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Comparative Between Traditional and Nano Fertilization of Zn and Fe on Flame Seedless Grapevines Productivity

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Abstract: Nano fertilization utilizing zinc and iron oxide nanoparticles is an effective approach to enhance and improve the nutritional quality of the plant's edible portion. The aim was to compared the efficiency of traditional and nano fertilization in form of zinc and iron on yield and quality of Flame seedless grapevines. The treatments were distributed using a completely randomized design, comprising seven treatments, administered by foliar sprays three times. Results suggested that foliar application of nano Zn (20 ppm) in conjunction with Fe (40 ppm), followed by a lower dosage of nano-oxide fertilizer, which did not exhibit significant differences (P≤0.05) between them, positively influences cluster characteristics, yield, and the physico-chemical quality of the berries under investigation. From the data, it could conclude that foliar application of nano Zn (10 ppm) in conjunction with Fe (20 ppm) serves as an alternative to conventional fertilizers (EDTA) for enhancing the quality and productivity of Flame seedless grapevines.

Key words: Nano oxide, zinc, iron, yield, quality and Flame seedless grapevines.

1. Introduction

Numerous nanomaterials exhibit significant potential for application in the vine cultivation process. To safeguard vines from phytopathogens and enhance the quality and yield of grapes, nanotechnology can be implemented in the field of viticulture. Consequently, nanotechnology may enable the utilization of reduced quantities of phytochemical compounds, thereby fostering a more sustainable agriculture and reducing the environmental impact (**Garde-Cerdán *et al.*, 2021**). Due to the high cost of plants absorbing certain micronutrients from the soil when their efficiency is low, spraying is a viable option **(Siavashi *et al.*, 2004). Shaaban *et al.* (2024)** assert that foliar treatment can grant plants access to nutrients that will guarantee optimal performance. The application of nano-fertilizers via foliar spray might facilitate the direct absorption of nutrients into the plant system through epidermal penetration, hence minimizing fertilizer loss associated with alternative approaches that may pose environmental hazards (**Mahil and Kumar, 2019**). The absorption of nanoparticles is projected to be 15-20 times more than that of traditional bulk particles (**Rajput *et al.*, 2018**).

Zinc (Zn) is a crucial element for plants, and Zn shortages are common in numerous crops (**Ojeda-Barrios *et al.*, 2014**). Zinc is essential for the functionality of various enzymes, including RNA and DNA polymerases, as well as for cell division. It also contributes to tryptophan synthesis, the maintenance of membrane structure, and photosynthesis. Zinc serves as a regulating cofactor in protein synthesis (**Yadav *et al.*, 2022**). Nanoparticle-based micronutrient fertilizers have demonstrated efficacy in providing plants with nutrients in a controlled manner, hence mitigating environmental concerns linked to conventional fertilizer use (**Naderi and Abedi, 2012**). The diminutive size and superior surface area-to-volume ratio of zinc nanoparticles render them suitable for topical application or plant ingestion. Both soil treatment approaches and foliar application techniques efficiently facilitate the transfer of the element (**Czyżowska and Barbasz, 2022**). Zinc nanoparticles, while beneficial to horticultural crops, may potentially have adverse effects on plants. Zinc nanoparticles generally enhance certain facets of plant growth and development. **Aslani *et al.* (2014**) assert that zinc content influences the yield and quality of fruits, vegetables, and other crops. They are utilized in agriculture to enhance seed germination and various other characteristics. Vegetative and fruiting traits were maximized by the use of ZnO nanoparticles (1.2 ppm) in comparison to traditional fertilizers ($ZnSO_4$ and Zn EDTA) in the grape variety Flame Seedless (**El-Said *et al.*, 2019**).

Iron is a vital element for agricultural crops (**George *et al.*, 2008**). Micronutrients can enhance plant development attributes and augment plants' resilience to the detrimental impacts of harmful ions. Iron is a vital nutrient for plant metabolism, acting as a cofactor for many enzymes involved in respiration and DNA synthesis, either directly or indirectly. Additionally, it serves as a cofactor for numerous enzymes engaged in redox reactions, including respiration, photosynthesis, and hormone synthesis (**Barberon *et al.*, 2011). Álvarez-Fernández *et al.* (2003**) assert that iron shortage diminishes the effectiveness of photosynthesis and carbon fixation in plants, resulting in decreased vegetative growth and crop output. Young leaves turn yellow when it is lacking, and photosynthetic activity is significantly reduced, ultimately leading to decreased biomass production (**Briat *et al.*, 2007**). **Mohamed, (2020)** demonstrated that the application of iron, whether in bulk or nano form, considerably enhanced yield, improved cluster and berry characteristics, and augmented leaf area, leaf nutrient content and total chlorophyll, in comparison to the control group of the "Thompson Seedless" grapevine.

The foliar application of these nutrients is increasingly recognized for its multiple benefits, such as immediate effects and reduced fertilizer requirements in the solution (**Prasad *et al.*, 2014**). Foliar fertilizers demonstrate increased efficacy in conditions of high nutrient demand, particularly when soil supply and root uptake are insufficient (**Fernández *et al.*, 2013**). This study aims to investigate the effects of foliar sprays of micronutrients, specifically zinc and iron, in both conventional and nanoparticle forms, on yield and quality of the Flame Seedless grape.

2. Materials and Methods

2.1. Experimental site

A completely randomized block designed experiment was conducted out in a privet grapevine orchard, located at Al Biho village- Samalut- Minia Governorate to comparative the impact of conventional and nano fertilization of foliar applications with zinc and Fe on the vegetative, yield and berries physico-chemical quality of Flame Seedless grapevines during two successful seasons of 2023 and 2024.

The investigated 21 healthy vines and near uniform in growth vigor were used in the study. The cane pruning approach was used to leave a total bud load of 84 buds/vine for all of the selected vines, calculated as 6 cans x 12 buds plus 6 renewal spurs x 2 buds/vine. The selected grapevines underwent standard agricultural procedures employed in the vineyard, including irrigation and pest management. Vines are arranged with a spacing of 2 m between each vine and 3 m between rows on clay soil. The soil's physical and chemical parameters are presented in Table A as per **Wilde *et al.* (1985**), and a surface irrigation system was implemented utilizing Nile water.

2.2. Treatments description

Experimental design including 7 treatments with 3 duplicates as following:

1. Control (spray with tap water).
2. Normal Zn (50 ppm) + Fe (100 ppm).
3. Normal Zn (100 ppm) + Fe (200 ppm).
4. Normal Zn (200 ppm) + Fe (400 ppm).
5. Nano Zn (5 ppm) + Fe (10 ppm).
6. Nano Zn (10 ppm) + Fe (20 ppm).
7. Nano Zn (20 ppm) + Fe (40 ppm).

During the two research seasons, the chosen vines were sprinkled thrice till runoff using a hand sprayer at the beginning of vegetative development, after fruit set, and one month after the second application.

Nanoparticle for each zinc and iron were applied in oxide form contain (9.6% Zn and 6.1% Fe), the source of nano elements was a commercial product brought from “Bio Nanotechnology” company. While, conventional zinc and iron were applied in form of EDTA contain (15% Zn and 13% Fe).

Table (A). Analysis of the tested soil

Soil characters		2023/2024
Particle size distribution (%)	Sand	10.55
	Silt	11.84
	Clay	77.61
	Texture class	Clay
EC ppm (1:2.5 extract)		242
pH (1:2.5 extract)		7.81
Organic matter %		1.74
$CaCO_3$ %		1.98
Soil nutrients	Total N (%)	0.13
	Available P (ppm)	4.87
	Available K (ppm)	489
	Zn (ppm)	3.8
	Fe (ppm)	3.2
	Mn (ppm)	3.1

2.3. Measurements

2.3.1. Cluster characteristics and yield

Four clusters /vine were harvested at the ripening stage to determine the following data: Number of cluster/vine, cluster weight (g), cluster length (cm), cluster shoulder (cm), yield (kg)/vine was assessed in kg for each tree/replicate by multiply the previous parameters and Berry setting (%) was computed as the following: Five flower clusters were packaged per vine in perforated paper bags prior to blooming, which are released during berry set, calculated as follows:

$$\text{Fruit berry Setting\%} = \frac{\text{Number of berries /cluster}}{\text{Total number of flower /cluster}}$$

2.3.2. Physical characteristic of the berry

To get the shot berry proportion, the percentage of berries in each cluster was divided by the total number of berries across all clusters and then multiplied by 100, berry weight (g) and berry dimensions (longitudinal and equatorial).

2.3.3. Chemical characteristics of berries according to (A.O.A.C., 2000)

A hand refractometer used to measure TSS% in berry, titrating 5 ml of berry juice against 0.1 N NaOH with phenolphthalein determined the titratable acidity percentage, TSS/acidity ratio of berry juice was calculated, reducing sugar% and the total anthocyanin content of the berry skin was quantified as mg/100g of fresh weight (**Hsia *et al.*, 1965**).

2.4. Statistical analysis

In accordance with **Mead *et al.* (1993)**, all data were analyzed using a new L.S.D. technique at a significance level of 5%.

3. Results and Discussion

The following results demonstrated the comparative of conventional and nano fertilization of iron and zinc at different concentration relative to control treatment on physical and chemical status of berries as well as yield and its components on “Flame Seedless” grapevines during 2023 and 2024 seasons.

3.1. Cluster aspects and yield

Table 1, presented the results of the treatments applied to the leaves of Flame seedless grapevines regarding berry setting, cluster number and yield kg/vine as well as cluster weight, and dimensions (length and shoulder). During the 2023 and 2024 seasons, the berry setting, cluster number and yield kg/vine as well as cluster weight, and dimensions (length and shoulder) demonstrated a significant ($P \leq 0.05$) increase in the treated vines compared to the untreated ones. There was no notable distinction at ($P \leq 0.05$) between the foliar applications of the two higher concentrations for both fertilizer forms in either season. The traits were higher following the topical application of nano-oxide compared to the treatments using the EDTA form. The optimal mentioned parameters were attained with a treatment of nano Zn (20 ppm) combined with Fe (40 ppm), followed by a lower concentration of nano-oxide fertilizer, which did not show notable distinction ($P \leq 0.05$). The scores for the other treatments were average for both seasons.

All micronutrients, whether applied alone or in combination, are directly involved in various physiological processes. The enhancement of yield and its components is linked to the essential function of zinc in various biological processes that influence these factors. Zinc is essential for enhancing the amino acid tryptophan, which underpins the biological metabolism of auxin. The auxin balance in plants governs fruit drop or retention, hence increasing the overall amount of fruits per tree. This process results in an increased setting of berries within clusters and a higher yield, attributed to the greater weight and number of clusters. This is further facilitated by elevated chlorophyll levels and improved photosynthetic products due to the increased zinc content in the leaves (**Abo Almeekh *et al.*, 2020; Saleh *et al.*, 2022**). The increment in cluster weight associated with Zn application may be attributed to enhanced berry set, the number of berries within the cluster, and either cell size or cell number (**Abou-Zaid and Shaaban, 2019).**

According to **Ahmed and Abdelkader (2020**), nano-fertilizers enhance photosynthesis and dry matter production by facilitating nutrient absorption in plants. Moreover, the application of nano-fertilizers in agriculture has numerous benefits, such as accelerated plant absorption, improved growth, and increased yields (**Shareef *et al.*, 2021**). Significant alterations occurred in both study seasons relative to other treatments. **El-Said *et al.* (2019)** and **Abou El-Nasr *et al.* (2021)** reported that topical administration of zinc improved cluster quantity per vine, cluster mass, and yield per vine. These results align with those of the aforementioned investigations.

Iron is essential for the activation of chlorophyll and the synthesis of a variety of heme proteins, including the various cytochromes that are involved in a variety of plant metabolism functions (**Al-Bamarny *et al.*, 2010**). Iron is crucial for the synthesis of chlorophyll and the regulation of plant growth. Iron enhances the process of photosynthesis and facilitates the transportation of assimilates to sinks, ultimately leading to an increase in fruit yield (**Alvarez - Fernandez *et al.*, 2006**). The findings of the current investigation regarding the influence of iron on yield and cluster characteristics align with those of **Mustafa and Al-Atrushy (2018); Ali *et al.* (2021) and Abo-El-Ez *et al.* (2023).**

Table (1). Efficiency of traditional and nano iron and zinc on cluster aspects and yield kg/vine of Flame seedless grapevines in 2023 and 2024 growing seasons

Characteristics / Treatments	Berry setting %		No. of cluster/vine		Yield/vine (kg)		Cluster weight (g)		Cluster length (cm)		Cluster shoulder (cm)	
	2023	**2024**	**2023**	**2024**	**2023**	**2024**	**2023**	**2024**	**2023**	**2024**	**2023**	**2024**
Control	12.0	12.3	29.0	29.1	10.2	10.2	350.0	352.0	17.1	17.6	11.0	11.3
Normal Zn (50 ppm) + Fe (100 ppm)	13.4	13.7	29.0	31.0	10.5	11.3	363.0	365.0	19.2	19.8	12.0	12.3
Normal Zn (100 ppm) + Fe (200 ppm)	15.0	15.3	29.0	32.4	10.9	12.3	375.0	378.0	20.2	20.9	12.6	13.0
Normal Zn (200 ppm) + Fe (400 ppm)	16.2	16.5	29.0	33.6	11.1	13.0	383.0	385.0	20.8	21.5	12.9	13.2
Nano Zn (5 ppm) + Fe (10 ppm)	14.9	15.1	29.0	32.5	10.8	12.3	374.0	377.0	20.3	21.0	12.7	12.9
Nano Zn (10 ppm) + Fe (20 ppm)	16.3	16.7	29.0	33.8	11.2	13.1	386.0	388.0	21.2	22.0	13.2	13.4
Nano Zn (20 ppm) + Fe (40 ppm)	17.5	18.0	29.0	35.0	11.4	13.9	393.0	396.0	21.7	22.7	13.5	13.7
New LSD at 5%	**1.3**	**1.4**	**N.S**	**1.3**	**0.3**	**0.9**	**9.0**	**9.0**	**0.7**	**0.8**	**0.4**	**0.4**

3.2. Berry physical characteristic

The foliar application with three-time spray treatment with two studied forms of fertilizers from (Zn+Fe), specifically nano-oxide and EDTA at varying concentrations, significantly enhanced the berry physical parameters measurements in Flame seedless grapevines compared to the control (Table 2). The most effective fertilizer for raising berry weight, longitudinal and equatorial of berries and reduced shot berries% were nano-oxide, followed by conventional EDTA, in descending order of efficacy. The highest values of berry weight (3.71 & 3.78 g), berry longitudinal (1.80 and 1.94 cm) and equatorial of berries (1.66 & 1.70 cm), while the lowest value of shot berry (8.4 & 8.1) were achieved when the vines were treated with 20 ppm Zn plus 40 ppm Fe from nano-oxide, followed by 10 ppm Zn + 20 ppm Fe scored (3.66 & 3.72 g for berry weight), (1.78 & 1.91 cm for berry longitudinal, (1.65 & 1.73 cm for equatorial of berries) and (6.4. & 5.2 for shot berry) in two seasons, with negligible distinction observed between the treatments. The standard vines yielded the lowest values. The findings were consistent across both seasons.

Table (2). Efficiency of traditional and nano iron and zinc on shot berries, berry weight, longitudinal and equatorial of Flame seedless grapevines in 2023 and 2024 growing seasons.

Treatments \ Characteristics	Shot berries %		Berry weight (g)		Berry longitudinal (cm)		Berry equatorial (cm)	
	2023	2024	2023	2024	2023	2024	2023	2024
Control	8.4	8.1	3.40	3.48	1.70	1.74	1.50	1.53
Normal Zn (50 ppm) + Fe (100 ppm)	7.5	7.3	3.49	3.56	1.77	1.82	1.56	1.61
Normal Zn (100 ppm) + Fe (200 ppm)	6.9	6.7	3.58	3.66	1.83	1.87	1.61	1.67
Normal Zn (200 ppm) + Fe (400 ppm)	6.4	6.3	3.63	3.71	1.86	1.89	1.63	1.68
Nano Zn (5 ppm) + Fe (10 ppm)	6.9	5.8	3.58	3.65	1.72	1.86	1.62	1.68
Nano Zn (10 ppm) + Fe (20 ppm)	6.4	5.2	3.66	3.72	1.78	1.91	1.65	1.73
Nano Zn (20 ppm) + Fe (40 ppm)	6.1	4.8	3.71	3.78	1.80	1.94	1.66	1.70
New LSD at 5%	**0.5**	**0.5**	**0.06**	**0.07**	**0.04**	**0.04**	**0.03**	**0.03**

All yield-related parameters considerably improved due to the foliar applying of micronutrients, with the maximum values consistently recorded at the maximum nutrient doses given. The transformation of flowers into fruits with foliar nutrition treatment may influence the raise in cluster number /vine, cluster length, berry number per bunch, berry diameter, and bunch weight, resulting in enhanced grapevine output. The raise in berry weight and number results directly from zinc's role in enhancing photosynthetic efficiency. Consequently, increase the weight of the clusters in the vine (**AL-Imam, 1998**). **Khan *et al.* (2019**) assert that zinc (Zn) performs various vital physiological processes that may improve berry quality. Tryptophan serves two main functions in plants: it affects plant development and facilitates the synthesis of IAA (**Castillo-Gonzalez *et al.*, 2018**). Zinc is essential for plants to produce tryptophan. **Nicolas *et al.* (2013**) reported that IAA activated the gene (VvCEB1), which governs cellular development and modifies the grape cell-wall network. Zn serves as a structural component of the ribosome and aids in the production of proteins essential for cell division, differentiation, and fruit development (**Barker and Eaton, 2015**). Additionally, Zn may enhance berry firmness by inhibiting certain oxidative processes (**Zhao *et al.*, 2013**). For these reasons, zinc may enhance berry quality, which would enhance cluster quality and raise Flame Seedless grapevine output. The current findings align with those of **Al-Atrushy (2021); Saleh *et al.* (2022) and Shaaban *et al.* (2024).**

The enhancement of iron's role in fruit through several enzymatic activities and chlorophyll production may have augmented photosynthesis. The enhancement of berry diameter may be attributed to elevated chlorophyll levels in the leaf, which correlate with higher photosynthate synthesis in the plant (**Rana and Sharma, 1979**). The beneficial influence of iron on the physical quality of the examined berries aligns with the findings of **Wassel *et al.* (2017); Mustafa and Al-Atrushy (2018) and Abo-El-Ez *et al.*, (2023).**

3.3. Berry chemical quality characteristics

The application of various foliar sprays, as detailed in Table 9 and illustrated in Fig 26, resulted an enhancement of the berry's TSS%, TSS/TA, reducing sugar and total anthocyanin and reduced the total acidity. The most favourable outcomes were achieved through the application of nano-oxide on the vines, surpassing those obtained with the conventional form of EDTA. The elevation in the concentration of both fertilizers is led to the enhancement of berry TSS%, TSS/TA, reducing sugar and total anthocyanin and reduction in total acidity across both seasons, with no notable distinction observed between the two elevated levels of each fertilizer. Nevertheless, the control vines exhibited the lowest mean values at (18.3-18.4%), (25.2-25.5), (14.7-14.8%) and (25.3-25.5%) for TSS%, TSS/TA, reducing sugar and total anthocyanin and highest of total acidity as (0.725- 0.722%), whereas the highest mean values were observed with 20 ppm Zn +40 ppm Fe as nano-oxide, recorded at (20.1-20.3%), (31.7-32.3%), (16.2-16.5%) and 27.6-28.1%) for TSS%, TSS/TA, reducing sugar and total anthocyanin and lowest for total acidity (0.634-0.626%). This was closely followed by the combination of 10 ppm Zn + 20 ppm Fe as nano-oxide, which yielded mean values of (19.9-20.0% TSS), (30.5-31.0% TSS/TA), (16.1-16.3% reducing sugar) and 27.3- 27.7% total anthocyanin) and lowest total acidity (0.652-0.646%), with no statistically significant differences discernible among these results. The remaining treatments yielded moderate values, and this trend was observed across both seasons.

Photosynthesis and the enzymes that control plant metabolism depend heavily on micronutrients. The primary benefits of applying. micronutrients include enhanced leaf area, growth, productivity, and increased TSS and sugars, while simultaneously reducing the total acidity of grapevine cultivars (**Singh, 2002**). Our results align with those of **Abdollahi *et al.* (2010)** and **Nikkhah *et al.* (2013),** who reported that treatment with Zn significantly elevated TSS and sugar while reducing acidity. They are crucial to carbohydrate metabolism and the quality of fruit. The applying of micronutrients resulted in significantly increased anthocyanin levels in berries (**Song *et al.*, 2015; Ekbic *et al.*, 2018).** The chemical qualities of the berries are enhanced by the foliar application of several zinc treatments, especially nano zinc oxide at a dosage of 20 ppm. Zn increases TSS%, reducing sugars, total anthocyanin and lowers acidity% in berries by elevating potassium concentration. **Abou El-Nasr *et al.* (2021)** discovered that N-ZnO treatments enhanced the accumulation of sugars and total soluble solids in fruit juice while diminishing the concentration of titratable acidity. Zinc's function in protein and carbohydrate synthesis and translocation may be the cause of the effects (**Belal-Basma *et al.*, 2023**). Additionally, the subsequent processes have been suggested to elucidate the manner in which zinc affects antioxidant activity: a) Zinc can form complexes with phospholipids and sulfhydryl groups, thereby protecting lipids and membrane proteins from oxidative damage (**Broadley *et al.*, 2012**); b) Zinc can modulate the synthesis of antioxidant enzymes, including ascorbate, peroxidase, CAT, and SOD (**Noreen *et al.*, 2021**). Zinc augmented the antioxidant activity of grape berries therefore.

Table (3). Efficiency of traditional and nano iron and zinc berries TSS, total acidity, TSS/TA, reducing sugar and total anthocyanin of Flame seedless grapevines in 2023 and 2024 growing seasons

Characteristics / Treatments	TSS%		Total acidity%		TSS/acidity ratio		Reducing sugar%		Total anthocyanin (mg/100g)	
	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024
Control	18.3	18.4	0.725	0.722	25.2	25.5	14.7	14.8	25.3	25.5
Normal Zn (50 ppm) + Fe (100 ppm)	18.9	19.0	0.698	.695	27.1	27.3	15.2	15.4	26.0	26.2
Normal Zn (100 ppm) + Fe (200 ppm)	19.4	19.8	0.676	0.673	28.7	29.1	15.6	15.9	26.5	26.9
Normal Zn (200 ppm) + Fe (400 ppm)	19.7	19.8	0.660	0.654	29.8	30.3	15.8	16.0	26.9	27.2
Nano Zn (5 ppm) + Fe (10 ppm)	19.5	19.5	0.673	0.671	29.0	29.1	15.7	15.8	26.7	26.9
Nano Zn (10 ppm) + Fe (20 ppm)	19.9	20.0	0.652	0.646	30.5	31.0	16.1	16.3	27.3	27.7
Nano Zn (20 ppm) + Fe (40 ppm)	20.1	20.3	0.634	0.626	31.7	32.3	16.2	16.5	27.6	28.1
New LSD at 5%	**0.4**	**0.4**	**0.019**	**0.020**	**1.3**	**1.4**	**0.3**	**0.3**	**0.5**	**0.5**

Foliar fertilization may come from the advantageous effects of increased iron, enhanced iron availability, and the rapid direct uptake of ferrous iron (Fe-EDTA) by vine leaves, leading to improved absorption and translocation of nitrogen, phosphorus, potassium, iron, and zinc (**Al-Imam, 2014)**. Fruit quality was eventually impacted by these mineral statues' effects on the physiological processes of photosynthesis and its consequences. The inverse relationship of total acidity with foliar spray of Fe may result from an elevated metabolic rate that enhances the conversion of organic acids into lower carbohydrates in the berry solution, leading to decreased acidity. In contrast, Zn facilitates the translocation of carbohydrates from leaves to fruits, thereby improving both the quality and quantity of berries, characterized by increased content of sugar and reduced titratable acidity through their conversion into sugars. Comparable findings were documented (**Ullah *et al.*, 2012; Farid *et al.*, 2020**). These outcomes are comparable to those of **Abo-El-Ez *et al.* (2023).**

4. Conclusion

Under the same conditions of the experiment, it could be concluded that foliar spraying of nano Zn at 10 ppm combined with Fe at 20 ppm in the form of nano-oxide was the best economically to achieve optimal and superior quality output of Flame Seedless grapevines. The significance of utilizing zinc and iron in nanoform lies in its application in reduced quantities compared to conventional forms, hence minimizing environmental pollution and enhancing absorption rates by plants.

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مقارنه التسميد التقليدى بالتسميد النانوى لعناصر الزنك والحديد على إنتاجية كروم العنب فليم سيدلس

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***قسم البساتين – كلية الزراعة – جامعة المنيا – مصر**

التسميد بإستخدام جزيئات الزنك و الحديد بتقنيه النانوتكنولوجى يعتبر نهج جديد لتعزيز الجوده فى الثمار. كان الهدف من هذه التجربة هو مقارنه كفاءة التسميد التقليدي و النانوى لكل من الزنك و الحديد على محصول و جوده كروم العنب فليم سيدلس. بإستخدام تصميم كامل العشوائية يحتوى على ٧ معاملات تم إضافتها عن طريق الرش الورقى ٣ مرات، تشير النتائج إلى أن الرش الورقى بإستخدام ٢٠ جزء فى المليون زنك + ٤٠ جزء فى المليون حديد فى صوره أكاسيد نانويه يليها الرش الورقى بإستخدام ١٠ جزء فى المليون زنك + ٢٠ جزء فى المليون حديد فى صوره أكاسيد نانويه مع عدم ملاحظة أى فروق معنويه بينهما أدى إلى تأثير إيجابى فى جميع الصفات المدروسه لكل من صفات العناقيد و المحصول و الصفات الفيزيائية و الكيميائية للحبات. و من النتائج يمكن إستنتاج أن الرش الورقى بإستخدام ١٠ جزء فى المليون زنك + ٢٠ جزء فى المليون حديد فى صوره أكاسيد نانويه يعتبر بديل للأسمده التقليديه (إيديتا) فى تعزيز جودة و إنتاجية كروم العنب فليم سيدلس.

الكلمات المفتاحية: اكاسيد النانو، زنك، حديد، محصول، جودة و عنب فليم

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