

Effect of Nano NPK versus Normal Ones on Yield and Quality of Superior Grapevines

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Abstract: Superior grapevines grown under Minia region conditions were fertilized with NPK via nano technology versus normal NPK during 2016 and 2017 seasons. The vines received nano NPK at 10, 14 and 40 g / vine and normal NPK at 60, 84 and 240 g/ vine, respectively. The target was examining the effects of both nano or normal NPK on yield and berries characteristics. Yield and berries characteristics were improved by using all NPK fertilizers either alone or in combinations via nano or normal methods. Using these fertilizers via nano was materially preferable than using them via normal method. For promoting yield and berries quality of Superior, grapevines grown under Minia region conditions, it is suggested to use NPK via nano system at 10, 14 and 40 g / vine, respectively.

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1. Introduction

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 controlled manner (slow or quickly) in reaction to different signals such as heat, moisture and etc. (FAO, 2018).

Since fertilizers, particularly synthetic fertilizers, have a potential to pollute soil, water and air, in recent years, many efforts were done to minimize these problems by agriculture 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 suggests that, about 4070% 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 yield and berries characteristics in grapevine cvs (**Wassel et al., 2017, Ahmed, 2018;; Ahmed et al., 2018 and Dabdoub- Basma, 2019**).

The target was elucidating the effect of nano NPK versus normal NPK on fruiting 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 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).

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

Except those dealing with the present treatments (nano and normal NPK fertilizers), all the

selected vines (84 vines) received the usual horticultural practices which are commonly used in the vineyard.

This experiment included the following fourteen treatments:

1- Fertilization with N via normal method at 60 g N/ vine/ year.

2- Fertilization with P via normal method at 84 g P₂O₅/ vine/ year.

3- Fertilization with K via normal method at 240g K₂O / vine/ year.

4- Fertilization with P + K via normal method

5- Fertilization with N + K via normal method

6- Fertilization with N + P via normal method

7- Fertilization with N + P + K via normal method

8- Fertilization with N via nano method at 10 g N/ vine/ year.

9- Fertilization with P via nano method at 14 g P₂O₅/ vine/ year.

10- Fertilization with K via nano method at 40 g K₂O / vine/ year.

11- Fertilization with P+ K via nano method

12- Fertilization with N+ K via nano method

13- Fertilization with N+ P via nano method

14- Fertilization with N+ P+ K via nano method

15- 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 P₂O₅ / vine / year in the form of mono calcium superphosphate (15.5 % P₂O₅) and 240 g K₂O / vine/ year in the form of potassium sulphate (40 % K₂O). 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 P₂O and 40 g K₂O/ 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.

- Different measurements:

The following measurements were recorded during the two experimental seasons.

1- Measurements of yield and both physical- and chemical characteristics of the berries:

1- yield:

Harvesting took place when T.S.S./ acid in the berries of the check treatment reached at least 25:1 (at the last week of June in the three seasons)

(according to **Winkler *et al.*, 1974 and Weaver, 1976**). The yield per vine expressed in weight (kg.) and number of clusters per vine was recorded.

2 Berries quality:

Five clusters from each vine were taken at random for determination of the following physical and chemical characteristics.

1- Cluster dimensions (length and shoulder, cm)

2- Shot berries % by dividing number of shot berries cluster by the total number of berries cluster and multiplying the product x 100.

3- Average berry weight (g)

4- Average berry dimensions (longitudinal and equatorial, in cm).

5- Percentage of total soluble solids in the juice by using handy refractometer.

6- Percentage of reducing sugars in the juice by **Lane and Eynon (1965)** volumetric method as described in **A.O.A.C. (2000)**.

7- Percentage of total acidity (as a tartaric acid/ 100 ml juice) by titration against 0.1N NaOH using phenolphthalein as an indicator **A.O.A.C. (2000)**.

Statistical analysis:

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

3. Results

1-The yield and cluster aspects.

It is clear from the obtained data in Table (2) that varying treatments of NPK had significant effect on yield and cluster aspects (length, weight and shoulder). The best nutrients in this respect were N, P and K, in descending order. Supplying the vines with N, P and K either alone or in combinations via nano technology significantly was superior than using NPK via normal form in improving yield and cluster aspects. Significant differences on these characteristics were observed among the fourteen nano and normal NPK treatments. The maximum number of clusters (24.0 & 35.0), yield (11.3 & 16.6 kg), weight of cluster (471.2 & 475.0 g), length (210.0 & 21.2 cm) and shoulder (14.5 & 14.7 cm) were recorded on the vines that received N at 10 g / vine, P at 14 g / vine and K at 40 g / vine via nano technology, during 2016 and 2017 seasons, respectively. The lowest values were recorded on the vines that fertilized with K via normal system. Using normal NPK produced yield reached 10.6 & 14.2 kg during 2016 and 2017 seasons, respectively. The percentage of increment on the yield due to application of nano NPK over normal NPK reached 6.6 and 16.9% during both seasons, respectively. Number of clusters in the first season of study was significantly unaffected by the present treatments.

Similar trend was noticed during both seasons.

The percentage of shot berries

Table (2): Effect of using nano NPK versus normal NPK on the yield, cluster aspects and percentage of shot berries of Superior grapevines during 2016 and 2017 seasons.

Treatments	No. of clusters / vine		Yield/ vine (kg.)		Av. Cluster weight (g.)		Av. Cluster length (cm)		Av. Cluster shoulder (cm)		Shot berries %	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Normal N	24.0	30.0	9.7	12.3	406.0	410	19.4	19.5	13.1	13.3	5.4	5.3
Normal P	23.0	27.0	8.8	10.4	383.0	387	18.5	18.6	12.5	12.7	6.4	6.2
Normal K	23.0	25.0	8.6	9.4	371.9	375	18.0	18.1	12.2	12.4	6.7	6.6
Normal P + K	23.0	29.0	9.1	11.5	394.0	398	19.0	19.1	12.8	13.0	5.9	5.7
Normal N + K	24.0	31.0	10.0	13.1	417.0	421	19.8	19.9	13.4	13.6	5.0	4.9
Normal N +P	24.0	32.0	10.3	13.8	428.0	432	20.2	20.1	13.8	14.0	4.6	4.5
Normal N + P + K	24.0	32.0	10.6	14.2	440.0	444	20.6	20.6	14.1	14.3	4.2	4.1
Nano N	24.0	32.0	10.1	13.6	420.0	425	19.8	20.0	13.5	13.7	5.0	4.9
Nano P	24.0	29.0	9.5	11.7	397	402	19.0	19.1	12.9	13.0	5.9	5.8
Nano K	24.0	27.0	9.5	10.6	387	392	18.4	18.5	12.7	12.8	6.2	6.1
Nano P +K	24.0	31.0	9.3	12.8	409	414	19.5	19.6	13.1	13.3	5.4	5.3
Nano N +K	24.0	33.0	9.8	14.5	433	438	20.2	20.3	13.8	14.0	4.5	4.4
Nano N+P	24.0	34.0	10.4	15.6	455.0	460	20.7	20.8	14.2	14.3	4.2	4.1
Nano N+P+K	24.0	35.0	11.3	16.6	471.2	475	21.0	21.2	14.5	14.7	3.7	3.6
New L.S.D. at 5%	NS	2.0	0.3	0.3	10.0	9.5	0.4	0.3	0.3	0.2	0.4	0.5

It is clear the data in Table (2) that percentage of shot berries was significantly varied among the fourteen NPK treatments. It was significantly declined by using NPK fertilizers via nano technology than by using normal NPK. The best control for shot berries was observed by using N, P and K in descending order, regardless the method of application. Combined applications of these nutrients in both systems had significant reduction on the percentage of shot berries compared with using each nutrient alone. The lowest values of shot berries (3.7 & 3.6%) were recorded on the vines that fertilized with NPK via nano technology at 10, 14 and 40 g / vine during 2016 and 2017 seasons, respectively. The highest values (6.7 & 6.6 %) were noticed on the vines that received K via normal method at 240 / vine during both seasons respectively. Similar trend was noticed during both seasons.

Some physical and chemical characteristics of the berries

It is clear from the obtained data in Table (3) that both physical and chemical characteristics of the berries were significantly varied among the fourteen nano and normal NPK treatments. Using N, P and K at 10, 14 and 40 g / vine, respectively very effective in improving quality of the berries in terms of increasing berry weight, longitudinal and equatorial, T.S.S. % and reducing sugars and reducing total acidity % than using normal NPK. The best results with regard to quality of the berries were observed when the vines were fertilized with NPK via nano technology. Unfavourable effects on quality of the berries were detected in the vines that receive K at 140 g / vine via normal alone. These results were true during both seasons.

Table (3): Effect of using nano NPK versus normal NPK on some physical and chemical characteristics of the berries of Superior grapevines during 2016 and 2017 seasons.

Treatments	Av. Berry weight (g.)		Av. Berry equatorial (cm)		Av. Berry longitudinal (cm)		T.S.S.%		Reducing sugars %		Total acidity %	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Normal N	3.30	3.38	2.15	2.18	2.33	2.39	19.0	19.2	17.0	16.9	0.655	0.650
Normal P	3.10	3.19	2.05	2.08	2.26	2.28	18.0	18.2	15.9	16.0	0.685	0.680
Normal K	3.00	3.08	2.00	2.04	2.22	2.23	17.6	17.7	15.6	15.6	0.700	0.695
Normal P + K	3.20	3.29	2.10	2.13	2.31	2.33	18.5	18.6	16.4	16.4	0.670	0.666
Normal N + K	3.39	3.46	2.20	2.24	2.36	2.44	19.5	19.6	17.4	17.5	0.640	0.615
Normal N + P	3.50	3.59	2.25	2.29	2.41	2.48	20.0	20.1	17.7	17.8	0.625	0.610
Normal N + P + K	3.60	3.69	2.31	2.35	2.46	2.52	20.5	20.6	18.0	17.9	0.609	0.595
Nano N	3.40	3.48	2.20	2.25	2.40	2.44	19.4	19.5	17.4	17.5	0.640	0.615
Nano P	3.20	3.27	2.10	2.15	2.33	2.33	18.5	18.6	16.5	16.6	0.670	0.655
Nano K	3.10	3.18	2.05	2.10	2.30	2.28	18.1	18.2	16.3	16.4	0.685	0.670
Nano P +K	3.30	3.39	2.15	2.20	2.36	2.38	19.0	19.1	16.7	16.8	0.655	0.640
Nano N +K	3.49	3.59	2.25	2.30	2.42	2.50	20.0	20.1	17.8	17.9	0.625	0.610
Nano N+P	3.60	3.70	2.30	2.36	2.47	2.55	20.5	20.6	18.1	18.1	0.610	0.595
Nano N+P+K	3.71	3.84	2.36	2.40	2.53	2.60	21.1	21.1	18.5	18.6	0.594	0.590
New L.S.D. at 5%	0.08	0.09	0.03	0.03	0.04	0.04	0.4	0.5	0.03	0.03	0.011	0.012

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) and Al Amin Sadek and Jayasuriya (2007)).

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

Conclusion

For promoting yield and berries quality of Superior, grapevines grown under Minia region conditions, it is suggested to use NPK via nano system at 10, 14 and 40 g / vine, respectively.

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