesis and photosynthesis activation **(Mohammadi *et al*., 2018)**. Several studies have found that Fe, in its natural or nanoform, improves leaf photosynthetic pigments and photosynthesis parameters **(Duhan *et al.*, 2017; Fatima *et al*., 2020; Mittal *et al*., 2020)**. Due to the preliminary improvement of vegetative growth and photosynthesis in response to the application of different iron forms (nano, sulfate, and chelated).

Nano Boron shows positive effect in increasing yield and enhanced the content of chlorophyll and essential nutrients like Nitrogen, Potassium, phosphorus, Manganese, Magnesium, Boron, Zinc and Iron in leaves **(Abdelaziz *et al*., 2019).** Foliar spray of nano Zinc and nano Boron increased pomegranate fruit quality, yield **(Davarpanah *et al*., 2016)**.

Nano Calcium based fertilizers improve foliage development, chlorophyll content provides best yield and improves quality of grape berry and nutrient content of leaf **(Sabir *et al*., 2014)**.

Spraying pomegranate fruits of Ardestani cultivar with Nano Nitrogen (nN) at 1.8 kg ha-1 gave highest yield and a greater number of fruits per tree **(Davarpanah *et al*. 2017)**.

The positive effects of potassium silicate application on yield, bunch weight, growth, chlorophyll content and leaf surface area of Flame seedless grapevine are in line with those reported by **Liu *et al*. (2011), Bhavya *et al*. (2011), Ahmed *et al.* (2012), Ramteke *et al*. (2012), Al-Khawaga (2014), Al-Wasfy (2014); Mohamed (2017) and Mekawy and Galal (2021).**

Potassium is considered an important mineral nutrient for all stages of protein synthesis that contributes to all plant growth processes. Potassium plays a key role in many physiological functions (stomata opening and photosynthesis, translocation of photosynthates, polypeptide synthesis and meristematic growth, enzyme activation, charge balancing and neutralizing functions, osmoregulation, stress resistance, quality improvement of fruits etc.) **(Epstein and Bloom, 2005; Arquero *et al*., 2006)**. Potassium silicate was improved the vegetative growth characters, through its role in cel1 division and expansion by their effect on DNA and RNA synthesis **(Sahebi *et al*., 2015)**. Thus, it is role in protective mechanisms that avoid the damage of the photosynthetic apparatus **(Qin *et al*., 2016).** Also, **Iqbal *et al*. (2021)** mentioned that the role of silicon in maintained growth by modulating stomatal conductance, higher green pigments, internal CO and photosynthetic activity in grape leaves thereby enabling them to produce biomass and this may be contributed in improving of vegetative growth characteristics and chlorophyll content in leaves of Superior Seedless and Red Globe grapevines by using foliar application with potassium silicate.

Conclusions

It concluded that the use of nano fertilizers which contain any or combine of nano N, P, K, Ca, Mg, B, Fe, Zn had a positive effect on improving yield, bunch characteristics and growth of Flame seedless grapes with minimize the traditional used fertilizers.

REFERENCES

Abdelaziz, F.H., A.M. Akl, A.Y. Mohamed and M.A. Zakier (2019). Response of Keitte mango trees to spray boron prepared by nanotechnology technique. NY Sci. J., 12: 48-55.

Ahmed, F.F., A.E.M. Mansour, A.Y. Mohamed, E.A.M. Mostafa and N.E. Ashour (2012). Using silicon and salicylic acid for promoting production of Hindy Bisinnara mango trees grown under sandy soil. Middle East J. Agric. Res., 2: 51–55.

Ahmed, M.M.A., Y. Mohamed Ahmed and A.Z. Mohamed (2019). Response of Keitte mango trees to spray boron prepared by nanotechnology technique. New York Sci. J., 12 (6): 48-55.

Al-Hchami, S.H.J. and T.K. Alrawi (2020). Nano fertilizer, benefits and effects on fruit trees: A review. Plant Archives, 20 (1): 1085 - 1088.

Al-Khawaga, A. S. (2014). Impact of Vitamins B and C, Glutamic acid and Silicon on Fruiting of Superior Grapevines. World Rural Observations, 6 : 4.

Al-Wasfy, M.M.M. (2014). The synergistic effects of using silicon with some vitamins on growth and fruiting of Flame seedless grapevines. Stem Cell, 5: 8–13.

Arquero, O., D. Barranco and M. Benlloch (2006). Potassium starvation increases stomatal conductance in olive trees. Hort. Sci., 41: 433-436.

Balakhnina, T. and A. Borkowska (2013). Effects of silicon on plant resistance to environmental stresses: review. Int. Agrophys, 27: 225-232.

Bhavya, H.K., V. Nache gowda, S. Jaganath, K.N. Sreenivas and N.B. Prakash (2011). Effect of foliar silicic acid and boron acid in Bangalore blue grapes. Proc. 5th, Int. Conf. on Silicon in Agric., September 13-18, 2011, pages 7-8, Beijing, China.

Briat, J.F., C. Curie and F. Gaymard (2007). Iron utilization and metabolism in plants. Curr. Opin. Plant Biol., 10: 276-282.

Davarpanah, S., A. Tehranifar, G. Davarynejad, A. Medi, J. Abadía and R. Khorasani (2017). Effects of foliar nano-nitrogen and urea fertilizers on the physical and chemical properties of pomegranate (*Punica granatum* cv. Ardestani) fruit. Hort. Sci. 52 (2): 228-294.

Davarpanah, S., A. Tehranifar, G. Davarynejad, J. Abadía and R. Khorasani (2016). Effects of foliar applications of zinc and boron nano-fertilizers on pomegranate (*Punica granatum* cv. Ardestani) fruit yield and quality. Scientia Hort., 210:57-64.

Doaa, M.H., R.F. Sefan and M.S. El-Boray (2019). Effect of potassium nano fertilizer on yield and berry qualities of Flame Seedless' grapevines. J. Plant Prod., Mansoura Univ., 10 (11): 929-934.

Duhan, J.S., R. Kumar, N. Kumar, P. Kaur, K. Nehra and S. Duhan (2017). Nanotechnology: The new perspective in precision agriculture. Biotechnol. Rep., 15: 11 – 23.

Duncan, D.B. (1958). Multiple Rang and Multiple F test. Biomet., 11: 1-42.

El-Gioushy, S.F., Z. Ding, A.M. E. Bahloul, M.S. Gawish, H.M. Abou El Ghit, A.M.R. A. Abdelaziz, H.S. El-Desouky, R. Sami, E. Khojah, T.A. Hashim, A.M.S. Kheir and R.M.Y. Zewai (2021). Foliar application of nano, chelated, and conventional iron forms enhanced growth, nutritional status, fruiting aspects, and fruit quality of Washington Navel orange trees (*Citrus sinensis* L. Osbeck). Plants, 10 (12): 2577.

El-Said, R.E.A., S.A. El- Shazly, A.A.M. El-Gazzar, E.A. Shaaban and M.M.S. Saleh (2019). Efficiency of nano-zinc foliar spray on growth, yield and fruit quality of Flame Seedless grape. J. Appl. Sci., 19: 612-617.

Epstein, E. and A. J. Bloom (2005). Mineral nutrition of plants: Principles and perspectives, 2nd Ed. Sinauer Associates, Inc. Publishers, Sunderland Massachusetts, 225–227.

Fatima, Z., M. Ahmed, M. Hussain, G. Abbas, S. Ul-Allah, S. Ahmad, N. Ahmed, M.A. Ali, G. Sarwar and E.U. Haque (2020). The fingerprints of climate warming on cereal crops phenology and adaptation options. Sci. Rep., 10:18013.

George, E.F., M.A. Hall and G.J. De Klerk (2008). The components of plant tissue culture media I: macro-and micro-nutrients. In: George EF et al (eds) Plant propagation by tissue culture, 3rd edn. Springer, Berlin, 65–113.

Hegazi, A. and A. El Kader Sallam (2003). Cluster and berry characteristics of 'Flame Seedless' grapes under different environmental condition in Egypt. ISHS Acta Hort. 603: VIII Int. Conf. on Grape Genet. and Breed., 1 April, Kecskemet, Hungary.

Iqbal, Z., A. Sarkhosh, R.M. Balal, C. Gomez, M. Zubair, N. Ilyas, N. Khan and M.A. Shahid (2021). Silicon alleviates hypoxia stress by improving enzymatic and non-enzymatic antioxidants and regulating nutrient uptake in Muscadine grape (*Muscadinia rotundifolia* michx.). Front. Plant Sci., 11: 618873.

Kim, Y.H., A.L. Khan, M. Waqas , J.K. Shim, D.H. Kim, K.Y. Lee and I.J. Lee (2014). Silicon application to rice root zone influenced the phytohormonal and antioxidant responses under salinity stress. J. Plant Growth Regul., 33: 137–149.

Labuayai, S., V. Promarak and S. Maensiri (2009). Synthesis and optical properties of nanocrystalline ZnO powders prepared by a direct thermal decomposition route. Appl. Physicsa, 94 (4): 755-761.

Liu, J.M., C. Han, X.B. Sheng, S.K. Liu and X. Qi (2011). Potassium-containing silicate fertilizer: its manufacturing technology and agronomic effects. Oral Presentation at 5th Int. Conf. Silicon in Agric., September 13–18, Beijing.

Liu, J., S. Chakraborty, P. Hosseinzadeh, Y. Yu, S. Tian, I. Petrik, A. Bhagi and Y. Lu (2014). Metalloproteins containing cytochrome, iron-sulfur, or copper redox centers. Chem. Rev., 114:4366–4469.

Ma, X., J. Geiser-Lee, Y. Deng and A. Kolmakov (2010). Interactions between engineered nanoparticles (ENPs) and plants: Phytotoxicity uptake and Accumulation. Science of the Total Environment. 408: 3053-3061.

Mahil, E. I. T. and B. N. A. Kumar (2019). Foliar application of nano fertilizers in agricultural crops – A review. J. Farm Sci., 32(3): 239-249.

Mandal, D. and Lalrinchhani (2021). Nano fertilizer and its application in horticulture. J. Applied Horticulture, 23(1): 70-77.

Manna, A. C. (2012). Synthesis, characterization, and antimicrobial activity of zinc oxide nanoparticles. In Nno-antimicrobials, Springer berlin Heidelberg, 151-180.

Mekawy, A.Y. and A.A. Galal (2021). Effect of foliar application with silicon and seaweed extract on the vegetative growth, bunch quality and some fungal diseases of Red Globe and Superior Seedless grapevines. World Journal of Agricultural Sciences 17 (3): 177-188.

Mittal D., G.Kaur, P. Singh, K. Yadav and S.A. Ali (2020). Nanoparticle-based sustainable agriculture and food science: Recent advances and future outlook. Front. Nanotechnol.,2:10.

Mohamed, A. A. (2020). Impact of foliar application of nano micronutrient fertilizers on some quantitative and qualitative traits of" Thompson seedless" grapevine. Mid. East J. Appl. Sci., 10(3): 435-441.

Mohamed, H.M.A. (2017). Promoting the productivity of early sweet grapevines grown under sandy soil conditions by using glutamic acid and potassium silicate. J. Hort. Sci. and Ornamen. Plants, 9 (3): 138-143.

Mohammadi, M., N. MajnounHoseini, M.R. Chaichi, H. Alipour, M. Dashtaki and S. Safikhani (2018). Influence of nano-iron oxide and zinc sulfate on physiological characteristics of peppermint. Commun. Soil Sci. Plant Anal., 49:2315–2326.

Mosa, W.F., A.M. El-Shehawi, M.I. Mackled, M.Z. Salem, R.Y. Ghareeb, E.E. Hafez and N.R. Abdelsalam (2021). Productivity performance of peach trees, insecticidal and antibacterial bioactivities of leaf extracts as affected by nanofertilizers foliar application. Scientific Rep., 11 (1): 1-19.

Qin, L., W. Kang, Y. Qi, Z. Zhang and N. Wang (2016). The influence of silicon application on growth and photosynthesis response of salt stressed grapevines (*Vitis vinifera* L.). Acta. Physiologiae Plantarum, 38 (3): 1-9.

Rahemi, M., S.R. Gharechahi and S. Sedaghat (2020). The application of nano-iron chelate and iron chelate to soil and as foliar application: treatments against chlorosis and fruit quality in quince. Int. J. Fruit Sci., 20 (3): 300–313.

Ramteke, S.D., R.J. Kor, M.A. Bhanga, A.P. Khot, N.A. Zende, S.S. Datir and K.D. Ahire (2012). Physiological studies on effects of Silixol on quality and yield in Thompson seedless grapes. Ann. Plant Physiol., 26: 47–51.

Sabir, A, K. Yazar, F. Sabir, Z. Kara, M.A. Yazici and N. Goksu (2014). Vine growth, yield, berry quality attributes and leaf nutrient content of grapevines as influenced by seaweed extract (*Ascophyllum nodosum*) and nano size fertilizer pulverizations. Scientia Hort., 175:1-8.

Sahebi, M., M.M. Hanafi, A. Siti Nor Akmar, M.Y. Rafii, P. Azizi, F. Tengoua and M. Shabanimofrad (2015). Importance of silicon and mechanisms of biosilica formation in plants. BioMed. Res. Int. Article ID 396010 Sci., U S A 91 : 11–17.

Sekhon, B.S. (2014). Nanotechnology in agri-food production: an overview. Nanotechnol. Sci. Appl. 7: 31 – 53.

Shang, Y., M.K. Hasan, G.J. Ahammed, M. Li, H. Yin and J. Zhou (2019). Applications of nanotechnology in plant growth and crop protection: A Review. Molec., 24(13): 2558.

Shi, Y., Y. Zhang, H. Yao, J. Wu, H. Sun and H. Gong (2014). Silicon improves seed germination and alleviates oxidative stress of bud seedlings in tomato under water deficit stress. Plant Physiol. Biochem., 78: 27 – 36.

Snedecor, G.W. and W.G. Cochran (1980). Statistical Methods. 8 Ed., the Iowa State Univ. Press, Iowa, USA.

Statistics of the Ministry of Agriculture (2020). Statistics of fruit production.

Taiz, L., E. Zeiger, I.M. Møller and A. Murphy (2015). Plant physiology and development. Sinauer Associates, Incorporated, Sunderland.

Uauy, C., A. Distelfeld, T.Fahima, A. Blechl and J. Dubcovsky (2006). A NAC gene regulating senescence improves grain protein, zinc, and iron content in wheat. Sci., 314: 1298–1301.

Vafaee, M. and M.S. Ghamsari (2007). Preparation and characterization of ZnO nanoparticles by a novel sol-gel route materials letter, 61(14): 3265-3268.

Wettestein, D. (1957). Chlorophyll. Lethale under submikross-kopische formwechesl der plastiden. Exptl. Cell. Res., 12 : 427-433.

Xie, Z. , R. Song, H. Shao, F. Song, H. Xu and Y. Lu (2015). Silicon improves maize photosynthesis in saline-alkaline soils. Sci. World J. Article ID 245072.

Yin, L., S. Wang, P. Liu, W. Wang, D. Cao, X. Deng and S. Zhang (2014). Silicon mediated changes in polyamine and 1-aminocyclopropane-1- carboxylic acid are involved in silicon-induced drought resistance in *Sorghum bicolor* L. Plant Physiol. Biochem., 80: 268–277.

تأثير الرش الورقي ببعض الأسمدة النانوية أو سليكات البوتاسيوم مع التقليل من الأسمدة التقليدية المستخدمة على النمو والمحصول وصفات العناقيد لصنف عنب فليم سيدلس

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أجريت هذه الدراسة خلال موسمين متتاليين 2017 و2018 على عنب صنف فليم سيدلس بعمر 4 سنوات مزروعة في تربة رملية بمسافة 2×3م عن بعضها البعض تحت نظام الري بالتنقيط وتم تدعيم الكروم بنظام حرف Y في مزرعة عنب خاصة بمركز بلبيس بمحافظة الشرقية، مصر. تضمنت التجربة 8 معاملات كالتالي :Control -T1 (رش بالماء) تسميد الكروم حسب برنامج التسميد المتبع في المزرعة (60 N و40 P_2O_5 و80 K_2O جم/كرمة/سنة). T2- رش الكروم بخليط من سماد نانوي يحتوي على البوتاسيوم (36%) والأحماض الأمينية (5%) والنيتروجين الكلي (5%) والفوسفور الكلي (2%) والمغذيات الدقيقة (2%) [بوتاكريستال بمعدل 3 سم/لتر] (ما عدا البوتاسيوم و 5/1 النيتروجين). T3- رش الكروم بخليط من سماد النانو الذي يحتوي على كالسيوم (15%)، مغنيسيوم (2%)، بورون (1.5%) مع حمض أميني (2%) ونيتروجين (10%) [كالمجبور بمعدل 3سم/لتر] (عدا 10/1 نيتروجين). T4- رش الكروم بخليط من سماد النانو المحتوي على الفسفور (40%) والبوتاسيوم (28%) والأحماض الأمينية (5%) والنيتروجين (5%) [فوسفو واحد بمعدل 3 سم/لتر] (عدا البوتاسيوم والفوسفور و1 /5 نيتروجين). T5- رش الكروم بخليط النانو عناصر صغرى + حامض الستريك (خليط ماجرو نانو بمعدل 1 جم/لتر) +T1. T6- رش الكروم بالحديد المخلبى العادي بمعدل 2 جرام/ لتر+T1. T7-رش الكروم بالحديد المخلبى النانوي بمعدل 3 سم/لتر +T1. T8- رش الكروم بسليكات البوتاسيوم العادي بمعدل 5 جم/ لتر + T1. تم الرش لكل المعاملات ثلاث مرات في السنة على فترات شهرية، أي الأسبوع الأول من كل من مارس وأبريل ومايو. أظهرت النتائج أن المحصول الكلي للفدان (طن) ازداد معنوياً عند إضافة جميع المعاملات مقارنة بالكنترول في كلا الموسمين. سجلت أعلى قيم للإنتاج الكلي للفدان (طن) للمعاملتين T4 (15.59 و19.94 طن) و T7(17.20 و22.11 طن) في الموسم الأول والثاني على التوالي. أقصر عناقيد كانت من معاملات الكنترول وسيليكات البوتاسيوم العادى في الموسمين الأول والثاني على التوالي، بينما سجلت المعاملات الأخرى قيماً أعلى لطول العنقود في الموسمين دون فروق معنوية بينهما. كما لوحظ زيادة معنوية في مساحة سطح الورقة (سم2) ووزن الورقة الرطب والجاف بالمعاملات المختبرة مقارنة مع معاملة الكنترول (T1) في الموسمين. ومع ذلك، فإن أوراق معاملة T7 (الحديد المخلب النانوي) تحتوي على أعلى كمية من الكلوروفيل أ (1.133 و1.233 ملجم/100 ملجم وزن طازج)، كلوروفيل ب(0.933 و0.920 ملجم/ 100 ملجم وزن طازج)، والكلوروفيل الكلى (2.033 و2.153 ملجم/100 ملجم وزن طازج). والكاروتينات (0.950 و1.077 ملجم/ 100 ملجم وزن طازج).

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