J. of Plant Production, Mansoura Univ., Vol. 10 (11):929-934, 2019

Journal of Plant Production

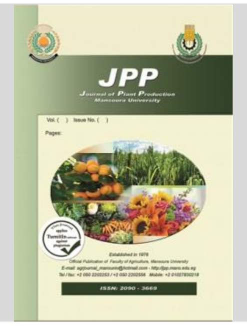
Journal homepage: www.jpp.mans.edu.eg
Available online at: www. jpp.journals.ekb.eg

Effect of Potassium Nano Fertilizer on Yield and Berry Qualities of 'Flame Seedless' Grapevines

Doaa M. Hamza[1*]; Raeesa F. Sefan[2] and M. S. El-Boray[1]

[1] Pomology Dept., Fac. Agric., Mansoura Univ., Egypt.
[2] Hort. Res. Inst., Agric. Res. Center, Egypt.

Cross Mark



ABSTRACT

This research was performed during the 2017 and 2018 seasons in a private orchard located at Dakahlia governorate to investigate the impact of soil potassium fertilization and foliar spray with Potassium Nano chitosan on growth, yield and berry quality of 'Flame seedless' grapes. Results showed that foliar treatments carried out with chitosan significantly increased vegetative growth (shoot diameter and leaf area). The application of foliar Nano chitosan Potassium fertilizer significantly increased yield and berries quality. In addition, the Foliar application of Potassium Nano chitosan along with potassium sulfate treatments significantly increased N and K content in petiole of grape leaves than the control.

Keywords: Potassium, Chitosan, Foliar fertilization, Grapevines.

INTRODUCTION

Grape (*Vitis vinifera* L.) is one of the major commercial fruit crops with high export potential. In Egypt, grapes came in the second rank after citrus. The harvest area is 77,895 hectares which produced 1,703,394 tons (FAO, 2017). Fertilization is one of the most promising tools to increase production. Mineral nutrition is one of the main tools to optimize fruit yield and quality (Tagliavini and Marangoni, 2002). Foliar application of nutrients turned out to be most well-known among fruit tree growers that could contribute to satisfying plant nutrient requirements (Inglese *et al.*, 2002).

Potassium is an activator of many enzymes that are essential for photosynthesis and respiration as well as enzymes that produce starch and proteins (Bhandal and Malik, 1988). Potassium is also involved in the osmotic potential of cells as well as the turgor of the guard cells that open and close stomata (Salisbury and Ross, 1992). It has been notified that around 50–90 % of potassium content of applied fertilizers is lost in the environment and not absorbed by plants, which causes great economic losses (Trenkel, 2010; Saigusa, 2000 and Solanki *et al.*, 2015). Moreover, chemical fertilizers have low use efficiency, which increases the cost of production and also result in pollution of the environment (Wilson *et al.*, 2008). Therefore, it could be helpful to use and test other fertilization methods to supply important elements for vine growth and productivity, with keeping soil structure in good shape and the surrounding environment clean (Miransari, 2011).

Nanotechnology has become a new methods for the development and application of new types of fertilizers. The nano term is from the Greek word meaning many small. The word nano equal one-billionth part of a meter. Particles have at least one dimension less than hundred nm are known as nano-particles (Thakkar *et al.*, 2010). Nano-fertilizers are nutrient carriers of Nano dimensions ranging from 30 to 40 nm and able to hold bountiful of nutrient ions according to its high surface area and release it steadily and slowly that proportional with tree needs (Subramanian *et al.*, 2015). Using Nano-fertilizers not only causes increase use efficiency of the elements but also reduce the toxicity produced due to over-application in the soil as well as reduce the split application of fertilizers (Naderi and Danesh-Shahraki 2013). Nano fertilizers were classified into three groups according to Kah *et al.* (2018): nanomaterials made of micronutrients; nanomaterials made of macronutrients; and nanomaterials used as carriers for macronutrients.

Nano-particles of chitosan recently used to bear ions of nutrient element and introduce it to plants. Recently, Chitosan-based materials have been used to produce nanoparticles able to efficiently supply plants with chemicals and nutrients (Kah *et al.*, 2013). Chitosan is a natural, safe, and cheap biopolymer produced from chitin, the major constituent of arthropods exoskeleton and fungi cell walls and the second renewable carbon source after lignocellulosic biomass (Kurita, 2006), it has the best chelating properties (Kamari *et al.*, 2011). Nano-particles of chitosan are absorbed easily by the leaves and translocate to stems, and promote the growth and yield of different plants (Malerba and Cerana, 2016).

The present study objective was to examine the impact of foliar addition of Nano chitosan-K fertilizer with several rates (250, 500 as well as 1000 ppm) with K soil application of potassium fertilizer (50 and 75% of recommended dose) on vegetative growth, productivity and berry quality of 'Flame seedless' grapevines.

MATERIALS AND METHODS

This research was performed during 2017 and 2018 seasons to study the effect of using different levels of potassium Nano fertilizer with potassium soil application on vegetative growth, yield, cluster, and berries physical and chemical characteristics, as well as nitrogen, phosphorus and potassium % in petioles of 'Flame seedless' grapevine leaves. The experiment was performed on 6-year-old 'Flame seedless' vines cultivated in loamy soil under flood irrigation system at 2

[*] **Corresponding author.**
E-mail address: Doaahamza2@gmail.com
DOI: 10.21608/jpp.2019.68553

× 2.5 meters in a private farm located at Aga near Mansoura city, Dakahlia governorate, Egypt. The vines were trained on T- trellis system and spur pruned. Pruning was done on first January in both seasons of study, leaving around 90 eyes/vine (based on 30 fruiting spurs/vine × 3 eyes/spur).

Seventy-two vines have nearly similar vigor were chosen to do this research, all chosen vines got the same agriculture practices as, irrigation, fertilization, pest and diseases control programs that normally done in this location. A complete randomized blocks design was used. Vines subjected to eight treatments, each treatment was three times replicated with three vines per each. treatments applied were as following:

1) 100 % of Potassium Sulphate recommended dose. (Control)
2) 75 % of Potassium Sulphate recommended dose + 1000 ppm Nano Chitosan-K.
3) 75 % of Potassium Sulphate recommended dose + 500 ppm Nano Chitosan-K.
4) 75 % of Potassium Sulphate recommended dose + 250 ppm Nano Chitosan-K.
5) 50 % of Potassium Sulphate recommended dose + 1000 ppm Nano Chitosan-K.
6) 50 % of Potassium Sulphate recommended dose + 500 ppm Nano Chitosan-K.
7) 50 % of Potassium Sulphate recommended dose + 250 ppm Nano Chitosan-K.
8) 1000 ppm Nano Chitosan-K.

Potassium Sulphate was applied as a soil application, Potassium sulfate (48 % K_2O) was added at the rate of 100% (125 g/vine) , 75% (100 g/vine) and 50% (75 g/vine) at three equal doses, while Nano chitosan – K fertilizer was applied as a foliar application. These treatments were applied at 3 stages, at the beginning of vegetative growth, after fruit set stage and at the véraison stage. Nano chitosan – K fertilizer was from the Genetic engineer department, Ain Shams University.

Before the experiment, soil samples at 40 cm depth were taken to measure the properties of experimental soil. Such samples were totally mixed and subjected to chemical and mechanical analysis as presented in Table (1).

Table 1. Some mechanical and chemical measurements of the orchard soil at the depth of (40 cm).

Mechanical	Sand (%)	36.40
	Silt (%)	39.92
	Clay (%)	23.68
	Texture	Loamy soil
	Field Capacity, FC(%)	27.50
	The wilting point, WP(%)	14.25
	Bulk Density (mg /cm^{-3})	1.25
Chemical	Organic matter, OM(%)	3.74
	pH	8.23
	EC (mmho/cm)	0.57
	N (mg / L)	40.62
	P (mg / L)	53.39
	K (mg / L)	618

Measurements:

Vegetative growth Measurements:

Shoot length (m) was taken and shoot diameter (mm) using a digital caliper and average leaf area (cm^2 / leaf) (Montero *et al.,* 2000):

$$\textbf{Leaf area (cm}^2\textbf{ / leaf) = 0.587 (L × W)}$$

Where L= the leaf blade length. W= the leaf blade width.

Leaf petioles Chemical analysis:

Digestion of N, P, and K by mixed H_2SO_4+ $HClO_4$ method according to (Jackson, 1973). Total N content (%) was measured using the micro-Kjeldahl method (Hesse, 1971). K% was measured by using a flame photometer (Jackson, 1967), element concentrations were calculated as percentages on a dry weight basis. P% was measured colorimetrically spectrophotometer at a wave length of 700 nm using the method of Schouwenburg and Walinge (1967).

Yield and Cluster Physical characteristics:

At harvest time, the yield in weight (kg) was estimated by multiplying the clusters number per vine by the average cluster weight. Average cluster length (cm) was also measured.

Berries chemical properties:

Juice soluble solids content (SSC%) of fresh berries was estimated using Carlsize hand refractometer. Total acidity (%) was estimated using titration method (AOAC, 1984). The soluble solids content / acid ratio was also calculated. Total anthocyanin content in skin berries (mg/100 g FW) was determined (Mazumadar and Majumder, 2003). Total sugars were determined in grape berries with phenol sulphuric acid method (Dubois *et al.,* 1956).

Statistical analysis:

Obtained data were analyzed using Analysis of Variance (ANOVA) method in a complete randomized blocks design by GenStat Package, 11th Edition. Treatment means were compared using the least significant differences (LSD) at 5% of probability (Waller and Duncan, 1969).

RESULTS AND DISCUSSION

Results

Effect of Nano chitosan – K fertilizer application on vegetative growth of 'Flame Seedless' grapevines.

Data in Table 2 show that T4 (75% mineral + 250 ppm Nano K) gave a significant increase in shoot length in 2017 and 2018 seasons of the study compared by control treatment as it gave the highest values in that respect (2.13 – 2.27 m in 2017 and 2018 seasons, respectively). However, insignificant differences were obtained between T4, T2 (75% mineral + 1000 ppm Nano K) and T8 (1000 ppm Nano K) in 2017 and 2018 seasons. On the other hand, the control treatment recorded the lowest values of shoot length compared with other treatments in the two seasons of the study (1.62 – 1.68 m in 2017 and 2018 seasons, respectively).

Data in the same Table indicate that all Nano K fertilizer treatments significantly enhanced shoot diameter in the two seasons of study when compared to control treatment. The highest values in this respect were corresponding with T7 (50% mineral + 250 ppm Nano K), which recorded 11.54 and 11.64 mm during the two seasons of study, respectively. In addition, the control treatment gave the lowest values recorded (8.69 and 8.89 mm) in the 2017 and 2018 seasons, respectively.

Concerning the leaf area, data from the same Table show that T7 (50% mineral + 250 ppm Nano K) significantly gave the highest value in comparison with all of the other treatments in the first season (113.3 cm^2 / leaf). However, insignificant differences were obtained between all Nano K treatments in the second season. While, control treatment significantly recorded the lowest values for leaf area (64.2 and 82.4 cm^2 / leaf in both seasons, respectively) when compared with the interaction between different potassium rates and Nano chitosan-K concentrations.

Effect of Nano chitosan – K fertilizer application on N, P and K (%) content in leaf petioles of 'Flame Seedless' grapevines.

The concerned results in Table 3 indicated that N% significantly increased in leaf petioles by application of T2 (75% mineral + 1000 ppm Nano K) compared with other treatments in the two seasons of study, the recorded values were 2.24 and 2.24% in 2017 and 2018, respectively). While, T1 (Control) significantly gave the lowest values (1.83 and 1.83 % in 2017 and 2018 seasons, respectively) of N% in leaf petioles. Data also indicated that all Nano K fertilizer treatments significantly increased N leaf petioles compared to control treatment in both seasons of study.

Table 2. Effect of Nano chitosan – K fertilizer on Shoot length (m), Shoot diameter (mm) and Leaf area (cm^2 / leaf) of 'Flame Seedless' grapevines during the 2017 and 2018 seasons.

	Shoot length (m)		Shoot diameter (mm)		Leaf area (cm^2 / leaf)	
	2017	2018	2017	2018	2017	2018
T1 (100% of recommended dose, Control)	1.62	1.68	8.69	8.89	64.2	82.4
T2 (75% mineral + 1000 ppm Nano K)	1.81	1.94	11.32	11.45	87.9	105.7
T3 (75% mineral + 500 ppm Nano K)	1.90	1.73	11.36	11.58	88.4	110.2
T4 (75% mineral + 250 ppm Nano K)	2.13	2.27	10.63	10.90	81.7	103.3
T5 (50% mineral + 1000 ppm Nano K)	1.86	1.84	10.86	10.62	84.1	111.9
T6 (50% mineral + 500 ppm Nano K)	2.05	1.83	10.37	10.95	87.9	102.8
T7 (50% mineral + 250 ppm Nano K)	1.75	1.91	11.54	11.64	113.3	110.9
T8 (1000 ppm Nano K)	1.80	1.97	11.21	11.26	86.9	103.2
LSD 5%	0.37	0.39	0.71	0.79	8.86	9.71

As for P%, results in Table 3 showed that T8 (1000 ppm Nano K) gave a significant increase of P% in leaf petioles when compared with the other studied treatments during both seasons of study, it recorded (0.068 and 0.069 % in 1st and 2nd seasons, respectively). Data also reveal that control treatment gave the lowest significant values during the two seasons of study (0.037 and 0.038 % during the two seasons, respectively).

Data in the same Table reveal that T7 (50% mineral + 250 ppm Nano K) significantly increased values of K% in the two experimental seasons, it recorded (4.16 and 4.17 % in 2017 and 2018 seasons, respectively). On the contrary, the lowest values were recorded by T1 (Control) treatment, which recorded values of (2.52 – 2.52 % during the 2017 and 2018 seasons, respectively).

Table 3. Effect of Nano chitosan – K fertilizer on N, P and K (%) content in leaf petioles of 'Flame Seedless' grapevines during 2017 and 2018 seasons.

	N (%)		P (%)		K (%)	
	2017	2018	2017	2018	2017	2018
T1 (100% of recommended dose, Control)	1.83	1.83	0.037	0.038	2.52	2.52
T2 (75% mineral + 1000 ppm Nano K)	2.24	2.24	0.043	0.041	3.83	3.83
T3 (75% mineral + 500 ppm Nano K)	1.98	1.98	0.041	0.042	3.35	3.47
T4 (75% mineral + 250 ppm Nano K)	2.20	2.21	0.040	0.042	3.58	3.61
T5 (50% mineral + 1000 ppm Nano K)	1.95	1.96	0.058	0.059	3.86	3.87
T6 (50% mineral + 500 ppm Nano K)	2.07	2.08	0.044	0.045	2.59	2.66
T7 (50% mineral + 250 ppm Nano K)	2.14	2.15	0.057	0.058	4.16	4.17
T8 (1000 ppm Nano K)	2.10	2.11	0.068	0.069	3.79	4.05
LSD 5%	0.02	0.02	0.002	0.002	0.21	0.05

Effect of Nano chitosan – K fertilizer application on yield and cluster physical characteristics of 'Flame Seedless' grapevines.

Data in Table 4 show that T5 (50% mineral + 1000 ppm Nano K) tabulated the highest yield values (12.43 – 15.49 Kg|vine in both seasons, respectively) followed by T7 (50% mineral + 250 ppm Nano K), while control treatment tabulated the lowest values in that respect. Results in the same Table pointed to the superiority of T5 (50% mineral + 1000 ppm Nano K) in the case of cluster length in both seasons of study. Concerning cluster weight, T5 tabulated the highest value in the 1st season (469.0 g), while T7 gave the highest value in the second season (559.0 g). Data also revealed that all Nano K fertilizer treatments were significantly superior to control treatment in yield/vine and cluster weight during both seasons of study.

Table 4. Effect of Nano chitosan – K fertilizer on Yield/vine (Kg), Cluster length (cm) and Cluster weight (g) of 'Flame Seedless' grapevines during 2017 and 2018 seasons.

	Yield/vine (Kg)		Cluster length (cm)		Cluster weight (g)	
	2017	2018	2017	2018	2017	2018
T1 (100% of recommended dose, Control)	8.62	8.76	20.50	23.00	322.0	377.7
T2 (75% mineral + 1000 ppm Nano K)	10.39	13.85	23.00	24.83	420.0	483.4
T3 (75% mineral + 500 ppm Nano K)	11.21	14.64	23.00	24.33	441.0	534.6
T4 (75% mineral + 250 ppm Nano K)	10.70	11.24	23.00	25.17	421.0	452.9
T5 (50% mineral + 1000 ppm Nano K)	12.43	15.49	25.00	27.17	469.0	554.1
T6 (50% mineral + 500 ppm Nano K)	10.13	13.58	23.33	25.67	428.0	521.6
T7 (50% mineral + 250 ppm Nano K)	12.20	14.82	22.00	24.33	446.0	559.0
T8 (1000 ppm Nano K)	11.93	11.87	24.67	26.83	432.0	526.8
LSD 5%	0.87	0.90	3.10	2.68	86.1	67.44

Effect of Nano chitosan – K fertilizer application on chemical properties of 'Flame Seedless' berries.

Results in Table 5 show that T7 (50% mineral + 250 ppm Nano K) recorded the highest increase for SSC % and SSC/acid ratio and the lowest values for total acidity during the two seasons of study when compared with the other treatments. In addition, it was observed that all the tested Nano K fertilizer treatments led to a significant increase in SSC % and SSC/acid ratio and a significant decrease in total acidity compared with control treatment.

Table 5. Effect of Nano chitosan – K fertilizer on SSC (%), acidity (%) and SSC/acid ratio of 'Flame Seedless' juice berry during 2017 and 2018 seasons.

	SSC (%)		Acidity (%)		SSC/Acid ratio	
	2017	**2018**	**2017**	**2018**	**2017**	**2018**
T1 (100% of recommended dose, Control)	17.00	17.17	0.847	0.870	20.09	19.73
T2 (75% mineral + 1000 ppm Nano K)	18.17	19.00	0.723	0.707	25.12	26.88
T3 (75% mineral + 500 ppm Nano K)	18.33	19.67	0.740	0.750	24.78	26.23
T4 (75% mineral + 250 ppm Nano K)	18.67	19.83	0.723	0.737	25.82	26.92
T5 (50% mineral + 1000 ppm Nano K)	19.17	19.67	0.730	0.713	26.30	27.58
T6 (50% mineral + 500 ppm Nano K)	18.33	19.67	0.697	0.670	26.41	29.59
T7 (50% mineral + 250 ppm Nano K)	19.67	20.00	0.620	0.617	31.81	32.50
T8 (1000 ppm Nano K)	18.67	19.33	0.637	0.670	29.33	28.90
LSD 5%	1.12	1.06	0.046	0.048	2.51	2.48

Table 6. Effect of Nano chitosan – K fertilizer on total anthocyanin in skin berries (mg/100g FW) and total sugars (%) of 'Flame Seedless' berries during 2017 and 2018 seasons.

	Total anthocyanin (mg/100g FW)		Total sugars (%)	
	2017	**2018**	**2017**	**2018**
T1 (100% of recommended dose, Control)	36.68	33.00	24.10	23.21
T2 (75% mineral + 1000 ppm Nano K)	52.58	49.40	35.25	35.52
T3 (75% mineral + 500 ppm Nano K)	49.95	51.60	32.81	33.91
T4 (75% mineral + 250 ppm Nano K)	56.66	49.70	34.84	35.11
T5 (50% mineral + 1000 ppm Nano K)	53.15	53.20	30.58	31.85
T6 (50% mineral + 500 ppm Nano K)	53.07	55.50	29.04	29.76
T7 (50% mineral + 250 ppm Nano K)	59.73	61.10	41.56	41.83
T8 (1000 ppm Nano K)	55.92	59.10	36.10	35.80
LSD 5%	7.77	10.15	0.30	1.61

Data in Table 6 once again cleared that T7 (50% mineral + 250 ppm Nano K) significantly increased total anthocyanin in skin berries when compared with the control, it tabulated the highest values (59.73 and 61.10 mg/100g fresh weight in both seasons, respectively) without significant differences among (T5, T6, T7 and T8) in both tested seasons. Regarding total sugars in berries, data in the same Table obviously revealed that T7 (50% mineral + 250 ppm Nano K) also again recorded the highest significant values of total sugars (41.56 and 41.83 % in 1st and 2nd seasons, respectively) in comparison with other treatments during both seasons. On the other hand, the control treatment significantly gave the lowest values which recorded (24.10 and 23.21 % in 2017 and 2018 seasons, respectively.

Discussion:-

The positive effect of potassium application on yield, berry quality and leaf potassium content of Flame seedless grapevine are in line with those reported by El-Boray *et al.* (1996), who found a positive effect of potassium application for Thompson seedless grape on yield and berry qualities as for as K leaf content when applied potassium fertilizers either as soil or foliar application.

The interaction between different potassium rates and Nano chitosan-K concentrations increased significantly all chemical characteristics of berries (SSC, SSC/acid ratio, total anthocyanin, and total sugars) of 'Flame seedless' grapevines as compared to control treatment in both seasons. These results are in agreement with those found by Ibrahim *et al.* (2019), they reported that the foliar spraying treatments with Nano trace elements and/or Nano chitosan gave a significant effect on SSC, acidity, and SSC/acid ratio of Superior seedless grapevines. Abd El-Razek *et al.* (2011) found that increasing the amount of K fertilization caused a significant increase in total soluble solids and TSS/acid ratio and a decrease of acid concentration, they suggested that increasing K fertilization improves sugar transport into the berries. In addition, Martin *et al.* (2004) reported that higher K supplies to " Tempranillo " grapevines increased TSS content and decreased the total acidity of berries, Similar results were also obtained by (El-Sese *et al.,* 1988) they mentioned that SSC/acid ratio of "Thompson seedless" grapevines was increased as K application-level increased.

These findings are in parallel with those mentioned that K enhances the translocation of sugars and starch (Ramming *et al.,* 1995). The increase in SSC might be due to the hydrolyzation of starch into simple sugars with the role of potassium in translocation of sugar from leaves to fruits (Kumaran *et al.,* 2019), In the same line, Morris *et al.* (1983) mentioned that potassium fertilization with 450 kg/ha increased yield of 14-year-old concord (*Vitis labrusca* L.) grapes and vine size compared with control (0 kg). Similar results were also obtained by Mohsen (2011) on "Crimson seedless" grapevines and Thakur *et al.* (2008) on "Perlette" grapevines, they found that foliar application of potassium increased berry weight. (El-Baz *et al.,* 2003) reported that the cluster and berry weight were increased due to the application of potassium sulfate at 50-350 g/vine. The increase in fruit weight and length may be attributed to higher cell division and photosynthetic activities (Kumaran *et al.,* 2019).

Numerous investigators have extensively studied the advantage of potassium in plant nutrition. Potassium is considered an important mineral nutrient for all stages of protein synthesis that contributes to all plant growth processes (Arquero *et al.,* 2006). In addition, it controls several enzymes activities in plants, by the modulation of photosynthesis rate as well as an increase in the translocation rate from leaves through the phloem to storage tissue, leading to improve the yield and fruit quality (Saykhul *et al.,* 2013). Moreover, Southwick *et al.* (1996) mentioned that uptake of potassium from the foliar spray may be more predictable and efficient than uptake from the soil, where soil-cation interactions may delay the process.

The enhancement of grapevine growth characters by foliar application of chitosan are in accordance with those reported by (El-Kenawy, 2017) on Thompson seedless grapevines, who found that spraying vines with the combination of chitosan + fulvic acid + salicylic acid at rate of 500 ppm recorded the highest significant values of shoot length, leaf area, N, P and K content in leaf petioles as compared with control in both seasons. In addition (Barka *et al.,* 2004) reported that chitosan treated plants showed better growth than that of controls. In mangos, foliar application of chitosan at 5 mL L^{-1} Increased yield and improved vegetative growth (Zagzog *et al.,* 2017).

The positive effect of chitosan on plant growth may be attributed to an increase in the key enzyme activities of nitrogen metabolism (nitrate reductase, glutamine synthetase, and protease) and increased photosynthesis which enhanced the plant growth (Gornik *et al.,* 2008 and Mondal *et al.,* 2012). In addition, Chitosan absorbed easily to the epidermis of leaves and stems prolonging the contact time and facilitating the uptake of the bioactive molecules (Malerba and Cerana, 2016).

Lower doses of chitosan could have an effective increase in crop growth and yield; whereas higher doses decrease this benefit (Maksimov *et al.,* 2014). Similar results were observed in this study. Thus, the lower concentration of chitosan T7 (50% mineral + 250 ppm Nano K) improved the berry quality of 'Flame seedless' grapevines. These results go in line with those reported by Kumaran *et al.* (2019) they indicated that foliar application of chitosan oligosaccharide with lower concentration (0.2% and 0.4%) improved the yield and quality of " Muscat Hamburg " grapes.

CONCLUSION

This study show that all Nano Potassium fertilizer treatments increased petioles N and K concentrations of 'Flame seedless' grapevines and improved all vegetative growth (shoot length, shoot diameter and leaf area). In addition, a significant increase was observed for yield/vine, when compared to control treatment. Concerning fruit quality, data obtained also revealed the superiority of all Nano K fertilizer treatments for physical and chemical properties of Flame seedless berries compared to control treatment, and it was obvious that T7 (50% mineral + 250 ppm Nano K) recorded the highest values for (SSC, SSC/acid ratio, total anthocyanin and total sugars) and the lowest values for acidity in both seasons of study.

REFERENCES

Abd El-Razek, E., D. Treutter, M.M.S. Saleh, M. El-Shammaa, A. A. Fouad and N. Abdel-Hamid (2011). Effect of nitrogen and potassium fertilization on productivity and fruit quality of 'Crimson seedless' grape. Agric. Biol. J. N. Am., 2(2): 330-340.

AOAC (1984). "Official Methods of Analysis" 13th Ed. Published by the Association of Official Analytical chemists, Washington. Dc. USA.

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

Barka, E.A.; P. Eullaffroy ; C. Clément and G. Vernet (2004). Chitosan improves development, and protects *Vitis vinifera* L. against *Botrytis cinerea*. Plant Cell Rep., 22: 608–614.

Bhandal, J.S. and C.P. Malik (1988). Potassium estimation, uptake, and its role in the physiology and metabolism of flowering plants. International Review of Cytology, 110: 205-254.

Dubois, M., K.A. Gilles, J.K. Hamilton, P.A. Rebers and F. Smith (1956). Colorimetric method for determination of sugars and related substances. Anal. Chem., 28:350-356.

EL-Baz E.T., G.I. EL-Banna, E.F. EL-Dengawy, A.N. Ramadan (2003). Yield and quality of Thompson Seedless fresh grapes and raisins as influenced by potassium application. J Agric. Sci. Mansoura Univ., Egypt, 28(1):547-554.

El-Boray, M.S., M.M. Fahmy, M.A. Iraqi and Lo'ay A.A. (1996). Effect of potassium soil and foliar fertilization on leaf potassium content, yield and berry qualities of Thompson seedless grape. J. Agric. Sci. Mansoura Univ., 21(3):1153-1162.

El-Kenawy M. A. (2017). Effect of chitosan, salicylic acid and fulvic acid on vegetative growth, yield and fruit quality of Thompson seedless grapevines. Egypt. J. Hort., 44(1): 45 – 59.

El-Sese, A.M, S.Z. El-Gamy and M.A. Hussein (1988). Effect of potassium application on the yield and fruit quality of table Banati grapes (*Vitis vinifera* L.). Assiut J. Agric. Sci., 19: 247-258.

FAO (2017). Food and Agriculture Organization of the United Nations, www.FAO.org.

Gornik, K., M. Grzesik and B.R. Duda (2008). The effect of chitosan on rooting of grapevine cuttings and on subsequent plant growth under drought and temperature stress. J. Fruit Ornamental Plant Res., 16: 333-343.

Hesse, P. R. (1971). "A Text Book of Soil Chemical Analysis". John Murry (publishers) Ltd, 50 Albermarle Street, London.

Ibrahim M.M., A.A. Ali and N.K.H. Serry (2019). Effect of Nano trace elements and Nano chitosan foliar application on productivity and fruits quality of grapevine CV. 'Superior seedless' .Hort. Sci. & Ornamen. Plants, 11 (1): 07-13.

Inglese, P., G. Gullo and L.S. Pace (2002). Fruit growth and olive oil quality in relation to foliar nutrition and time of application. Acta Hortic., 586: 507–509.

Jackson, M. L. (1967). "Soil Chemical Analysis". Printic Hall of India, New Delhi. pp 144-197.

Jackson, M. L. (1973). "Soil Chemical Analysis". Verlag: prentice-Hall. Inc Egelwood Cliffs, NJ. 1958, 498 S. DM 39.40. U.S.A.

Kah, M., K. Tiede, S. Beulke and T. Hofmann (2013). Nanopesticides: State of knowledge, environmental fate, and exposure modeling. Crit. Rev. Environ. Sci. Technol., 43: 1823–1867.

Kah, M., R.S. Kookana, A. Gogos and T.D. Bucheli (2018). A critical evaluation of nano pesticides and nano fertilizers against their conventional analogs. Nat Nanotechnol., https://doi.org/10.1038/s41565-018-0131-1.

Kamari, A., I.D. Pulford and J.S.J. Hargreaves (2011). Chitosan as a potential amendment to remediate metal-contaminated soil-A characterization study. Colloids and Surfaces B: Biointerfaces, 82: 71–80.

Kumaran P.B., K. Venkatesan, A. Subbiah and C.N. Chandrasekhar (2019). Effect of pre-harvest foliar spray of potassium schoenite and chitosan oligosaccharide on yield and quality of grapes var. Muscat Hamburg. International Journal of Chemical Studies, 7(3):3998-4001.

Kurita, K.(2006). Chitin and chitosan: functional biopolymers from marine crustaceans. Mar. Biotech., (N Y) 8: 203–226.

Maksimov I.V., A.S. Valeev, E.A. Cherepanova and G.F. Burkhanova (2014). Effect of chitooligosaccharides with different degrees of acetylation on the activity of wheat pathogen inducible anionic peroxidase. Appl. Biochem. Microbiol., 50:82-87.

Malerba, M. and R. Cerana (2016). Chitosan effects on plant systems. International Journal of Molecular Sciences, 17, 996.

Martin, P.; R. Relgado; M.R. González and J.I. Gallegos (2004). Colour of 'Tempranillo' grapes as affected by different nitrogen and potassium fertilization rates. Proc. 1st International Symposium on Grapevine Growing, Commerce and Research, Lisbon, Portugal. Acta Hort., 652:153-159.

Mazumadar, B. C. and K. Majumder (2003). Methods on Physico – Chemical Analysis of Fruits. Daya Publishing House, Delhi, India, pp: 137-138.

Miransari, M. (2011). Soil microbes and plant fertilization. Appl. Microbiol. Biotechnol., 92:875–885.

Mohsen A.T. (2011). Attempts to improve the berry quality and storability of grape "Crimson Seedless" with potassium compounds under desert conditions. J. Hort. Sci. Ornam. Plants, 3:75-85.

Mondal, M.M.A., M.A. Malek, A.B. Puteh, M.R. Ismail, M. Ashrafuzzaman and L. Naher (2012). Effect of foliar application of chitosan on growth and yield in okra. A.J.C.S., 6: 918-921.

Montero, F. J.; J. A. De Juan; A. Cuesta and A. Brasa (2000). Non-destructive methods to estimate leaf area in *Vitis vinifera* L., HortScience, 35: 696-698.

Morris, J.R., S.E. Spayd and D.L. Cawthon (1983). Effects of irrigation, pruning severity and nitrogen levels on yield and juice quality of Concord grapes. Am. J. Enol. Vitic. 34: 229-233.

Naderi, M.R. and A. Danesh-Shahraki (2013). Nano fertilizers and their roles in sustainable agriculture. Int. J. Agric. Crop Sci., 5(19):2229–2232.

Ramming, D.W., T. Roland and S.A. Badr (1995). 'Crimson Seedless': a new late-maturing, red seedless grape. HortScience, 30:1473-1474.

Saigusa, M. (2000). Broadcast application versus band application of polyolefin-coated fertilizer on green peppers grown on Andisol. J. Plant Nutr., 23:1485–1493.

Salisbury F.B. and C.W. Ross (1992). Plant Physiology 4th Edition. Wadsworth Publishing Company, USA.

Saykhul, A., T. Chatzistathis, C. Chatzissavvidis, S. Koundouras, I. Therios and K. Dimassi (2013). Potassium utilization efficiency of three olive cultivars grown in a hydroponic system. Sci. Hortic., 162: 55–62.

Schouweburg, J. C. Van and I. Walinga (1967). "The rapid determination of Phosphorus in presence of Arsenic, Silicon and Germanium". Anal. Chim. Aota., 37: 271-274.

Solanki P., A. Bhargava, H. Chhipa, N. Jain and J. Panwar (2015). Nano-fertilizers and their smart delivery system. In: Rai M, Ribeiro C, Mattoso L, Duran N (eds) Nanotechnologies in food and agriculture. Springer, Switzerland, pp 81–101.

Southwick, S.M., W. Olson, J. Yeager and K.G. (1996). Optimum timing of potassium nitrate spray application to' French' prune trees. J. Am. Soc. Hortic. Sci., 121: 326-333.

Subramanian, K.S., A. Manikandan, M. Thirunavukkarasu and C.S. Rahale (2015). Nano-fertilizers for balanced crop nutrition. In: Rai M, Ribeiro C, Mattoso L, Duran N (eds) Nanotechnologies in food and agriculture. Springer, Switzerland, pp 69–80.

Tagliavini, M. And B. Marangoni (2002). Major nutritional issues in deciduous fruit orchards of Northern Italy. Hortic. Technol., 12:26-31.

Thakkar, M.N., S. Mhatre and R.Y. Parikh (2010). Biological synthesis of metallic nanoparticles. Nanotechol. Biol. Med., 6:257–262.

Thakur A., N.K. Arora, A.S. Sidhu and J.S. Brar (2008). Effect of potassium sprays on the quality of Perlette grapes. Acta Hort., 785:201-206.

Trenkel, M.E. (2010). Slow-and controlled-release and stabilized fertilizers: an option for enhancing nutrient use efficiency in agriculture. International Fertilizer Industry Association, Paris, France, PP.1-162.

Waller, R. A. and D. B. Duncan (1969). A bays rule for the symmetric multiple comparison problem. J. Amer. Assoc., 64: 1484-1503.

Wilson M.A., N.H. Tran, A.S. Milev, G. Kannangara, H. Volk and G. Lu (2008). Nanomaterials in soils. Geoderma, 146(1):291–302.

Zagzog, O.A.; M.M. Gad, and N.K. Hafez (2017). Effect of Nano-chitosan on vegetative growth, fruiting, and resistance of malformation of mango. Trends Hortic. Res., 6: 673–681.

تأثير سماد البوتاسيوم النانو على المحصول وصفات ثمار العنب الفليم سيدلس

دعاء مصطفى حمزه[1]*، رئيسه فهمي سعفان[2] و محمد صلاح سيف البرعى[1]

[1] قسم الفاكهة ـ كلية الزراعة ـ جامعة المنصورة

[2] معهد بحوث البساتين ـ مركز البحوث الزراعية

أجريت هذه الدراسة خلال موسمى 2017 و2018 فى مزرعة خاصة تابعة لمركز أجا محافظة الدقهلية على كرمات عنب فليم سيدلس عمرها ستة أعوام ومنزرعة فى تربة طمييه وتروى بنظام الرى بالغمر ومنزرعة على مسافة 2,5 × 3 م ومرباة بالطريقة الكردونية وتحت نظام تدعيم ذو الأسلاك الثلاثة العادية وذلك بهدف دراسة تأثير الرش الورقى بسماد البوتاسيوم النانو المحمل على الشيتوسان بثلاث تركيزات (250 و500 و1000 جزء فى المليون) مع التسميد الأرضى بسلفات البوتاسيوم بتركيز (50 و75%) من الجرعة الموصى بها على النمو الخضرى والمحصول وجودة الحبات. أظهرت نتائج الدراسة أن جميع معاملات التسميد بالبوتاسيوم النانو كانت ذات تأثير ايجابى فى زيادة قيم النمو الخضرى مثل (طول الأفرخ وسمك الأفرخ والمساحة الورقية) والنسبة المؤية لكل من النتروجين والبوتاسيوم فى أعناق الأوراق وكذلك زيادة معنوية فى كمية المحصول ووزن العنقود ، كما أدت الى تحسين صفات الجودة فى الحبات وذلك مقارنة بمعاملة الكنترول خلال موسمى الدراسة ، وكان واضحا من النتائج أن المعاملة (50% معدنى + 250 جزء فى المليون نانو بوتاسيوم) تفوقت على باقى المعاملات بالنسبة لتحسين صفات الجودة فى الحبات حيث سجلت أعلى قيم للمواد الصلبة الذائبة ونسبة المواد الصلبة الذائبة الى الحموضة وصبغة الأنثوسيانين والسكريات الكلية خلال موسمى الدراسة.