EFFECT OF METHOD NANO APPLICATION WITH NPK FERTILIZER ON THE VEGETATIVE GROWTH OF TWO GRAPE CULTIVARS (VITIS VINIFERA L.)

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ABSTRACT

This studied the effect of method's and efficiency application of nano- NPK fertilizer (0, 1 and 2. l^{-1}) in addition to the soil or foliar spray on the vegetative growth of Olivetti noier and Thompson Seedless young grapevines grown under Nineveh Governorate during 2021 season. Applications three levels of nano- NPK 0, 2 and 4gm. as soil addition either alone or in combination with foliar application of nano- NPK sprayed three times at 0, 1 and 2.l^{-1} significantly promoted all vegetative growth traits, height and diameter of the main stem, number of leaves, chlorophyll concentration in leaves, leaf area and leaf area. Moreover, these treatments resulted of vegetative growth parameters compared with untreated (control). Result showed that fertilization with the addition of 4 gm. Nano NPK.l^{-1}, led to a significant increase in the rates of height and diameter of the main stem, number of leaves, chlorophyll concentration in leaves. Foliar fertilization with 2 gm. Nano NPK l^{-1}, led to a significant improving main stem diameter of seedling, leaf area, leaf area of seedling, chlorophyll concentration in leaves. Spray with 1 gm. Nano NPK l^{-1} led to a significant increase in the height of the main stem and the number of leaves per seedling. Thompson Seedless grape cv. over Olivetti noier cv. in height and diameter of the main stems, leaf area and the leaf area of the seedling.

KEYWORDS

Nano, NPK, Fertilizer, Grape.

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1. INTRODUCTION

Grape was one of the oldest fruits planted by man, and commercially the most cultivated and widespread fruit crop in the world, which was mentioned in the holy books, and the cultivation of grapes in Iraq is as old as the settlement of people in Mesopotamia (Childers et al. 1995 and Alsaidi, 2014).

In recent years, a lot of studies and research have appeared that dealt with the introduction of nanotechnology in the agricultural field, which is called Agro-Nanotechnology, which has significant effects on the global economy. The nano fertilizers are characterized by having a great ability to dissolve in water in addition to the speed of penetration into the plant cell, in addition to the possibility of adding such fertilizers to the soil or spraying on the vegetative system of the plant (Chinnamuthu and Boopathi, 2009 ; Sabir et al,2014).

Fertilization is one of the horticultural process that must be performed in the nurseries and vineyard orchards in order to give the requirements of growth and development of grape vines as a result of the depletion of the nutrients necessary from the soil. Among these elements nitrogen, phosphorus and potassium are the important nutrients of the plants, (Epstein and Bloom, 2005 and Marschner, 2012).

The aim of this research to study the efficiency of nano NPK fertilization on the vegetative growth, mineral content, response of the cultivars to nano-fertilizers and determining the best way to application of nano-fertilizer of grape seedlings.

2. MATERIALS AND METHODS

The present investigation was carried out during 2021 season on two young grape cultivars including Olivetti noier and Thompson were one year old, planted at 2×3 meters apart in the grape orchard of the Department of Horticulture and Landscape - College of Agriculture and Forestry - University of Mosul - Iraq. The soil was loam soil, full description of the tested soil is given in Table 1.

Table 1. Physical and chemical properties of the experimental soil.

Item	Value	Available nutrients	Value
Sand %	34.8	N g.Kg^{-1}	0.121
Silt %	25.45	P g.Kg^{-1}	3.01
Clay %	39.75	K g.Kg^{-1}	49.76
Texture	Loam	O.M. %	1.20
E.C. ds/m		0.2	

Factorial experiment with the complete randomized block design was applied with three replicates, two young vines per each. The treatments were as follows by three factors:

The first factor: Cultivars on Olivette noire and Thompson Seedless Grape.

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The second factor: Fertilization by adding nano-NPK (20:20:20) at three levels: o, 2 and 4 gm. Young vine^{-1}

The third factor: foliar application with three concentrations of the nano-NPK at o,1 and 2gm.l^{-1} on vegetative growth till runoff.

Three levels of nano- NPK were added when the shoots reached 10 cm in the length on April 12, 2021, and the second addition was a month after the first addition. While the nano-NPK was sprayed on the vegetative growth in three times the first was on April 19, 2021, and the second spray was a month after the first and the third was a month after the second spray. Tween 80 as wetting agent was applied at 0.1% to all spray solutions and the young vines were sprayed solution till runoff and control vines were sprayed water containing Tween 80. Vegetative parameter such as height and diameter of the main stem, number of leaves / young vine, Leaf area (cm^2), The leaf area of the young vine (cm^2. Young vine) and the total chlorophyll concentration in the leaves were measured on 1 Oct. 2021.

3. RESULTS AND DISCUSSION

3.1. HEIGHT OF THE MAIN STEM OF GRAPE SEEDLINGS (CM)

The data in Table (2) showed that the seedling height of the Thompson Seedless cv. were significantly superior (165.99cm.) compared with the Olivette noire cv. (148.50cm). It's evident from the data in the same table that the height of grape seedlings were affected by nano NPK application, especially when adding 4g.seedlings^{-1} of nano NPK and reached 169.28cm. which provided the maximum value (169.28cm.) compared with the lowest value of height of seedling steam (156.77) in control treatment.

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Table 2. Effect the method of nano application with NPK fertilizer on height of the main stem of seedlings (cm) of Olivette noire and Thompson Seedless grape cultivars.

cultivars	Adding nano NPK (g.seedling^{-1})	Foliar nano NPK (mg.l^{-1})			CV. × NPK	Mean Effect of cultivar
		0	1	2		
Olevitte noire	0 NPK	139.83 f	145.55 ef	143.67 ef	142.83 d	148.50 b
	2 NPK	121.33 g	154.17 ed	135.33 f	136.94 e	
	4 NPK	166.67 cd	168.00 c	162.50 cd	165.72b	165.99 a
Thompson Seedless	0 NPK	136.30 f	229.50 a	146.33 ef	170.71a	
	2 NPK	135.83 f	168.50 c	159.00 cd	154.44 c	
	4 NPK	139.33 f	191.50 b	187.67 b	172.83 a	
Olevitte noire		142.61 ed	155.72 c	147.16 d	Main effect of adding nano NPK	
Thompson Seedless		137.16 e	196.50 a	164.33 b		
Adding × Foliar nano NPK	0 NPK	137.16 e	196.50 a	164.33 b	156.77 b	
	2 NPK	138.07 e	187.25 a	145.00 de	145.69 c	
	4 NPK	128.58 f	161.33 c	141.17 d	169.28 a	
Mean effect foliar nanoNPK		139.88 c	176.11 a	155.75 b		

Means with the same letter are not significantly different according to Duncan multiple ranges test at 5% level.

Spraying with 1 g.l^{-1} of nano-NPK was significantly superior in the height of the main stem of grape seedlings, which amounted to (176.11) cm, while the control treatment gave the lowest value were (139.88cm.) for the average height of the main steam.

The data in Table (2) also indicates that the binary, especially triple, interactions between the studied factors made clear significant differences between the treatments of adding 0 nano NPK + spraying with 1gm. nano NPK. l^{-1} for Thompson Seedless cv. was gave the highest values in the average height of the main stem and amounted to 229.50cm, which significantly outperformed all treatments, while the lowest height of the main stem was recorded when adding 2 g nano NPK. seedlings^{-1} + spraying with 0gm. nano NPK.l^{-1} for Olivette noire grape cv. which amounted to 121.33 cm.

3.2. MAIN STEM DIAMETER (MM):

It is noticed from the data of Table (3) that there are significant differences between the two grape cultivars in the main stem diameter, especially the Thompson Seedless cv. (14.67mm.) was superior than Olivette noire cv. (12.32 mm.). It is also evident from the data of the same table that addition 4gm. of nano NPK are significant superior in

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the main stem diameter (14.64 mm.), than control treatment which amounted to 12.24 mm.

It is also noted that spraying with 2gm. nano NPK.l^{-1} has a clear effect which achieved the highest significant increase in the average diameter of the main stem of grape seedlings (14.99 mm), while the control treatment recorded the lowest value for this trait, which amounted to 11.92 mm. It is also evident from the data of the same table that addition 4gm. of nano NPK are significant superior in the main stem diameter (14.64 mm.), than control treatment which amounted to 12.24 mm.

It is also noted that spraying with 2gm. nano NPK.l^{-1} has a clear effect which achieved the highest significant increase in the average diameter of the main stem of grape seedlings (14.99 mm), while the control treatment recorded the lowest value for this trait, which amounted to 11.92 mm. It is also noted in the data of Table (4) that the interactions between the factors under this study achieved a significant increase in the average diameter of the main stem diameter of grape seedlings, especially when adding 4 gm. nano NPK + spraying with 2gm. nano NPK fertilizer for Thompson Seedless grape cv. which achieved the highest average for the main stem diameter (16.67 mm), while the comparison treatment for Olivette noire grape cv. recorded the lowest values for this trait, which amounted to (7.79 mm).

Table 3. Effect the method of nano application with NPK fertilizer on stem diameter of seedlings (mm) of Olivette noire and Thompson Seedless grape cultivars.

Cultivars	Adding nano NPK (g.seedling^{-1})	Foliar nano NPK (mg.l^{-1})			CV. × NPK	Mean Effect of Cultivar
		0	1	2		
Olevitte noire	0 NPK	7.79 f	11.49 ed	16.03 ab	11.77 e	12.32 b
	2 NPK	10.88 e	12.38 d	12.48 d	11.91 e	
	4 NPK	12.46 d	12.71 d	14.66 cd	13.28 c	
Thompson Seedless	0 NPK	10.76 e	12.98 d	14.40 c	12.72 b	14.67 a
	2 NPK	14.51 bc	15.60 abc	15.71abc	15.27 b	
	4 NPK	15.12 abc	16.26 a	16.67 a	16.01 a	
Olevitte noire		10.38 e	12.19 d	14.39 b	Main effect of adding nanoNPK	
Thompson Seedless		13.46 c	14.95 ab	15.54 a		
Adding × Foliar nano NPK	0 NPK	9.28 e	12.23 d	15.22 ab	12.24 c	
	2 NPK	12.69 d	13.99 c	14.09 c	13.59 b	
	4 NPK	13.79 c	14.48 bc	15.66 a	14.64 a	
Mean effect foliar nanoNPK		11.92 c	13.57 b	14.99 a		

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Means with the same letter are not significantly different according to Duncan multiple ranges test at 5% level.

3.3. NUMBER OF LEAVES / SEEDLINGS

The data in Table (4) indicate the clear discrepancy in number of leaves for the two grape cultivars under study. The Olivette noire grape cv. (164.17 leaves, seedlings^{-1}) were significantly outperformed compared with Thompson Seedless grape cv. (153.06 leaves, seedlings^{-1}).

It is also noted from the data of the same table that the addition of nano-fertilizer was significantly superior to the average number of leaves per seedling for treatments 4 and 2 g. seedling^{-1} were significantly over the comparison treatment (176.77, 176.24 and 122.81) leaves. seedling^{-1}, respectively.

Table 4. Effect the method of Nano application with NPK fertilizer on number of leaves of seedlings of Olivette noire and Thompson Seedless grape cultivars.

Cultivars	Adding nano NPK (g.seedling^{-1})	Foliar nano NPK (mg.l^{-1})			CV. × NPK	Mean Effect of cultivar
		0	1	2		
Olevitte noire	0 NPK	100.33 jk	121.33 h	119.03 hi	113.56 f	164.17 b
	2 NPK	182.33 cd	201.13 a	166.66 ef	183.37 b	
	4 NPK	187.33 bcd	198.83 ab	198.83 ab	195.55 a	
Thompson Seedless	0 NPK	95.00 k	108.16 ij	108.16 cd	132.06 e	153.05 b
	2 NPK	178.83 de	182.16 cd	182.16 cd	169.11 c	
	4 NPK	131.50 h	183.50 cd	183.30 cd	158.00 d	
Olevitte noire		156.66 c	174.32 a	161.51 bc	Main effect of adding nanoNPK	
Thompson Seedless		135.11 d	166.12 b	157.94 c		
Adding × Foliar nano NPK	0 NPK	97.66 e	157.18 c	113.60 d	122.81 b	
	2 NPK	18.58 b	173.73 b	174.41 b	176.24 a	
	4 NPK	159.41 c	179.75 b	191.16 a	176.77 a	
Mean effect foliar nanoNPK		145.88 c	170.22 a	159.72 b		

Means with the same letter are not significantly different according to Duncan multiple ranges test at 5% level.

The data of Table (4) shows the significant superiority of the treatment of spraying with 1 gm. nano NPK l^{-1} over treatments (2 and 0 gm. nano NPK. l^{-1}), as well as the superiority of the spraying treatment with 2 gm. nano NPK. 1^{-1} was significantly on the comparison treatment. The treatment of triple interaction between the factors in this study when adding 2 gm.1^{-1} of nano NPK + spraying with 1 gm. nano NPK l^{-1} was

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significantly outperformed most of the treatments, which amounted to 201.13 leaves. seedlings^{-1}, while the treatment of adding zero gm.seedling^{-1} of nano fertilizer for Thompson Seedless grape cultivar recorded the lowest values for the average number of leaves, which amounted to 95.00 leaves. Seedlings^{-1}.

3.4. LEAF AREA (CM^2)

It is evident from the data of Table (5) that Thompson Seedless cv. was significantly outperformed the average leaf area (101.10 cm^2.leaf^{-1}) over the Olivette noire cv. (66.69 cm^2.leaf^{-1}). It is noted from the data of the same table showed that the addition of nano NPK fertilizer had a clear effect on increasing the leaf area, as the treatment of adding 2 gm. nano NPK. Seedlings^{-1} was significantly (90.15 gm. leaf^{-1}) over the comparison treatment (73.30 gm. leaf^{-1}).

Table 5. Effect the method of nano application with NPK fertilizer on leaf area (cm^2) of Olivette noire and Thompson Seedless grape cultivars.

Cultivars	Adding nano NPK (g.seedling^{-1})	Foliar nano NPK (mg.l^{-1})			CV. × NPK	Mean Effect of Cultivar
		0	1	2		
Olevitte noire	0 NPK	29.82 j	62.83 ghi	66.68 gh	53.11 e	66.69 b
	2 NPK	57.04 hi	78.17 ef	84.52 ed	73.24 d	
	4 NPK	63.28 ghi	88.31 de	69.50 fg	73.69 d	
Thompson Seedless	0 NPK	54.47 i	87.83 de	138.18 a	93.49 c	101.10 a
	2 NPK	125.10 b	102.27 c	93.82 cd	107.06 a	
	4 NPK	93.43 cd	92.98 cd	121.78 b	102.73 b	
Olevitte noire		50.05 d	76.43 c	73.57 c	Main effect of adding nanoNPK	
Thompson Seedless		91.00 c	94.36 b	117.93 a		
Adding × Foliar nano NPK	0 NPK	42.14 d	75.33 c	102.43 a	73.30 b	
	2 NPK	91.07 b	90.22 b	89.17 b	90.15 a	
	4 NPK	78.36 c	90.65 b	95.64 b	88.21 a	
Mean effect foliar nanoNPK		70.52 c	85.40 b	95.75 a		

Means with the same letter are not significantly different according to Duncan multiple ranges test at 5% level.

The data of Table (6) also showed that spraying with 2 gm.l^{-1}nano NPK fertilizer (95.71 cm^2.leaf^{-1}) had a significantly increase in the leaf area compared with the other treatments. In addition to the significant superiority of spraying at a concentration of 1 gm nano NPK.l^{-1} over the control treatment (70.52 cm^2.leaf^{-1}).

The triple interactions between the factors studied in Table (5), it is also showed that the addition 0 gm. seedling^{-1} of nano NPK + foliar spray with 2 gm. l^{-1} of the same

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fertilizer for Thompson Seedless cv. (138.18 $cm^2.leaf^{-1}$) was significantly superior to all treatments, while the comparison treatment of Olivette noire cv. was recorded the lowest values (29.82 $cm^2.leaf^{-1}$) for this trait.

3.5. THE LEAF AREA OF THE SEEDLING ($CM^2.SEEDLING^{-1}$)

The data in Table (6) indicates that Thompson Seedless cv. (15657.2 $cm^2.seedling^{-1}$) was significantly superior to the Olivette noire cv. in the seedling leaf area which reached 11345.2 $cm^2.seedling^{-1}$. It is noted from the data of the same table that the addition of 2 gm..$seedling^{-1}$) of nano NPK fertilizer (15764.8 $cm^2.seedling^{-1}$) achieved a significant superiority over the control treatment (9276.0 $cm^2.seedling^{-1}$).

Spraying at a concentration of 2 gm. l^{-1} of nano NPK fertilizer on caused a significant increase in the seedling leaf area (15036.3 $cm^2.seedling^{-1}$) compared to the treatment of 0 $gm.l^{-1}$ of nano fertilizer (10845.4 cm^2. $seedlings^{-1}$).

Table 6. Effect the method of nano application with NPK fertilizer on seedling leaf area ($cm^2.seedling^{-1}$) of Olivette noire and Thompson Seedless grape cultivars.

Cultivars	Adding nano NPK (g.$seedling^{-1}$)	Foliar nano NPK (mg.l^{-1})			CV. × NPK	Mean Effect of cultivar
		0	1	2		
Olevitte noire	0 NPK	2996.0 k	7619.7 i	7920.3 i	53.11 e	11345.2 b
	2 NPK	10392.3 h	15731.0 cd	14089.7de	73.24 d	
	4 NPK	11860.3 gh	17706.3 b	13791.3 ef	73.69 d	
Thompson Seedless	0 NPK	5186.0 j	16946.3 bc	14987.7 de	93.49 c	15657.2 a
	2 NPK	22353.3 a	14941.7 de	17080.7 bc	107.06 a	
	4 NPK	12284.3 fg	14786.7 de	22348.3 a	102.73 b	
Olevitte noire		8416.2 e	13685.7 c	11933.8 d	Main effect of adding nanoNPK	
Thompson Seedless		13274.6 c	15558.2 b	18138.9 a		
Adding × Foliar nano NPK	0 NPK	4091.0 d	12283.0 c	11454.0 c	9276.0 b	
	2 NPK	16372.8 b	15336.3 b	15585.2 b	15764.8 a	
	4 NPK	12072.3 c	16246.5 b	18069.8 a	15462.9 a	
Mean effect foliar nanoNPK		10845.4 b	14621.9 a	15036.3 a		

Means with the same letter are not significantly different according to Duncan multiple ranges test at 5% level.

Studying the effect of the triple interaction between the studied factors, it is clear showed the data in Table (7) that the treatment of adding 4 gm. nano NPK. $seedlings^{-1}$ + spraying with 2 gm. nano NPK.l^{-1}) for Thompson Seedless grape cultivar gave the highest values for seedling leaf area (22348.3 $cm^2.seedling^{-1}$), which was significantly

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superior to all treatments, while the comparison treatment of grape cultivar olivette noire (2996.0 cm^2.seedling^{-1}) recorded the lowest values for this trait.

3.6. TOTAL CHLOROPHYLL IN THE LEAVES (MG.G^{-1}F.W)

The results presented in Table (7) showed that there weren't any different between the cultivars in the total chlorophyll content of the leaves in this study. However, fertilization with 4gm.nano NPK.seedling^{-1} gave the highest value of chlorophyll content 1.31 mg.g^{-1}F.W which surpassed significantly compared with the addition of 0 nano NPK.seedling^{-1}. The lowest value of chlorophyll content was 0.934 mg.g^{-1} F.W.

Table 7. Effect the method of nano application with NPK fertilizer on total chlorophyll in leaves (mg.g^{-1}F.W) of Olivette noire and Thompson Seedless grape cultivars.

Cultivars	Adding nano NPK (g.seedling^{-1})	Foliar nano NPK (mg.l^{-1})			CV. × NPK	Mean Effect of cultivar
		0	1	2		
Olevitte noire	0 NPK	0.81 b	0.92 b	0.96 b	0.90 a	1.02 a
	2 NPK	0.86 b	0.98 b	1.06 b	0.97 a	
	4 NPK	0.98 b	1.2400 ab	1.37 ab	1.19 a	
Thompson Seedless	0 NPK	0.93 b	0.98 b	0.99 b	0.96 a	1.18a
	2 NPK	0.95 b	1.26 ab	1.29 ab	1.17 a	
	4 NPK	1.03 b	1.45 ab	1.77 a	1.42 a	
Olevitte noire		0.88 b	1.05 ab	1.13 ab	Main effect of adding nanoNPK	
Thompson Seedless		0.97ab	1.23 ab	1.35 a		
Adding × Foliar nano NPK	0 NPK	0.87 b	0.95 b	0.97 b	0.93 b	
	2 NPK	0.90 b	1.12 ab	1.17ab	1.07 ab	
	4 NPK	1.00 b	1.34ab	1.57a	1.31 a	
Mean effect foliar nanoNPK		0.92 b	1.14 ab	1.24 a		

Means with the same letter are not significantly different according to Duncan multiple ranges test at 5% level.

Foliar application of 2gm.l^{-1} nano-NPK was a significant increases in leaf chlorophyll content giving the highest significant value of 1.242 mg.g^{-1} F.W compared to the lowest value of chlorophyll content was shown in the control treatment of 0.928 mg.g^{-1} F.W.

Regarding the interactions between all factors, the results showed a combination of fertilization with 4gm nano-NPK.seedling^{-1} + spraying with 2gm.l^{-1} nano-NPK.l^{-1} with Thompson Seedless cv. was reached 1.77 mg.g^{-1} F.W and gave the highest content of

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chlorophyll compared with control treatment, which gave the lowest value 0.813 mg. g^{-1} F.W. for the total chlorophyll concentration in the leaves.

It is clear from the data of the results that the cultivar has a major role in the vegetative growth characteristics of grape seedlings (young vines). This variation is due to the genetic factor between the cultivars and according to their strength and the efficiency of the biological processes that take place in each cultivar, especially the variation of the genetic structures of each cultivar and the extent of their interaction with the different environmental conditions and fertilizer treatments, which works to vary the efficiency of the photosynthesis process and the use of its products in the growth processes and increase the vegetative growth of seedlings of different grape cultivars (Alimam, 1998; Mangel and Kirkby, 2001; Hopkins and Huner 2004 and Aljubori et al., 2022).

Through the study of the effect of nano NPK fertilizer on increasing the vegetative growth of grape seedlings shown in Tables (2,3,4,5,6 and 7), the efficiency of the surfaces of particles in ion exchange of nano fertilizer increases the chances of the absorption of nutrients by the root and vegetative systems and high speed of nanoparticles in the leaves of seedlings to meet the requirements of vegetative growth by increasing enzymatic activity and speed of reactions (Morteza et al., 2013 and Aljubori et al., 2022).

Nitrogen increases the vitality and activity of the meristem areas of seedlings by increasing the biosynthesis of auxins, amino acids, nucleic acids, chlorophyll, and many enzymatic facilities that increase the efficiency and elongation of cell divisions for different plant organs, in addition to the role of physiology of phosphorous in increasing vegetative growth, which includes its entry into vital energy compounds, especially phospholipids and nucleic acids and its role in building cell membranes that have a major role in increasing the activity and effectiveness of seedlings to carry out photosynthesis, respiration that lead to increase seedling height, diameter, number of leaves.

In addition to the physiological role of potassium in the processes of regulating the osmotic effort of cells and its clear role in increasing and activating enzymes related to photosynthesis (Yasin, 2001, Taiz and Zeiger 2001, and Marschner, 2003 and Aljubori et al., 2022) and that all these roles of nutrients were reflected in increasing the vegetative growth of grape seedlings (Alimam and Alsaidi, 2003; Cheng et al. 2010; Barad et al. 2010 and Aljubori, et al., 2022).

Although the foliar spraying of major nutrients such as nitrogen, phosphorous and potassium as a method is highly efficient in absorbing these elements through spraying techniques with nano-fertilizers. Which increasing the efficiency of absorption of major nutrients, which resulted in the response of grape seedlings in increasing vegetative growth spraying with nano-fertilizers (Mengel and Kirkby,2001and Alimam, and Al-Qasim, 2022).

4. CONCLUSION

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The results of this study showed that the cultivar had a clear role in the average height and diameter of the main stem of the seedling, the area of one leaf and the leaf area of the seedling, especially for the grape cultivar Thompson Seedless, compared with the Olivette noire cv.. The addition of nano NPK fertilizer at 4g.seedlings^{-1} or foliar spraying with 2g.l^{-1} with nano NPK fertilizer singly or overlap with each other caused a significant increase in the rates of length and diameter of the main stem of seedlings, leaf area of seedlings, chlorophyll and protein content in leaves and carbohydrate in branches and the concentration of nutrients nitrogen, phosphorous and potassium in the petioles of the leaves.

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