Effect of Nano NPK versus Normal NPK on Growth and Vine Nutritional Status of Superior Grapevines

Faissal F. Ahmed [1], Mohamed A.M. Abada[2]; Moawad A. Mohamed[1] and Ahmed R.M. Alwany[2]

[1]Hort. Dept. Fac. of Agric. Minia Univ. Egypt.
[2]Viticulture Res. Dept. Hort. Res. Instit. ARC, Giza, Egypt

Abstract: During 2016 and 2017 seasons, Superior grapevines grown under Minia region conditions received NPK via normal at 60, 84 and 240 g/ vine and nano at 10, 14 and 40 g/ vine respectively. The merit was exploring the effect of nano NPK versus normal NPK on vegetative growth and vine nutritional status of Superior grapevines. Using NPK via nano technology was Superior than using these fertilizers via normal method. Combined application of these fertilizer via both systems was preferable than using each fertilizer alone in enhancing all growth aspects, photosynthetic pigments and percentages of N, P, K, Mg, Ca, Zn, Fe and Mn. The best results with regard to growth and vine nutritional status were obtained due to supplying Superior grapevines with N at 10 g / vine, P at 14 g / vine and K at 40 g / vine applied via nano technology.
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1. Introduction

Nanotechnology has provided the feasibility of exploiting nanooscale or nanostructred materials as fertilizers carries or controlled — release vectors for building of so- called smart fertilizer as new facilities to enhance nutrient use efficiency **(Al-Amin- Sadek and Jayasuriya, 2007).**

Encapsulation of fertilizers within a nanoparticle is one of these new facilities which are done in three ways a) the nutrient can be encapsulated inside nanoporous materials, b) coated with thin polymer film, or c) delivered as particle or emulsions of nanoscales dimensions (**Rai *et al,* 2012**). In addition. nanofertilizers will combine nanodevices in order to synchronize the release of Fertilizer-N and -P with their uptake by crops, so preventing undesirable nutrient losses to soil, water and air via direct internalization by crops, and avoiding the interaction of nutrients with soil, microorganisms, water, and air (**Derosa *et al.,* 2010**).

Coating and binding of nano —and subnano-composites are able to regulate the release of nutrients from the fertilizer capsule (**Liu *et al,* 2006**). In this regard, **Jinghua (2004)** showed that application of a nano-composite consists of N, P, K, micronutrients mannose and amino acids enhance the uptake and use of nutrients by grain crops. Moreover, nanotechnology could supply tools and mechanisms to synchronize the nitrogen release from fertilizers with crop requirements. This will be accomplished only when they can be directly internalized by the plants. Zinc- aluminium layered double- hydroxide nanocomposites have been employed for the controlled release of chemical compounds 'which act as plant growth regulators. Studies have shown that fertilizer incorporation into cochleate nanotubes (rolled-up lipid bilayer sheets), had improved crop yield **(Derosa *et al,* 2010).**

More recent strategies have focused on technologies to provide nanofertilizer delivery systems which react to environmental changes. The final goal is production of nanofertilizers that will release their shipment in a cardrailled manner (slowly or quickly) in reaction to different signals such heat. moisture and etc. **(FAO, 2018)**.

Since fertilizers, particularly synthetic fertilizers, have a potential to pollute soil, water and air, in recent rears, many efforts were done to minimize these problems by agricultural practices and the design of the new improved fertilizers. The appearances of nanotechnology open up potential novel applications in different fields of agriculture and biotechnology. Nanostructured formulation through mechanisms such as targeted deliver or slow/controlled release mechanisms, conditional release, could release their active ingredients in responding to environmental triggers and biological demands more precisely. There is the possibility of using these mechanisms to design and construction of nanofertilizers. The use of these nanofertilizers causes an increase in their efficiency, reduces soil toxicity, minimizes the potential negative effects associated with over dosage and reduces the frequency of the application. Nanofertilizers mainly delays the release of the nutrients and extends the fertilizer effect period. Obviously. there is an opportunity for nanotechnology to have a significant influence on energy, the economy and the environment, by improving fertilizers, Hence, nanotechnology has a high potential for achieving sustainable agriculture. especially in developing countries. **(Sultan *et al,* 2009, Prasad *et al,* 2014; Mukhopudhyay, 2014 and Mahjunatha *et al.,* 2016).**

Modern agriculture involves the use of, among others, a substantial amount of inorganic fertilizers - a greater Portion of which is removed from the realm of soil once the crop is harvested. Making the plant growth to approach its genetic limit is what the growers are striving for now-a-days (**Tisdale *et al.*, 1990**). Resorting to replace these nutrients is the ultimate choice.

Globally, crop yields have increased by at least 30 to 50% as a result of fertilization (**Stewart *et al.*, 2005**). Agricultural development has provided much evidence that fertilizer application is the most efficient measure for substantially increasing crop production and ensuring food security (**Bockman *et al.*, 1990**) and that sustained yield growth is difficult without fertilizer supply (**Larson and Frisvold, 1996**). Statistics suggest that, about 40- 70% of the nitrogen of the applied fertilizers is lost into the environment and is not utilizable by crops, which not only causes large economic and resource losses but also is instrumental to very serious environmental pollution (**Guo *et al.*, 2005**).

Previous studies showed that using fertilizers via nano technology was very effective in enhancing growth, plant pigments and different nutrients in grapevine cvs (**Wassel *et al.*, 2017, Ahmed, 2018; Ahmed *et al.*, 2018 and Dabdoub- Basma, 2019**).

The target of this study was examining the effect of nano and normal NPK on growth and vine nutritional status of Superior grapevines.

2. Materials and Methods

This study was carried out during the two successive seasons of 2016 and 2017 on 84 uniform in vigour 10- years old Superior grapevines grown in a private vineyard located at El- Hawarta village – Minia district, Minia Governorate where the soil texture is clay and well drained water since table depth is not less than two meter (Table 1). The chosen vines are planted at 2x 3 meters apart. Cane pruning system was followed at the first week of Jan. leaving 84 eyes per vine (on the basis of six fruiting canes x 12 eyes plus six renewal spurs x two eyes) with the assistance of Gabel shape supporting system. The vines were irrigated through surface irrigation system using Nile water.

Mechanical, physical and chemical analysis of the tested soil were carried out at the start of the experiment according to the procedures of **Chapman and Pratt (1965)** and the data are shown in Table (1).

Except those dealing with the present treatments (application of nano and normal NPK fertilizers), all the selected vines (84 vines) received the usual horticultural practices which are commonly used in the vineyard.

Table (1): Analysis of the tested soil

Constituents	Values
Particle size distribution:	
Sand %	11.0
Silt %	22.5
Clay %	68.5
Texture %	Clay
pH (1: 2.5 extract) ppm	8.05
E.C. (1: 2.5 extract) ppm	1.03
O.M. %	1.88
$CaCO_3$ %	2.55
Total N %	0.10
Available P (Olsen method, ppm)	2.22
Available K (ammonium acetate, ppm)	400

This experiment included the following fourteen treatments:

1- Fertilization with N via normal at 60 g N/ vine/ year.
2- Fertilization with P via normal at 84 g P_2O_5/ vine/ year.
3- Fertilization with K via normal at 240g K_2O / vine/ year.
4- Fertilization with P + K via normal
5- Fertilization with N + K via normal
6- Fertilization with N + P via normal
7- Fertilization with N + P + K via normal
8- Fertilization with N via nano at 10 g N/ vine/ year.
9- Fertilization with P via nano at 14 g P_2O_5/ vine/ year.
10- Fertilization with K via nano at 40 g K_2O / vine/ year.
11- Fertilization with P+ K via nano
12- Fertilization with N+ K via nano
13- Fertilization with N+ P via nano
14- Fertilization with N+ P+ K via nano

Each treatment was replicated three times, two vines per each. Normal N, P, and K was added at 60 g N/, vine / year in the form of ammonium nitrate (33.5 % N), 84 g P_2O_5 / vine / year in the form of mono calcium superphosphate (15.5 % P_2O_5) and 240 g K_2O / vine/ year in the form of potassium sulphate (40 % K_2O). Nitrogen mineral fertilizer was added at three unequal batches 40% at growth start the second batch at 30% just after berry setting and the third batch at 30%, 30 days later. Normal K fertilizer was added at two equal batches the first before blooming and the second just after berry setting. Normal P fertilizer was added also twice equally the first with farmyard manure and the second before blooming. Nano NPK were added at 10 g N, 14g P_2O and 40 g K_2O/ vine/ year, respectively once at growth start.

Randomized complete block design was followed where this experiment consisted of fourteen treatments, each treatment was replicated three times, two vines per each.

1. Measurement of vegetative growth characteristics:

At the middle of June, the following growth aspects were recorded:

1-Average main shoot length (cm.) as a result of measuring the length of the ten labeled main shoots per vine and then the average was estimated.

2- Average leaf area (cm^2) as a result of measuring the diameter of twenty mature leaves from those opposite to the basal clusters on the main shoots.

Leaf area (cm^2) was measured using the following equation that outlined by **Ahmed and Morsy (1999)**.

Leaf area (cm^2) = 0.45 (0.79 x d^2) + 17.77 w

Where d is the maximum diameter of the leaf, then average leaf area was registered.

3- Number of leaves / shoot.

4- Wood ripening coefficient was measured by dividing the length of brownish part of the cane by the total length of cane just before pruning date (1^{st} week of January) **(Bourad, 1966).**

5- Just after carrying out winter pruning, the weight removal of 1- year old pruning wood per each vine was recorded (kg/ vine)

For each vine five canes were selected just before Winter pruning (1^{st} week of January) for measuring the cane thickness (mm) by using vernier caliper.

6-Cane thickness cm.

2 Measurements of plant pigments:

Samples of five mature and fresh leaves from those leaves opposite to the basal clusters on each shoot were taken at the middle of June during the three seasons and cut into small pieces and 0.05 g weight from each sample was taken, homogenized and extracted by 25% acetone in the presence of little amounts of Na_2CO_3 then filtered. The residue was washed several times with acetone until the filtrate became coulorless. The extract was completed to a known volume (20 ml) with acetone 85%. A portion of this extract was taken for the determination of chlorophylls A & B as well as total carotenoids colormetrically and acetone (85 % V/V) was used as a blank (as mg/ 100 g F.W). The optical density of the filtrate was determined at the wave length of 662, 664 and 440 nm to determine chlorophylls A & B and total carotenoids, respectively. Concentration of each pigment was calculated by using the following equations according to **Von-Wettstein (1957)**.

Cl. A = (9.784 x E 662) – (0.99x E 644) = mg / g/ FW

Cl. B = (21.426 x E 644) – (4.65 x E 622) = mg / g/ FW

Where E = optical density at a given wave length. Total chlorophylls was estimated by summation of chlorophyll a plus chlorophyll b (mg/ g. / F.W)

Total carotenodis = (4.965 x E 4460- 0.268 (chlorophylls a + b)

3- Measurements of leaf chemical composition:

Twenty leaves picked from the main shoots opposite to the basal clusters (according to **Summer, 1985**) for each vine were taken at the middle of June during the three seasons. Blades of the leaves were discarded and petioles were saved for determining different nutrients. Petioles were oven dried at $70^{o}C$ and grind then 0.5 g weight of each sample was digested using H_2SO_4 and H_2O_2 until clear solution was obtained (according to **Wilde *et al.* 1985**). The digested solutions were quantitatively transfer to 100 ml volumetric flask and completed to 100 ml by distilled water. Thereafter, leaf contents of N, P, K, Mg, Ca, Zn, Fe, Mn and Cu were determined as follows:

1-N % by the modified microkejldahl method as described by **Chapman and Pratt (1965)**.

2- P % by using Olsen method as reported by **Wilde *et al.*, (1985).**

3- K % by using flame photometer as outlined by (**Chapman and Pratt (1965)**.

4- Mg and Ca by titration against EDTA (Versene method) (**Wilde *et al.*, 1985**)

5- Micronutrients namely Fe, Zn, Mn and Cu (as ppm) by using atomic absorption spectrophotometer according to (**Wilde *et al.*, 1985**).

Statistical analysis:

The obtained data were tabulated and statistically analyzed according to **Mead *et al.*, (1993).** Differences between treatment means were compared using new L.S.D. test at 5% level of probability according to **Steel and Torrie (1984).**

3. Results

1- Some vegetative growth characteristics

It is clear from the obtained data in Table (2) that supplying Superior grapevines with N, P and K either alone or in combinations via nano technology significantly was accompanied with enhancing the tested six growth aspects namely main shoot length, number of leaves/ shoot, leaf area, wood ripening coefficient, cane thickness and pruning wood weight compared to using these fertilizers via normal method. The best nutrient in this respect was N either applied via nano or normal systems followed by P and K. Combined applications were significantly favourable than using each nutrient alone in enhancing these growth aspects. The maximum values were recorded on the vines that fertilized with NPK at 10, 10 and 40 g / vine via nano technology, respectively. The vines received K at 40 g / vine via normal method gave the lowest values. These results were true during both seasons.

2- Photosynthetic pigments.

It is noticed from the obtained data in Table (3) that varying nano and normal NPK treatments had significant differences on chlorophylls a & b, total chlorophylls and total carotenoids in the leaves of Superior grapevines. Using NPK either singly or in combination via nano technology was significantly followed by enhancing these photosynthetic pigments compared to those used by normal method. The best nutrients in this respect was N either applied via nano or normal method followed by P and K element that occupied the last position in this respect. Using these nutrients via combined application resulted in significant promotion on these pigments. The maximum values of chlorophyll a (& 4.1 7.7 & 7.8 mg/ g F.W.), b (3.6 & 3.8 mg/ g F.W.), total chlorophylls (11.3 & 11.6 mg/ g F.W.) and total carotenoids (4.0 and 4.1 mg/ g F.W.) were observed on the vines that fertilized with NPK via nano technology at 10, 14 and 40 g / vine, respectively during 2016 and 2017 seasons. The lowest values were recorded on the vines that supplied with K via normal method. These results were true during both seasons.

Table (2): Effect of using nano NPK versus normal NPK on some vegetative growth characteristics of Superior grapevines during 2016 and 2017 seasons.

Treatments	Main shoot length (cm)		No of leaves / shoot		Leaf area $(cm)^2$		Wood ripening coefficient		Cane thickness (cm)		Pruning wood weight (kg.)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Normal N	115.0	115.9	22.0	23.0	111.0	110.9	0.77	0.76	1.31	1.40	1.89	1.90
Normal P	112.0	113.0	18.0	19.0	108.0	107.8	0.68	0.67	1.19	1.28	1.71	1.72
Normal K	110.2	111.0	16.0	17.0	106.4	106.5	0.63	0.62	1.14	1.23	1.61	1.62
Normal P + K	113.3	114.0	20.0	22.0	109.5	109.6	0.72	0.71	1.25	1.34	1.80	1.81
Normal N + K	116.3	117.0	24.0	25.0	112.3	112.2	0.81	0.80	1.36	1.45	2.00	2.01
Normal N +P	118.0	118.0	26.0	27.0	114.0	113.9	0.86	0.85	1.41	1.50	2.10	2.11
Normal N + P + K	119.0	120.0	28.0	29.0	116.0	115.9	0.90	0.89	1.46	1.55	2.51	2.51
Nano N	125.0	126.0	36.0	37.0	123.3	123.5	0.94	0.94	1.59	1.68	2.81	2.82
Nano P	122.1	123.0	32.0	33.0	120.0	119.9	0.92	0.91	1.54	1.63	2.60	2.60
Nano K	120.2	121.0	30.0	31.0	118.0	118.2	0.91	0.90	1.50	1.59	2.41	2.41
Nano P +K	123.2	124.0	34.0	35.0	121.9	122.1	0.93	0.92	1.55	1.66	2.71	2.71
Nano N +K	126.0	117.0	38.0	39.0	125.0	125.2	0.95	0.94	1.69	1.79	2.91	2.91
Nano N+P	127.0	128.0	39.0	40.0	126.3	126.5	0.96	0.96	1.79	1.90	2.95	2.96
Nano N+P+K	129.3	130.1	40.0	42.0	128.0	128.3	0.97	0.97	1.85	1.94	3.01	3.05
New L.S.D. at 5%	1.0	1.1	2.0	1.8	1.1	1.2	0.04	0.03	0.04	0.03	0.03	0.06

3- The percentage of N in the leaves

As shown in Table (3) percentage of N was significantly varied among the fourteen nano and normal NPK treatments. It was significantly stimulated when NPK were applied via nano technology than when NPK were used via normal method. Using N via normal or nano system significantly achieved the maximum values followed by P and K. Combined applications of N, P and K regardless the method of application was significantly very effective in enhancing the percentage of N. The maximum values of N (2.52 & 2.55 %) were recorded in the leaves of the vines that fertilized with NPK applied via nano technology. The lowest values (1.59 & 1.58 %) of N were observed on the vines that fertilized with Normal K during both seasons, respectively. These results were true during both seasons.

4- The percentage of P in the leaves.

As shown in Table (3) it was varied significantly among the fourteen nano and normal NPK treatments. Using NPK via nano form was significantly enhanced P compared with using NPK via normal form. Combined application of NPK via any methods were significantly beneficial in enhancing P in the leaves than using any nutrient alone. The increase in P was significantly depended on using P, K and N, in descending order. The maximum values of P (0.35 & 0.36 %) were observed on the vines that fertilized with NPK via nano technology during 2016 & 2017 seasons, respectively. The vines fertilized with K via normal method gave the minimum values (0.13 & 0.14%) during both seasons, respectively. Similar trend was noticed during 2016 & 2017 seasons.

5- The percentage of K in the leaves:

As shown in Table (3) percentage of K was significantly varied among the fourteen nano and normal NPK treatments. It was significantly increased with using N, P and K via nano technology than using these nutrients via normal form. Using K, P and N singly in descending order was significantly effective in enhancing K % in the leaves. Using all nutrients together via both systems had significant promotion on such percentage than using each element alone. The maximum values of K % (1.60 & 1.59 %) were recorded on the vines that fertilized with NPK via nano technology during 2016 and 2017 seasons, respectively. Supplying the vines with N alone via normal technology gave the lowest values (1.11 & 1.13 %) during both seasons, respectively. These results were true during both seasons.

6- The leaf content of Mg and Ca (as %) and Zn, Fe, Mn and Cu (as ppm) in the leaves.

It is clear from data in Table (4) that leaf content of Mg, Ca, Zn, Fe and Mn were significantly varied among the fourteen NPK applied via nano and normal treatments. The best nutrient in this respect was N, P and K in descending order. Using all nutrients together was significantly superior than using each nutrient alone in enhancing Mg, Ca, Zn, Fe and Mn in the leaves. Nano technology use of NPK significantly was followed by enhancing Mg, Ca, Zn, Fe and Mn than normal use of NPK. The maximum values of Mg, Ca, Zn, Fe and Mn were detected on the vines that fertilized with NPK together via nano technology. Normal use of K was significantly responsible for minimizing the leaf content of Mg, Ca Zn, Fe and Mn. These results were true during both seasons. Leaf content of Cu was significantly unaffected by the present treatments.

Table (3): Effect of using nano NPK versus normal NPK on photosynthetic pigments (mg g F.W.) and percentages of N, P, and K leaves of Superior grapevines during 2016 and 2017 seasons.

Treatments	Chlorophyll a (mg/ g. F.W.)		Chlorophyll b (mg/ g. F.W.)		Total Chlorophylls (mg/ g. F.W.)		Total carotenoids (mg/ g. F.W.)		Leaf N %		Leaf P %		Leaf K %	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Normal N	4.9	5.0	1.8	2.0	6.7	7.0	2.0	2.2	1.75	1.74	0.13	0.14	1.11	1.13
Normal P	4.4	4.5	1.2	1.4	5.6	5.9	1.4	1.6	1.64	1.63	0.18	0.19	1.16	1.18
Normal K	4.1	4.2	1.0	1.2	5.1	5.4	1.2	1.4	1.59	1.58	0.15	0.16	1.30	1.32
Normal P + K	4.7	4.8	1.5	1.6	6.2	6.4	1.7	1.8	1.71	1.69	0.22	0.22	1.36	1.39
Normal N + K	5.2	5.3	2.0	2.1	7.2	7.4	2.3	2.3	1.81	1.80	0.20	0.21	1.22	1.23
Normal N +P	5.5	5.6	2.2	2.4	7.7	8.0	2.4	2.3	1.90	1.88	0.25	0.26	1.42	1.34
Normal N + P + K	5.8	5.9	2.4	2.6	8.2	8.5	2.6	2.8	1.97	1.95	0.29	0.30	1.50	1.51
Nano N	6.8	6.9	3.0	3.2	9.8	10.1	3.2	3.4	2.29	2.30	0.16	0.17	1.15	1.16
Nano P	6.3	6.4	2.8	3.0	9.1	9.4	3.0	3.2	2.12	2.13	0.20	0.20	1.20	1.21
Nano K	6.0	6.0	2.6	2.8	8.6	8.8	2.8	3.0	2.05	2.06	0.17	0.18	1.34	1.35
Nano P +K	6.5	6.6	2.9	3.1	9.4	9.7	3.0	3.3	2.20	2.21	0.25	0.26	1.40	1.39
Nano N +K	7.1	7.2	3.2	3.4	10.3	10.6	3.4	3.6	2.39	2.40	0.22	0.23	1.26	1.27
Nano N+P	7.4	7.5	3.4	3.6	10.8	11.1	3.6	3.8	2.45	2.46	0.27	0.28	1.46	1.47
Nano N+P+K	7.7	7.8	3.6	3.8	11.3	11.6	4.0	4.1	2.52	2.55	0.33	0.36	1.60	1.59
New L.S.D. at 5%	0.2	0.2	0.2	0.2	0.3	0.4	0.2	0.4	0.05	0.05	0.002	0.002	0.04	0.05

Table (4): Effect of using nano NPK versus normal NPK on the leaf content of Mg and C a (as %) and Zn, fe a, Mn and Cu Superior grapevines during 2016 and 2017 seasons.

Treatments	Leaf Mg %		Leaf Cu %		Leaf Mn (ppm)		Leaf Fe (ppm)		Leaf Zn (ppm)		Leaf Cu (ppm)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Normal N	0.61	0.59	2.92	2.95	55.0	55.9	55.8	56.0	56.7	57.0	1.13	1.14
Normal P	0.52	0.90	2.71	2.74	50.0	51.0	50.9	51.0	51.7	52.0	1.12	1.13
Normal K	0.49	0.50	2.60	2.64	47.1	48.0	48.0	48.1	48.8	49.1	1.11	1.11
Normal P + K	0.56	0.57	2.82	2.86	52.9	53.7	54.0	54.1	54.8	55.1	1.12	1.12
Normal N + K	0.66	0.66	3.00	3.05	57.2	58.0	58.0	58.2	59.0	59.3	1.14	1.15
Normal N +P	0.71	0.69	3.11	3.15	59.0	59.9	60.0	60.3	61.0	61.3	1.15	1.15
Normal N + P + K	0.79	0.80	3.20	3.25	60.9	61.9	62.0	62.2	62.0	63.2	1.16	1.16
Nano N	1.00	0.99	2.99	3.04	56.9	58.8	58.0	58.3	58.0	58.3	1.16	1.17
Nano P	0.90	0.89	2.79	2.84	51.8	53.8	53.0	52.9	53.8	54.1	1.12	1.12
Nano K	0.85	0.86	2.67	2.72	48.9	50.7	50.5	50.6	56.4	56.8	1.11	1.11
Nano P +K	0.95	0.96	2.90	2.96	54.9	56.8	56.0	55.9	56.8	57.1	1.12	1.12
Nano N +K	1.05	1.06	3.09	3.15	58.9	60.8	60.0	59.9	60.8	61.1	1.11	1.11
Nano N+P	1.10	1.09	3.20	3.25	61.9	63.7	63.0	62.9	63.7	64.3	1.14	1.14
Nano N+P+K	1.15	1.14	3.06	3.12	64.0	65.5	65.0	64.8	65.7	66.3	1.15	1.15
New L.S.D. at 5%	0.03	0.03	0.07	0.08	1.2	1.0	1.5	1.3	1.1	1.0	NS	NS

4. Discussion

The outstanding effect of using NPK via nano technology on growth and vine nutritional status of Superior grapevines might be attributed to their positive action on controlling the release of different nutrients and lowering nutrient losses to soil water and air and avoiding the interaction of nutrients with soil, microorganisms of water and air as well as increasing efficiency and reducing soil toxic. The potential negative effects were associated with over dosage and frequency of application. They mainly delay the release of the nutrients and extent the fertilizer effect period **(Guo *et al.*, (2005).**

These results are in agreement with those obtained by (**Wassel *et al.*, 2017, Ahmed, 2018; Ahmed *et al.*, 2018 and Dabdoub- Basma, 2019**)

Conclusion

The best results with regard to growth and vine nutritional status were obtained due to supplying Superior grapevines with N at 10 g / vine, P at 14 g / vine and K at 40 g / vine applied via nano technology.

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