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Response Superior Grape Yield and Quality to Organic and Inorganic Fertilization

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ABSTRACT

The study was conducted across two consecutive growing seasons (2020/2021 and 2021/2022) on Superior seedless grapevines to assess the effects of organic, mineral, and biofertilization techniques on the yield, and quality of Superior grapevines, as well as specific chemical constituents.

The impact of utilizing organic treatments on grape production was apparent as it led to an improvement in both quantity and quality. By incorporating compost along with compost tea treatment, the yield of superior seedless grapes was maximized, with notable enhancements in terms of cluster number per vine, cluster weight, yield per vine, and yield per fed. Additionally, this method contributed to enhanced berry quality, as indicated by increased TSS% and TSS/TA ratio, as well as reduced TA% and sugar%.

Enhanced yield and quality of Superior seedless grapes were achieved through the application of mineral and/or biofertilization. The combination of Min-NK and bio-P resulted in the highest yield, including improvements in cluster number per vine, cluster weight, yield per vine, and yield per hectare over two growing seasons. Additionally, the treatment involving mineral potassium and biological nitrogen and phosphorus demonstrated supreme quality aspects compared to other treatments.

The influence of combination between organic and mineral and/or bio fertilization was significant for all studied traits. The best yield and its components were achieved from vines fertilized by (compost + compost tea) and supplied by (Min-NK + bio-P), however, the highest quality was observed with vines treated with (compost + compost tea) and supplied with (Min-K + bio-NP).

KEYWORDS: Compost, Mineral NPK, biofertilization, Superior, yield, quality.

1. INTRODUCTION

In addition to being extensively consumed domestically, grapes are exported to many temperate and tropical countries around the world. The grape, *Vitis vinifera* L., is among the most significant and nutrient-dense fruit crops. The health and nutritional benefits of grapes, the second most produced fruit, are making them increasingly popular. Manufacturing wine is one of the main uses of grapes. Its variants have been modified to thrive in a variety of global climes. Numerous cultivars are created for usage on tables and in wine consumption, and they are employed in a wide range of goods, including as fresh fruit, juice, wine, preserves, and raisins (El-Mamlouk *et al*., 2016; Hassan and Salem, 2020; El-Salhy *et al*., 2021 and Zhu *et al*., 2022). One of the best and most often grown grape types in Egypt is considered to be Superior grapevine cv. Due to the early ripening season (beginning in May and lasting until mid-June), there is greater possibility for export to foreign markets. Reducing the amount of mineral fertilizer used is a good strategy to boost export performance and avoid contaminating our environment (Shaheen *et al*., 2013; Ahmed and Mohamed, 2018 and El-Salhy *et al*., 2023).

To maintain healthy growth and performance, certain amounts of nutrients necessary for photosynthetic functioning, metabolic pathways, and grapevine development must be present. The classification of essential elements and their corresponding macro- or micronutrients is based on the amount of each element that the plant needs. Plant tissue has large concentrations of macronutrients such as nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur, which make up 0.2 to 3% of dry weight. In plant tissue, micronutrients are found at lower concentrations: 0.5 to 40 ppm dry weight for molybdenum, copper, zinc, and boron, and 50 to 150 ppm dry weight for iron and manganese. The availability of a single element determines how well a vine performs if it is not accessible in sufficient quantities. When shortages in micronutrients are noted, availability, rather than element concentration, is frequently the limiting factor. Individual essential element toxicity or deficiencies can cause distinctive foliar symptoms as well as a limited growth habit (Ashley, 2011).

During the growth sea son, one of the most crucial cultural activities is fertilization, especially organic fertilization. An additional method for providing the macro and micronutrients required for plant growth is organic fertilization. Organic fertilizer promoted grapevine growth and enhanced nutritional status. Moreover, organic compounds lower soil pH and enhance soil structure, aeration, and moisture retention. It is now critically necessary to produce fruits organically by using biological and organic fertilization instead of chemical fertilizers and stimulants (Calleja-Cervantes *et al*., 2015; Birjely and Al-Atrushy, 2017; Al-Hawezy and Ibrahim, 2018 and Hassan and Salem, 2020).

Bio-fertilizers play a significant role in the sustainability of various agricultural crops by minimizing the application of artificial fertilizers. By maintaining the physical characteristics of the soil, it contributes to lowering the cost of chemical fertilizers for N, P, and K and enhancing soil fertility. Utilizing biofertilizers increases the quantity and health of soil microorganisms, which in turn increases plant nutrient availability in the rhizospheric zone (Khalil, 2012; El-Abbasy *et al*., 2013 and Refaai and Soltan, 2023).

Biofertilizers have recently gained popularity as a better alternative to chemical fertilizers because they are safe for humans, animals, and the environment, and their use has been linked to a decrease in environmental pollution. They can improve crop productivity and quality by boosting biological N fixation, nutrient availability and uptake, and natural hormone stimulation. The most crucial component of biofertilizers is soil because they have a significant impact on grapevine yield and quality (Kassem and Marzouk, 2002 and Shaheen *et al*., 2013).

The aim of this study was to examine potential effects on yield and quality of superior seedless grapevines when biofertilizers were applied as a partial replacement for mineral fertilizers under organic fertilization.

2. MATERIALS AND METHODS

This research was conducted across two successive growing seasons (2020/2021 and 2021/2022) to evaluate the influence of mineral, organic, and biofertilization treatments on the growth of Superior grapevines.

To achieve this objective, 96 Superior grapevines were utilized from an orchard in Talla village, Minia district, Minia governorate. These grapevines, aged 6 years, were spaced at intervals of two by three meters and were nourished with Nile water through a surface irrigation system. An annual pruning was performed in the first week of January, leaving 72 buds per vine (6 fruiting canes x 10 buds, plus 6 renewal spurs x 2 buds). Ahead of the experiments, the soil was thoroughly analyzed mechanically, physically, and chemically at a depth of 0.0 to 90 cm, following the method described by Wilde *et al*. (1985). The findings of these analyses are presented in Table (1).

The study involved 32 different treatments, consisting of four forms of organic fertilization and eight types of mineral and/or biofertilization. The experiment was conducted using a split-plot design with three replicates, with one vine assigned to each. The eight mineral and/or biofertilization treatments were allocated to the sub-plots (factor B), while the four compost treatments were allocated to the main plots (factor A).

Table 1. Physical and chemical analysis of the used soil in the study.

Character	Values
Particle size distribution	
Sand (%)	5.2
Silt (%)	23.8
Clay (%)	71.0
Texture	Clay
pH (1:2.5 ratio extract)	7.7
EC (1:2.5 extract) mmhos/l cm 25°C	0.79
Total $CaCO_3$ (%)	1.96
O.M. (%)	1.72
Total N (%)	0.07
P ppm (Olsen)	4.2
K ppm (ammonium acetate)	605.0
Mg (ppm)	6.0
Available micronutrients (EDTA)	
Fe (ppm)	3.8
Zn (ppm)	3.0
Mn (ppm)	5.3
Cu (ppm)	1.0

The existing treatments may be presented as shown below:

The organic fertilization treatments occupied the main plot (A) as follows:

1. A_0, control (without compost addition).
2. A_1. 2.5 kg compost/vine.
3. A_2. 2.5 l compost tea/vine.
4. A_3. 1.25 kg compost + 1.25 l compost tea/vine.

Mineral and/or biofertilization treatments (sub-plots, B):

1. B_0- Control (mineral NPK fertilization).
2. B_1- Min PK + bio-N.
3. B_2- Min NK + bio-P.
4. B_3- Min NP + bio-K.
5. B_4- Min N + bio-P and K.
6. B_5- Min P + bio-N and K.
7. B_6- Min K + bio-N and P.
8. B_7- Bio- NPK.

Obour compost (the Egyptian Corporation for Solid Waste Recycling provides compost. To create compost tea, a mixture of 1000 kg of compost and 1000 liters of fresh water was prepared and left to sit at room temperature for 48 hours. Subsequently, 200 liters of fresh tap water were mixed with 1.0 liter of the filtrate compost tea. The physio-chemical properties of the compost were analyzed using the methodology described by Wilde *et al*. (1985) and the results are presented in Table 2.

Throughout the two growing seasons, the specified quantities of compost and/or compost tea were incorporated once in the initial week of March. The mineral fertilizers employed included ammonium nitrate (33.5% N), calcium super-phosphate (15.5% P_2O_5), and potassium sulfate (48% K_2O) at a ratio of 300:300:300. The nitrogen application was split into three portions: 25% in the first week of April, 50% in the first week of May, and the remaining 25% in the first week of June. Additionally, phosphorus was divided into two equal parts, administered in the second week of January and immediately after berry setting

Table 2. Physio-chemical properties of the used compost in both seasons of 2020/2021 and 2021/2022.

Character	Value	Character	Value
Organic carbon (%)	16	**Wet cubic meter weight (kg)**	790
Total N (%)	1.3	**Dry cubic meter weight (kg)**	580
C/N ratio	12.31	**Density (g/cm)**	1.33
Organic matter (%)	26	**Saturated with water (%)**	180
Humidity (%)	28	**Fe (ppm)**	1170
pH (1:2.5)	7.7	**Zn (ppm)**	45
E.C. (mmhos/cm)	3.5	**Mn (ppm)**	110
Total P (%)	0.5	**Cu (ppm)**	160
Total K (%)	0.7		

(first week of May). Similarly, potassium was divided into two equal portions during the first bloom (last week of March) and again after berry setting (first week of May). All other agricultural practices were carried out as per usual.

Minia Azotein, a commercial biofertilizer, contains N-fixing bacteria (*Azotobacter chroococcum*) at a concentration of 10^7 bacterial cells, serving as an N-fertilizer. In addition, Minia Phosphorene, another biofertilizer, utilizes a specific strain of *Bacillus megatherium* var phosphoticum bacteria with a cell density of around 10^7 to provide bio-P. Moreover, Minia Potassein, a biofertilizer for bio-K, consists of actinomestat bacteria with a cell density of approximately 10^7. All these biofertilizers were sourced from the Laboratory of Biofertilizers at Minia University in Egypt and were applied at a rate of 10 milliliters per vine. Following the application of mineral fertilizer for a week, the respective biofertilizers were added, and irrigation commenced immediately.

2.1. Data recorded

Harvesting occurred when the TSS/acidity ratio in the berries of the control treatment reached a minimum of 25:1 (in July during the two seasons) as stated by **Weaver (1976)**. The yield of each vine was documented in terms of the number and weight (kg) of clusters per vine, and then the average cluster weight was recorded (g). Additionally, berry quality was assessed by randomly selecting five clusters from each vine to determine the physical and chemical characteristics of the berries, including cluster dimensions, average berry weight, total soluble solids, total sugars, titratable acidity, and the ratio between total soluble solids and acid in the juice.

1. Cluster characteristics:

1. Cluster number/vine.
2. Average cluster weight (kg).
3. Yield per vine (kg).
4. Yield per fed. (ton).

2. Berry quality traits:

1. Total soluble solids percentage (TSS%) in berry juice using hand refractometer.
2. Titratable acidity percentage (TA%), using phenolphthalein indicator method as outlined by A.O.A.C. (2000).
3. TSS/acidity ratio (calculated).
4. Total sugars (%) in the berry juice was measured using Lane and Eynon (1965) method as outlined by A.O.A.C. (2000).

2.2. Statistical analysis

Data were tabulated and statistically analyzed using L.S.D. at 5% as described by Snedecor and Cochran (1967) and Mead *et al*. (1993).

3. RESULTS AND DISCUSSION

3.1. Yield and its components

Data shown in Tables (3 to 6) observed the response of Superior seedless grape yield and its components (cluster number/vine, cluster weight yield/vine, and yield/fed) to organic, mineral and biofertilization in both seasons.

Supplying grapevines with compost significantly increased cluster characteristics and yield. The best values of Superior seedless grapevine yield and its components (cluster number/vine, cluster weight, yield/vine, and yield/fed) were obtained with the treatment of (compost + compost tea).

Table 3. Effect of compost, mineral NPK and bio-fertilizers combination treatments on cluster number/vine of Superior Seedless grapevines in the two growing seasons (2020/2021 and 2021/2022).

Mineral and/or bio-fertilizers (B)	Compost treatments (A)				
	Control	Compost	Compost tea	Compost + Compost tea	Mean (B)
			The 1st season (2020/2021)		
Control (Mineral NPK)	25.33	28.00	26.00	31.00	27.58
Min PK + bio-N	28.33	27.67	27.67	31.67	28.84
Min- PK + bio- N	28.67	29.00	29.00	32.00	29.67
Min- NK + bio- P	27.67	29.33	27.33	33.67	29.50
Min- NP + bio- K	28.33	26.33	28.67	30.00	28.33
Min- N + bio- PK	25.67	23.67	26.33	28.00	25.92
Min- P + bio- NK	26.33	26.33	30.33	29.00	28.00
Min- K + bio- NP	22.67	25.33	24.00	28.33	25.08
Mean (A)	26.63	26.96	27.42	30.46	
L.S.D. at 5 %	A: 0.89		B: 0.45	AB: 0.78	
			The 2nd season (2021/2022)		
Control (Mineral NPK)	27.33	23.33	28.33	31.00	27.50
Min- PK + bio- N	27.00	27.67	27.00	31.00	28.17
Min- NK + bio- P	26.67	30.33	28.67	30.00	28.92
Min- NP + bio- K	26.67	29.00	27.33	29.67	28.17
Min- N + bio- PK	25.33	27.67	28.33	29.00	27.58
Min- P + bio- NK	25.33	28.67	28.00	28.00	27.50
Min- K + bio- NP	27.33	25.33	28.00	31.00	27.92
Bio- NPK	26.33	26.67	26.33	29.00	27.08
Mean (A)	26.50	27.33	27.75	29.83	
L.S.D. at 5 %	A: 0.95		B: 0.49	AB: 0.85	

Min- NPK: mineral N, P and K.
Min N + bio-P&K: mineral N plus biofertilizer P and K.
Min P + bio-N&K: mineral P plus biofertilizer N and K.
Min K + bio-N&P: mineral K plus biofertilizer N and P.
Min PK + bio-N: mineral P and K plus biofertilizer N.
Min NK + bio-P: mineral N and K plus biofertilizer P.
Min NP + bio-K: mineral N and P plus biofertilizer K.
Bio- NPK: biofertilizer N, P and K.

The improvements of yield and its components due to organic fertilization were emphasized by El-Mamlouk *et al*. (2016) on Superior seedless grapevines; Al-Wasfy *et al*. (2006) on Roumi Red grapevines; Seleem and Abd El-Hameed (2009) and El-Mahdy *et al*. (2017) on Thompson seedless grapevine and Hassan and Salem (2020) on Flame seedless grapevines.

With regard to the impact of mineral and/or biofertilization on yield and its components of Superior seedless grapevines, it could be seen from the same tables that cluster number/vine, cluster weight, yield/vine, and yield/fed were influenced by mineral and bio fertilization in both seasons. The best values were achieved with the treatment of (Min- NK + bio- P). Such superior treatment produced highest values in number of cluster (29.67 and 28.92), the heaviest cluster weight (513.4 and 601.5 g), the heaviest yield/vine (13.54 and 17.40 kg) and the heaviest yield/fed (10.66 and 12.18 ton). On the other hand, plants treated with NPK in bio-form showed the lowest values during both seasons in this regard.

Many authors proved the valuable influences of mineral NPK fertilization on grapevines yield such as Ahmed and Mohamed (2018) and El-Salhy et al. (2023) on Superior seedless grapevine; Abbas et al. (2007) on Flame seedless grape; Mostafa et al. (2008) on Thompson seedless grape; Ahmed et al. (2016) on Early Sweet grapevines and Dosoky et al. (2021) on Crimson seedless grapevine.

Table 4. Effect of compost, mineral NPK and bio-fertilizers combination treatments on average cluster weight (g) of Superior Seedless grapevines in the two growing seasons (2020/2021 and 2021/2022).

Mineral and/or bio-fertilizers (B)	Compost treatments (A)				
	Control	Compost	Compost tea	Compost + Compost tea	Mean (B)
The 1st season (2020/2021)					
Control (Mineral NPK)	318.0	333.7	366.0	395.0	353.2
Min- PK + bio- N	362.3	336.0	354.3	374.7	356.8
Min- NK + bio- P	491.7	510.7	548.7	502.3	513.4
Min- NP + bio- K	476.3	477.7	457.7	429.7	460.4
Min- N + bio- PK	459.7	473.3	451.3	444.7	457.3
Min- P + bio- NK	452.0	465.0	411.7	386.0	428.7
Min- K + bio- NP	367.7	380.3	490.3	541.7	445.0
Bio- NPK	350.7	367.0	316.3	330.3	341.1
Mean (A)	409.8	418.0	424.5	425.6	
L.S.D. at 5 %	A: 6.17		B: 4.24		AB: 7.34
The 2nd season (2021/2022)					
Control (Mineral NPK)	342.3	329.7	358.0	436.0	366.50
Min- PK + bio- N	403.0	412.0	357.7	394.3	391.75
Min- NK + bio- P	574.0	583.3	659.3	589.3	601.48
Min- NP + bio- K	520.7	533.7	627.3	585.3	566.75
Min- N + bio- PK	541.0	551.3	559.3	576.3	556.98
Min- P + bio- NK	474.7	484.7	450.7	519.0	482.28
Min- K + bio- NP	494.0	504.0	516.7	493.3	502.00
Bio- NPK	347.7	354.7	358.3	338.3	349.75
Mean (A)	462.18	469.18	485.91	491.48	
L.S.D. at 5 %	A: 6.83		B: 4.65		AB: 8.05

Min- NPK: mineral N, P and K.
Min PK + bio-N: mineral P and K plus biofertilizer N.
Min N + bio-P&K: mineral N plus biofertilizer P and K.
Min NK + bio-P: mineral N and K plus biofertilizer P.
Min P + bio-N&K: mineral P plus biofertilizer N and K.
Min NP + bio-K: mineral N and P plus biofertilizer K.
Min K + bio-N&P: mineral K plus biofertilizer N and P.
Bio- NPK: biofertilizer N, P and K.

Closed to our results those obtained by El-Boray *et al*. (2015), Ahmed *et al*. (2017) and Abd El-Rahman and Bakr (2022) on Superior seedless grape; Abd El-Hameed and Rubeea (2005) on Red Roomy grapevines; Hamed (2002) and El-Abbasy *et al*. (2013) on Thompson Seedless grape; Rizk-Alla (2006), Mostafa (2008), Masoud (2012) and Mohyeldein *et al*. (2019) on Flame Seedless grapevine and Refaai and Soltan (2023) on Early sweet vineyards who established that the yield of grapevine increased as a result to biofertilization treatments.

The impact of the combinations between organic, mineral and/or bio fertilization was substantial for grape yield (cluster number/vine, cluster weight, yield/vine, and yield/fed) during both seasons, facing control treatment. In most cases, the interaction treatment [(compost + compost tea) + (Min- NK + bio-P)] produced the best values in this concern.

3.2. Berry chemical quality

Tables 7 to 10 presented the findings of the study on the impact of organic, mineral, and biofertilization on the quality of Superior seedless grapes. The study focused on various factors such as total soluble solids percentage (TSS%), titratable acidity percentage (TA%), TSS/TA ratio, and total sugars (%) in both seasons.

Supplying grapevines with compost notable augmented TSS% of berry juice in both seasons relative to check treatment. The most optimal values (18.3 and 19.1%) of Superior seedless grape TSS% during both seasons were achieved by utilizing a combination of compost + compost tea.

Table 5. Effect of compost, mineral NPK and bio-fertilizers combination treatments on yield/vine (kg) of Superior Seedless grapevines in the two growing seasons (2020/2021 and 2021/2022).

Mineral and/or bio-fertilizers (B)	Compost treatments (A)				
	Control	Compost	Compost tea	Compost + Compost tea	Mean (B)
			The 1st season (2020/2021)		
Control (Mineral NPK)	8.05	9.34	9.52	12.25	9.79
Min- PK + bio- N	10.26	9.30	9.80	11.87	10.31
Min- NK + bio- P	14.10	14.81	15.91	16.07	15.22
Min- NP + bio- K	13.18	14.01	12.51	14.47	13.54
Min- N + bio- PK	13.02	12.46	12.94	13.34	12.94
Min- P + bio- NK	11.60	11.01	10.84	10.81	11.06
Min- K + bio- NP	9.68	10.01	14.87	15.71	12.57
Bio- NPK	7.95	9.30	7.59	9.36	8.55
Mean (A)	10.98	11.28	11.75	12.98	
L.S.D. at 5 %	A: 0.59		B: 0.34		AB: 0.59
			The 2nd season (2021/2022)		
Control (Mineral NPK)	9.36	7.69	10.14	13.52	10.18
Min- PK + bio- N	10.88	11.40	9.66	12.22	11.04
Min- NK + bio- P	15.31	17.69	18.90	17.68	17.40
Min- NP + bio- K	13.89	15.48	17.14	17.37	15.97
Min- N + bio- PK	13.70	15.25	15.84	16.71	15.38
Min- P + bio- NK	12.02	13.90	12.62	14.53	13.27
Min- K + bio- NP	13.50	12.77	14.47	15.29	14.01
Bio- NPK	9.15	9.46	9.43	9.81	9.46
Mean (A)	12.23	12.95	13.53	14.64	
L.S.D. at 5 %	A: 0.62		B: 0.37		AB: 0.64

Min- NPK: mineral N, P and K.
Min PK + bio-N: mineral P and K plus biofertilizer N.
Min N + bio-P&K: mineral N plus biofertilizer P and K.
Min NK + bio-P: mineral N and K plus biofertilizer P.
Min P + bio-N&K: mineral P plus biofertilizer N and K.
Min NP + bio-K: mineral N and P plus biofertilizer K.
Min K + bio-N&P: mineral K plus biofertilizer N and P.
Bio- NPK: biofertilizer N, P and K.

On contrast, TA% was declined due to organic fertilization treatments in the two growing seasons. The greatest reduction (best quality) was achieved with compost + compost tea treatment. Similar to the response of TSS% to organic fertilizers, the TSS/TA ratio follows the same pattern as it increased with organic treatments compared to control.

The TSS/TA ratio saw an increase of 5.81, 8.02, and 13.68% with compost, compost tea, and a combination of both, respectively, compared to the control in the first season. In the subsequent season, the ratios rose by 8.39, 12.29, and 23.49% for the same treatments over the control. With regard total sugars (%) in berry juice, it takes the same trend of TA (%) response, as it was reduced by organic fertilizers facing untreated treatment.

The application of compost treatments led to an improvement in the quality of the juice (decline in sugar %). This improvement was reflected in the percentage of total sugars, which showed decreases of 6.55%, 11.21%, and 11.50% for compost, compost tea, and a combination of compost and compost tea, respectively, in comparison to the control during the first season. Similarly, during the second season, the percentages of total sugars were 7.29%, 9.60%, and 13.28% lower for compost, compost tea, and the combination of both treatments, relative to the control group.

El-Mamlouk *et al*. (2016) and Ahmed and Mohamed (2018) on Superior seedless grape; Al-Wasfy *et al*. (2006) on Roumi Red grape; Abbas *et al*. (2007), Bondok *et al*. (2007), Hassan and Salem (2020) and El-Salhy *et al*.

Table 6. Effect of compost, mineral NPK and bio-fertilizers combination treatments on yield/fed. (ton) of Superior Seedless grapevines in the two growing seasons (2020/2021 and 2021/2022).

Mineral and/or bio-fertilizers (B)	Compost treatments (A)				
	Control	Compost	Compost tea	Compost + Compost tea	Mean (B)
			The 1st season (2020/2021)		
Control (Mineral NPK)	5.64	6.54	6.66	8.57	6.85
Min- PK + bio- N	7.18	6.51	6.86	8.31	7.22
Min- NK + bio- P	9.87	10.37	11.14	11.25	10.66
Min- NP + bio- K	9.23	9.81	8.76	10.13	9.48
Min- N + bio- PK	9.12	8.72	9.06	9.34	9.06
Min- P + bio- NK	8.12	7.70	7.59	7.57	7.75
Min- K + bio- NP	6.78	7.01	10.41	11.00	8.80
Bio- NPK	5.57	6.51	5.31	6.55	5.98
Mean (A)	7.69	7.90	8.22	9.09	
L.S.D. at 5 %	A: 0.33		B: 0.19		AB: 0.33
			The 2nd season (2021/2022)		
Control (Mineral NPK)	6.55	5.38	7.10	9.46	7.12
Min- PK + bio- N	7.62	7.98	6.76	8.56	7.73
Min- NK + bio- P	10.72	12.38	13.23	12.38	12.18
Min- NP + bio- K	9.72	10.83	12.00	12.16	11.18
Min- N + bio- PK	9.59	10.68	11.09	11.70	10.77
Min- P + bio- NK	8.42	9.73	8.83	10.17	9.29
Min- K + bio- NP	9.45	8.94	10.13	10.70	9.80
Bio- NPK	6.41	6.62	6.60	6.87	6.63
Mean (A)	8.56	9.07	9.47	10.25	
L.S.D. at 5 %	A: 0.35		B: 0.22		AB: 0.38

Min- NPK: mineral N, P and K.
Min PK + bio-N: mineral P and K plus biofertilizer N.
Min N + bio-P&K: mineral N plus biofertilizer P and K.
Min NK + bio-P: mineral N and K plus biofertilizer P.
Min P + bio-N&K: mineral P plus biofertilizer N and K.
Min NP + bio-K: mineral N and P plus biofertilizer K.
Min K + bio-N&P: mineral K plus biofertilizer N and P.
Bio- NPK: biofertilizer N, P and K.

(2021) on Flame seedless grape; Seleem and Abd El-Hameed (2009) and El-Mahdy *et al.* (2017) on Thompson seedless grape highlighted the enhancements in berry quality resulting from the use of organic fertilizers.

The influence of mineral and/or biofertilization on berry quality was evident when examining the data presented in Tables (7-10), showing that various aspects were affected by these fertilization methods in both seasons. The total soluble solids percentage exhibited significant enhancement due to various mineral and biofertilization treatments during both seasons (Table 7). The combination of mineral potassium with bio-NP yielded the highest TSS%. This particular treatment resulted in a remarkable increase in TSS% with values of 19.28% and 26.11% during the first season, and 17.61% and 26.99% during the second season over mineral-NPK and bio-NPK, respectively. On contrast, the lowermost values of TSS% (15.7 and 16.3%) in both seasons were recorded with the treatment of bio-NPK.

The incorporation of biofertilizers alongside mineral fertilizers resulted in a noticeable reduction in TA% of berry juice compared to using mineral or bio NPK independently (Table 8). Across both seasons, the combination of mineral and biofertilization led to notably lower Juice TA% levels. The highest TA% values (0.68 and 0.65%) were observed when using mineral NPK alone in both seasons, which is considered less favorable. Conversely, the lowest TA% values (0.57 and 0.51%), good quality, were achieved through the application of (Min-K + Bio-NP) in both seasons.

Table 7. Effect of compost, mineral NPK and bio-fertilizers combination treatments on TSS (%) of Superior Seedless grapevines in the two growing seasons (2020/2021 and 2021/2022).

Mineral and/or bio-fertilizers (B)	Compost treatments (A)				
	Control	Compost	Compost tea	Compost + Compost tea	Mean (B)
The 1st season (2020/2021)					
Control (Mineral NPK)	15.6	16.4	16.9	17.5	16.6
Min- PK + bio- N	15.7	17.4	17.7	17.2	17.0
Min- NK + bio- P	17.4	16.7	17.0	16.8	17.0
Min- NP + bio- K	17.8	18.1	18.5	19.8	18.6
Min- N + bio- PK	19.1	18.2	18.6	19.7	18.9
Min- P + bio- NK	18.4	18.4	18.8	18.7	18.6
Min- K + bio- NP	19.2	19.4	19.5	20.9	19.8
Bio- NPK	15.0	15.9	15.9	16.0	15.7
Mean (A)	17.3	17.6	17.9	18.3	
L.S.D. at 5 %	A: 0.16		B: 0.12		AB: 0.21
The 2nd season (2021/2022)					
Control (Mineral NPK)	16.7	17.2	17.8	18.7	17.6
Min- PK + bio- N	16.4	17.9	18.2	17.6	17.5
Min- NK + bio- P	17.5	18.6	17.8	18.0	18.0
Min- NP + bio- K	18.5	18.5	18.8	20.2	19.0
Min- N + bio- PK	19.0	20.7	19.3	20.3	19.8
Min- P + bio- NK	18.2	18.4	18.6	19.4	18.7
Min- K + bio- NP	20.1	20.4	20.6	21.7	20.7
Bio- NPK	15.2	15.8	17.2	16.9	16.3
Mean (A)	17.7	18.4	18.5	19.1	
L.S.D. at 5 %	A: 0.20		B: 0.15		AB: 0.26

Min- NPK: mineral N, P and K.
Min N + bio-P&K: mineral N plus biofertilizer P and K.
Min P + bio-N&K: mineral P plus biofertilizer N and K.
Min K + bio-N&P: mineral K plus biofertilizer N and P.
Min PK + bio-N: mineral P and K plus biofertilizer N.
Min NK + bio-P: mineral N and K plus biofertilizer P.
Min NP + bio-K: mineral N and P plus biofertilizer K.
Bio- NPK: biofertilizer N, P and K.

Data in Table (9) reflected that the application of mineral and/or biofertilization treatments led to a pronounced increase in the TSS/TA ratio of Superior Seedless grapes compared to the control treatment (Min-NPK) in both seasons, with the exception of the Bio-NPK treatment which showed a decrease in ratio. The treatment combining mineral potassium with bio-NP resulted in the highest TSS/TA ratio values. Furthermore, the combination of mineral potassium with bio-nitrogen and phosphorus resulted in a substantial augment in the TSS/TA ratio compared to both mineral-NPK and bio-NPK treatments, with percentage increases ranging from 36.26% and 49.72% in 1st season to 45.79 and 61.91% across the second seasons, respectively.

The utilization of biofertilizers in conjunction with mineral fertilizers resulted in a noticeable reduction in the total sugars (%) of berry juice when compared to the use of mineral or bio NPK alone (Table 10). The combination of mineral and biofertilization causes significantly lower total sugar (%) in both seasons. The treatment of (Min- K + Bio- NP) yielded the best quality with recorded values of 14.30 and 14.80 in both seasons, respectively, while the treatment of mineral NPK produced the highest values (17.93 and 17.83%) in both seasons, which is not the preferred outcome.

Min-K was more effective than mineral N or P in berry quality. This reflects the important role of potassium in transporting the metabolic products of photosynthesis from leaves to storage areas in berries.

Table 8. Effect of compost, mineral NPK and bio-fertilizers combination treatments on titratable acidity (%) of Superior Seedless grapevines in the two growing seasons (2020/2021 and 2021/2022).

Mineral and/or bio-fertilizers (B)	Compost treatments (A)				
	Control	Compost	Compost tea	Compost + Compost tea	Mean (B)
The 1st season (2020/2021)					
Control (Mineral NPK)	0.72	0.64	0.63	0.64	0.66
Min- PK + bio- N	0.63	0.61	0.64	0.61	0.62
Min- NK + bio- P	0.68	0.66	0.62	0.61	0.64
Min- NP + bio- K	0.63	0.62	0.61	0.59	0.61
Min- N + bio- PK	0.62	0.60	0.61	0.60	0.61
Min- P + bio- NK	0.62	0.60	0.65	0.62	0.62
Min- K + bio- NP	0.60	0.58	0.56	0.55	0.57
Bio- NPK	0.73	0.70	0.66	0.64	0.68
Mean (A)	0.66	0.63	0.62	0.61	
L.S.D. at 5 %	A: 0.08		B: 0.03		AB: 0.05
The 2nd season (2021/2022)					
Control (Mineral NPK)	0.68	0.62	0.63	0.60	0.63
Min- PK + bio- N	0.61	0.59	0.61	0.53	0.59
Min- NK + bio- P	0.66	0.64	0.59	0.54	0.61
Min- NP + bio- K	0.57	0.56	0.55	0.51	0.55
Min- N + bio- PK	0.55	0.53	0.52	0.49	0.52
Min- P + bio- NK	0.62	0.59	0.55	0.52	0.57
Min- K + bio- NP	0.54	0.52	0.50	0.48	0.51
Bio- NPK	0.69	0.67	0.62	0.62	0.65
Mean (A)	0.62	0.59	0.57	0.54	
L.S.D. at 5 %	A: 0.09		B: 0.04		AB: 0.07

Min- NPK: mineral N, P and K.
Min N + bio-P&K: mineral N plus biofertilizer P and K.
Min P + bio-N&K: mineral P plus biofertilizer N and K.
Min K + bio-N&P: mineral K plus biofertilizer N and P.
Min PK + bio-N: mineral P and K plus biofertilizer N.
Min NK + bio-P: mineral N and K plus biofertilizer P.
Min NP + bio-K: mineral N and P plus biofertilizer K.
Bio- NPK: biofertilizer N, P and K.

It has been clearly demonstrated that mineral NPK plays a positively pronounced role in the Total Soluble Solids percentage of berry juice (El-Sayed, 2014 and Abd Ollrady *et al*., 2019 on Superior seedless grape; Mostafa *et al*., 2008 on Thompson Seedless grape; Ahmed *et al*., 2016 on Early sweet grape and El-Katawy *et al*., 2016 on Flame seedless grape).

The supportive role of biofertilization on berry quality was noted by Abd El-Aal *et al*. (2013), Ahmed *et al*. (2017), and Abd El-Rahman and Bakr (2022) on Superior seedless grape; El-Salhy *et al*. (2017) on Thompson Seedless grape; Mohyeldein *et al*. (2019) on Flame Seedless grapevine; and Refaai and Soltan (2023) on Early sweet vineyards.

The grape quality (TSS%, TA%, TSS/TA ratio and sugar%) was significantly affected by the combinations of organic, mineral, and/or bio fertilization in both seasons relative to check treatment. In all cases, the combined treatment of compost and compost tea, along with Min-K and bio-NP, resulted in the most favorable values for these parameters.

4. CONCLUSION

On the light of the previous results, can be stated that combination of [(compost + compost tea) + mineral NK + bio P] gave the best results concerning yield and its components.

Table 9. Effect of compost, mineral NPK and bio-fertilizers combination treatments on TSS/acidity ratio of Superior Seedless grapevines in the two growing seasons (2020/2021 and 2021/2022).

Mineral and/or bio-fertilizers (B)	Compost treatments (A)				
	Control	Compost	Compost tea	Compost + Compost tea	Mean (B)
			The 1st season (2020/2021)		
Control (Mineral NPK)	21.67	25.63	26.83	27.34	25.37
Min- PK + bio- N	24.92	28.52	27.66	28.20	27.32
Min- NK + bio- P	25.59	25.30	27.42	27.54	26.46
Min- NP + bio- K	28.25	29.19	30.33	33.56	30.33
Min- N + bio- PK	30.81	30.33	30.49	32.83	31.12
Min- P + bio- NK	29.68	30.67	28.92	30.16	29.86
Min- K + bio- NP	32.00	33.45	34.82	38.00	34.57
Bio- NPK	20.55	22.71	24.09	25.00	23.09
Mean (A)	26.68	28.23	28.82	30.33	
L.S.D. at 5 %	A: 0.89		B: 0.29		AB: 0.50
			The 2nd season (2021/2022)		
Control (Mineral NPK)	24.56	27.74	28.25	31.17	27.93
Min- PK + bio- N	26.89	30.34	29.84	33.21	30.07
Min- NK + bio- P	26.52	29.06	30.17	33.33	29.77
Min- NP + bio- K	32.46	33.04	34.18	39.61	34.82
Min- N + bio- PK	34.55	39.06	37.12	41.43	38.04
Min- P + bio- NK	29.35	31.19	33.82	37.31	32.92
Min- K + bio- NP	37.22	39.23	41.20	45.21	40.72
Bio- NPK	22.03	23.58	27.74	27.26	25.15
Mean (A)	29.20	31.65	32.79	36.06	
L.S.D. at 5 %	A: 0.95		B: 0.35		AB: 0.61

Min- NPK: mineral N, P and K.
Min PK + bio-N: mineral P and K plus biofertilizer N.
Min N + bio-P&K: mineral N plus biofertilizer P and K.
Min NK + bio-P: mineral N and K plus biofertilizer P.
Min P + bio-N&K: mineral P plus biofertilizer N and K.
Min NP + bio-K: mineral N and P plus biofertilizer K.
Min K + bio-N&P: mineral K plus biofertilizer N and P.
Bio- NPK: biofertilizer N, P and K.

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Table 10. Effect of compost, mineral NPK and bio-fertilizers combination treatments on total sugars (%) of Superior Seedless grapevines in the two growing seasons (2020/2021 and 2021/2022).

Mineral and/or bio-fertilizers (B)	Compost treatments (A)				
	Control	Compost	Compost tea	Compost + Compost tea	Mean (B)
			The 1st season (2020/2021)		
Control (Mineral NPK)	19.90	18.20	16.70	16.90	17.93
Min- PK + bio- N	17.80	17.00	16.80	15.70	16.83
Min- NK + bio- P	17.60	16.80	16.10	15.60	16.53
Min- NP + bio- K	16.30	15.30	14.70	15.00	15.33
Min- N + bio- PK	17.20	15.40	15.00	15.20	15.70
Min- P + bio- NK	15.40	14.40	14.10	14.80	14.68
Min- K + bio- NP	14.90	14.40	13.80	13.60	14.18
Bio- NPK	20.00	18.50	16.30	16.30	17.78
Mean (A)	17.39	16.25	15.44	15.39	
L.S.D. at 5 %	A: 0.64		B: 0.26		AB: 0.45
			The 2nd season (2021/2022)		
Control (Mineral NPK)	18.70	17.80	17.50	17.30	17.83
Min- PK + bio- N	17.20	15.90	15.60	14.90	15.90
Min- NK + bio- P	17.70	16.10	15.80	15.90	16.38
Min- NP + bio- K	18.80	17.60	16.20	15.20	16.95
Min- N + bio- PK	18.40	17.50	16.20	15.60	16.93
Min- P + bio- NK	16.40	14.00	15.00	14.20	14.90
Min- K + bio- NP	15.50	15.10	14.60	14.00	14.80
Bio- NPK	18.90	17.30	17.10	15.70	17.25
Mean (A)	17.70	16.41	16.00	15.35	
L.S.D. at 5 %	A: 0.69		B: 0.28		AB: 0.48

Min- NPK: mineral N, P and K.
Min PK + bio-N: mineral P and K plus biofertilizer N.
Min N + bio-P&K: mineral N plus biofertilizer P and K.
Min NK + bio-P: mineral N and K plus biofertilizer P.
Min P + bio-N&K: mineral P plus biofertilizer N and K.
Min NP + bio-K: mineral N and P plus biofertilizer K.
Min K + bio-N&P: mineral K plus biofertilizer N and P.
Bio- NPK: biofertilizer N, P and K.

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الملخص العربي

استجابة محصول وجودة العنب صنف سوبيريور للتسميد العضوي والغير عضوي

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[2]الزراعة العضوية – المعمل المركزي للزراعة العضوية – مركز البحوث الزراعية.

لتقدير تأثير أنواع مختلفة من معاملات الأسمدة، العضوية (الكنترول، والكبوست، و/أو شاي الكمبوست)، وثماني معاملات من التسميد المعدني والحيوي NPK، على إنتاج وجودة العنب صنف سوبيريور، تم إجراء تجربة حقلية في مزرعة خاصة تقع في قرية تلا – مركز المنيا – محافظة المنيا – مصر، خلال الموسمين ٢٠٢٠/٢٠٢١ و ٢٠٢١/٢٠٢٢.

كان تأثير استخدام المعاملات العضوية على إنتاج العنب واضحاً حيث أدى إلى تحسين الكمية والنوعية. من خلال الجمع بين الكمبوست مع شاي الكمبوست، تم تعظيم إنتاجية العنب عديم البذور، صنف سوبيريور، مع زيادات ملحوظة في عدد العناقيد لكل كرمة، ووزن العنقود، والمحصول لكل كرمة، والإنتاجية للفدان. بالإضافة إلى ذلك، ساهمت هذه الطريقة في تحسين جودة حبات العنب، كما يتبين من زيادة النسبة المئوية للجوامد الكلية الذائبة ونسبة الجوامد الكلية الذائبة/الحموضة الكلية، بالإضافة إلى انخفاض النسبة المئوية للحموضة الكلية والنسبة المئوية للسكريات.

تم تحقيق إنتاجية وجودة أفضل للعنب عديم البذور من خلال استخدام الأسمدة المعدنية و/أو الأسمدة الحيوية. حيث أدي الجمع بين النيتروجين والبوتاسيوم المعدني مع الفوسفور الحيوي إلى تحقيق أعلى إنتاجية، بما في ذلك التحسينات في عدد العناقيد لكل كرمة، ووزن العنقود، والمحصول لكل كرمة، والإنتاجية للفدان على مدار الموسمين. بالإضافة إلى ذلك، أظهرت المعاملة التي تتضمن البوتاسيوم المعدني والنيتروجين والفوسفور الحيوي صفات جودة عالية مقارنة بالمعاملات الأخرى.

وكان تأثير التفاعل بين التسميد العضوي والمعدني و/أو الحيوي معنوياً في جميع الصفات المدروسة. وتم الحصول على أفضل محصول ومكوناته من كرمات العنب المسمدة بـ (كمبوست + شاي كمبوست) مع التسميد بـ (النيتروجين والبوتاسيوم المعدني مع الفوسفور الحيوي)، بينما لوحظت أعلى جودة في كرمات العنب المعاملة بـ (كمبوست + شاي كمبوست) مع التسميد بـ (البوتاسيوم المعدني والنيتروجين والفوسفور الحيوي).

الكلمات المفتاحية: الكمبوست، الـ NPK المعدني، التسميد الحيوي، سوبيريور، المحصول، الجودة.