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(Original Article)

Effect of Some Phosphate Fertilizer Sources and Phosphate Solubilizing Microorganisms on Yield and Quality of Flame Seedless Grapes

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Abstract

The present study carried out during 2022 and 2023 seasons to investigate the effect of some phosphate fertilizer sources (superphosphate, triple phosphate, rock phosphate and orthophosphoric acid) either single and/ or in combination with some phosphate- solubilizing microorganisms (phosphorein, vesicular- arbuscular mycorrhizae (VA-M), phosphorein + VA-M, control (un-application on yield, cluster characters and some berry quality attributes of Flame Seedless grapes. There was a clear improvement in yield and berry quality characteristics in response to using the suitable phosphate per vine on four sources, 148.0 g RP, 277.0 g SP, 239.0 g TP and 54.0 ml OPA, in ascending order. On the other hand, the combined inoculation of phosphorein and VA- mycorrhizae had significant increases in yield and quality of berries compared with those of phosphorein or VA- mycorrhizae as single and untreated ones. The combined treatment of phosphate sources and phosphate-solubilizing microorganisms seemed to be more effective than the single one.

The best results for yield and fruit quality on Flame Seedless vine were obtained with a phosphorus fertilizer of 148.0 g rock phosphate plus 10.0 g phosphoric acid plus 10.0 g VA mycorrhiza per vine / year.

Keywords: *Phosphorein, Rock phosphate, Superphosphate, Triple phosphate, Vesicular arbuscular mycorrhizae (VAM).*

Introduction

Egypt ranks the thirty-two positions worldwide for grape production (FAO, 2018). In Egypt, Grapes is considered the third position proceeded only by citrus and mango because of its high net return. The cultivated area devoted for Grapevines estimated by 186404 feddans and fruiting area of 178485 feddans produced 1790734 tons of fruits (Egyptian Ministry of Agriculture and Reclamation Statistics, 2022).

Minia Governorate occupies the second position after Noubaria in grapevine area and production with fruiting area of 20735 fed. and total produced of more than 204140 tons of fruits (9.9 ton/ feddan) Flame Seedless grape cv. is considered a prime and popular grape grown successfully under Egypt conditions in spite of introducing many

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newly seedless grapevines cvs. Nowadays, the small berries of such grapevines cv. substantially reduce the economic value and the efficiency of marketing process.

Phosphorus (P) is the second most limiting nutrient for plants and is taken up by plants in the form of monovalent (H_2PO_4) and divalent (HPO_4) phosphate ions. The availability of phosphate ions is affected by soil pH. Monovalent phosphate ions are available below pH 7 and divalent phosphate ions are available above pH 7. Monovalent ions are the main phosphorus taken up by plants (Salisbury and Ross, 1992). The solubility of phosphorus in soil from triphosphate, superphosphate, orthophosphate and slow-release phosphate fertilizers can be determined by soil type, pH, organic matter and biofertilization. Use various organic fertilizers containing Bacillus megaterium var. Enrichment affects the solubility of phosphorus in soil. Phosphoproteins and VA mycorrhizae are significantly associated with improving phosphate utilization efficiency in plants (Motosugi *et al.*, 2002; Cabrera *et al.*, 2003; Kannaiyan, 2002).

Investigators agreed upon the effectiveness of mineral phosphates with slow-release phosphate fertilizers (rock phosphate) (RP) and phosphate-solubilizing microorganisms (Bacillius megatherium var.) phosphates (phosphoproteins and VA-mycorrhizae) on stimulating and improving yield and berry quality of various grapevines and other related crops (Abd El-Hameed, 2002; El-Naggar, 2004; El-Shenawy and Stino, 2005; Ibrahim, 2009; Ahmed and Abada, 2012; Shaheen *et al.,* 2013; Shaaban, 2014; Dakhly and Abada, 2018).

A study was conducted to study the possibility of using bio fertilizers as a partial alternative to mineral fertilizers in fertilizing seedless Ruby and Roman red grape bushes. The results showed the following. The highest values of pruning wood weight, leaf area and leaf content of nitrogen, phosphorus and potassium were recorded as a result of fertilization with yeast. The highest percentages of tree content of phosphorus were recorded as a result of the ground addition of yeast compared to other fertilizer treatments. Using yeast as a ground addition led to an increase in the number of red Roman grape clusters and thus increased the crowding coefficient. Fertilization with yeast led to an improvement in the characteristics of the berries in terms of increasing the weight of the berries and their content of total dissolved solids and anthocyanins compared to fertilization with the full dose of mineral fertilizers. Masoud A. A. B. *et al* (2011).

The aim of this study was to clear the effect of some phosphate fertilizer different sources and phosphate- solubilizing microorganisms (Phosphorein and VA-mycorrhizae) on yield as well as some physical and chemical characteristics of Flame Seedless grapevines.

Materials and Methods

This study was conducted on 96 vines, 19-year-old of Flame Seedless cultivar planted in a private vineyard in Tanda village, Malawi district, Minia governorate, Egypt, over two consecutive seasons in 2022 and 2023. The soil nature of this vineyard is fertile. A surface irrigation system using Nile water was used. The vine spacing was 2.0 × 3.0 m (700 vines/Feddan). The selected vines (96) were pruned in both seasons during the last week of December. The tenon cutting system was used along with the gable form support method. The vine load for all selected vines was adjusted to 72 eyes/vine (based on 15 fruiting canes × 4 eyes plus 6 spur × 2 eyes).

Analysis the soil was tested at a depth of 0.0 to 30.0 cm and the soil analysis result was as shown in (Table 1) (Chapman and Pratt, 1965).

Table 1. Mechanical, physical and chemical analysis of the tested vineyard soil

Characters	Values	Characters	Values
Sand %	10.2	**Total N%**	0.09
Silt %	12.8	**Available P (olsen ppm)**	4.8
Clay %	77.0	**Available K (ammonium ppm)**	481.0
Texture	Clay	**Fe (ppm)**	3.6
pH (1:2.5 extract)	7.8	**Zn (ppm)**	4.2
EC (1:2.5 extract) (mmhos/ 1 cm 25C)	0.92	**Mn (ppm)**	3.3
O.M. %	1.95	**Cu (ppm)**	0.5
CaCO3%	2.24		

The experiment consisted of two factors, with the first factor being (A) was the following four treatments from application of the recommended rate of phosphate (43 g P_2O_5/ vine/ year) phosphate fertilizer sources.

a1) Application of 277.0 g Superphosphate (SP) / vine/ year

a2) Application of 239.0 g Triple phosphate (TP) / vine/ year

a3) Application of 148.0 g Rock phosphate (RP) / vine/ year

a4) Application of 54.0 ml orthophosphate (OPA) / vine/ year

The second factor (B) consisted of the four treatments from different phosphate – solubilizing microorganisms

b1) Untreated vines.

b2) Application of phosphorein at 10.0 g / vine/ year.

b3) Application of VA- mycorrhize at 10.0 g / vine/ year.

b4) Application of phosphorein and VA – mycorrhize each at 10.0 g / vine/ year.

Each treatment was replicated three times using two vines per replicate. In total, 96 selected vines were included in the study.

The four phosphate fertilizer sources superphosphate (15.5% P_2O_5), triple phosphate (18.0% P_2O_5), rock phosphate (29.0% P_2O_5), and orthophosphoric acid (80% P_2O_5) were applied once during the first week of January in both the 2022 and 2023 seasons. Phosphate-solubilizing microorganisms, including Phosphorein and VA-Mycorrhizae, were added at a rate of 10.0 g per vine, administered once in the last week of February. All phosphate fertilizers were applied in 10 cm-deep holes spaced 50 cm apart around the canopy of each vine. Each of the 96 vines received phosphate (P_2O_5) at a consistent rate of 43.0 g P_2O_5 per vine annually. Standard horticultural practices were carried out throughout the study as usual.

Randomized Complete Block Design is split – plot arrangement was followed, where four phosphate fertilizer sources treatments (A) and four phosphate – solubilizing microorganism's treatments (B) were occupied eh main and sub- plots, respectively.

Different measurements

Measurement of the yield as well as some physical and chemical properties of berries.

-yield per vine (kg), Number of cluster / vines, weight (g.), length and width of clusters (cm.)

-Berry weight (g) as well as longitudinal and equatorial dimensions (cm)

-Total soluble solids (TSS) percentage

-Reducing sugars percentage (Lane and Eynon, 1965)

-Total acidity percentage (expressed as grams of tartaric acid per 100 ml of juice) (A.O.A.C., 2000)

-TSS to acidity ratio

Statistical analysis was performed using the new Least Significant Difference (L.S.D.) at a 5% significance level to compare the means of the sixteen treatments, as outlined by Mead *et al.* (1993).

Results and Discussion

1. Yield and Cluster Characteristics

Yield expressed in weight and number of cluster/ vine as well as weight, width and length of cluster increased significantly in response to application of different phosphate fertilizer sources namely superphosphate, triple phosphate, Rock phosphate and orthophosphoric acid. The promotive in the yield and cluster characters in response to using of the suitable phosphour per vine on four sources, 148.0 g RP, 277.0 g SP, 239.0g TP and 54.0 mL OPA in ascending order.

Single and combined applications of phosphate solubilizing microorganisms (Phosphorein and VA- mycorrhizae) each at 10.0 g / vine/ year were very effective in enhancing the yield as well as weight, width and length of cluster comparing with un-application. The promotion was associated with application VA- mycorrhizae rather than phosphorein. They were maximized with application of phosphoprein and VA-mycorrhizae together. Treating the vines with 148.0 g Rock phosphate plus phosphate-solubilizing microorganisms (phosphorein and VA- mycorrhizae) each at 10.0 g per vine/year gave the best results with regard to yield and cluster characters. While these treatments had no effect on number of clusters per vine in the first seasons of the study. These results were true during the two experimental seasons (Tables 2, 3 and 4).

The effect of phosphate on increasing the organic nutrients such as carbohydrates and proteins which reflected on improving the nutritional status of the trees as well as their effect on encouraging cell division (Nijjar, 1985) could give a good reason for the enhancing effect of phosphorus on the fruits.

Table 2. Effect of different sources of P and P- solubilizing microorganisms on the number of clusters and the cluster weight (g.) of Flame seedless grapevines during 2022 and 2023 seasons

Different sources of P (A)	Number of clusters per vine									
	P- solubilizing microorganisms (B)									
	2022					2023				
	b_1	b_2	b_3	b_4	Mean (A)	b_1	b_2	b_3	b_4	Mean (A)
a_1	25.0	26.0	26.0	24.0	25.3	25.0	27.0	29.0	30.0	27.8
a_2	24.0	26.0	25.0	26.0	25.3	26.0	28.0	30.0	32.0	29.0
a_3	25.0	26.0	24.0	25.0	25.0	24.0	29.0	31.0	34.0	29.5
a_4	25.0	26.0	26.0	24.0	25.3	27.0	28.0	30.0	33.0	29.5
Mean (B)	24.8	26.0	25.3	24.8		25.5	28.0	30.0	32.3	
New L.S.D. at 5%	A	B		AB		A	B		AB	
	NS	NS		NS		1.1	1.2		2.5	
Different sources of P (A)	Cluster weight (g.)									
	P- solubilizing microorganisms (B)									
	2022					2023				
	b_1	b_2	b_3	b_4	Mean (A)	b_1	b_2	b_3	b_4	Mean (A)
a_1	370.0	377.0	395.0	400.0	385.5	375.0	385.0	400.0	410.0	392.5
a_2	375.0	385.0	400.0	410.0	392.5	380.0	390.0	405.0	415.0	397.5
a_3	360.0	395.0	420.0	440.0	403.8	365.0	400.0	430.0	440.0	408.8
a_4	380.0	395.0	415.0	425.0	403.8	390.0	405.0	425.0	435.0	413.8
Mean (B)	371.3	388.0	407.5	418.8		377.5	395.0	415.0	425.0	
New L.S.D. at 5%	A	B		AB		A	B		AB	
	6.4	6.6		13.5		6.9	7.2		14.5	

A: Different sources of P, B: P- solubilizing microorganisms, AB: Interaction between treatments (A) and treatments (B). a1= 277.0 g superphosphate, b1= control (untreated), a2= 239.0 g Triple phosphate, b2= 10 g phosphorein, a3= 148.0 g Rock phosphate, b3= 10 g VA- mycorrhizae, a4= 54.0 ml orthophosphoric acid and b4= phosphorein plus VAM.

Table 3. Effect of different sources of P and P- solubilizing microorganisms on the yield / vine (kg.) and the cluster width (cm.) of Flame seedless grapevines during 2022 and 2023 seasons.

Different sources of P (A)	The yield per vine (kg.)									
	P- solubilizing microorganisms (B)									
	2022					2023				
	b_1	b_2	b_3	b_4	Mean (A)	b_1	b_2	b_3	b_4	Mean (A)
a_1	9.3	9.8	10.3	9.6	9.8	9.4	10.4	11.6	12.3	10.9
a_2	9.0	10.0	10.0	10.7	9.9	9.9	10.9	12.2	13.3	11.5
a_3	9.0	10.3	10.1	11.0	10.1	8.8	11.6	13.3	14.9	12.1
a_4	9.5	10.3	10.8	10.2	10.2	10.5	11.3	12.8	14.4	12.2
Mean (B)	9.2	10.1	10.3	10.4		9.6	11.1	12.5	13.7	
New L.S.D. at 5%	A	B		AB		A	B		AB	
	0.6	0.8		1.7		0.7	0.9		1.9	
Different sources of P (A)	The cluster width (cm.)									
	P- solubilizing microorganisms (B)									
	2022					2023				
	b_1	b_2	b_3	b_4	Mean (A)	b_1	b_2	b_3	b_4	Mean (A)
a_1	9.4	9.6	10.0	10.2	9.8	9.5	9.8	10.3	10.5	10.0
a_2	9.7	9.9	10.2	10.4	10.1	9.8	10.0	10.5	10.8	10.3
a_3	9.0	10.0	10.5	10.8	10.1	9.2	10.2	10.7	11.0	10.3
a_4	9.8	10.0	10.3	10.7	10.2	10.0	10.1	10.6	10.9	10.4
Mean (B)	9.5	9.9	10.2	10.5		9.6	10.0	10.5	10.8	
New L.S.D. at 5%	A	B		AB		A	B		AB	
	0.3	0.4		0.8		0.4	0.4		0.9	

A: Different sources of P, B: P- solubilizing microorganisms, AB: Interaction between treatments (A) and treatments (B). a1= 277.0 g superphosphate, b1= control (untreated), a2= 239.0 g Triple phosphate, b2= 10 g phosphorein, a3= 148.0 g Rock phosphate, b3= 10 g VA- mycorrhizae, a4= 54.0 ml orthophosphoric acid and b4= phosphorein plus VAM.

Phosphorus element plays an important role in certain essential steps, such as photophosphorylation and release of energy during cellular metabolism. Moreover, it is a compound of many organic compounds, in plants (Russell, 1950), in addition Rock phosphate is a slow release fertilizer which nutrient are released at a slower rate throughout the season, while superphosphate is a soluble material then trees was used it rapidly (Abdel- Mouty and El- Greadly, 2008) phosphorus observed on vineyard by Abd El- Hameed , 2005 ; Ahmed and Abada, 2012, Ibrahim, 2015, Abdel-Aal and Silem, 2018 and Dakhly and Abada, 2018).

2-Some physical and chemical characteristics of the berries

Data in Tables (4 to 7) clearly show that supplying the vines with the recommended rate of phosphate (P_2O_5) $\simeq$ 43.0 g / vine/ year through 277.0 g superphosphate, 239.0 g Triple phosphate, 148.0 g Rock phosphate and 54.0 ml orthophosphate acid significantly was responsible for improving some berries quality namely increasing berry weight, length and diameter of berry, TSS%, reducing sugars and TSS/ acid ratio and reducing total acidity %. The maximum values of some physical and chemical characteristics of the berries were recorded when the vines received the suitable phosphate at 54.0 ml oprthophosphoric acid per vine while application of 148.0 g Rock phosphate per vine produced the minimum values. Application of phosphate – solubilizing microorganisms (phosphorein and VA- mycorrizae) each at 10.0 g per vine year increasing berry weight and dimensions (equatorial and longitudinal), The application of TSS%, reducing sugars %, and the TSS/acid ratio, along with a reduction in total acidity %, was observed in comparison to the control group without treatment. The enhancement in these parameters was linked to the use of VA-mycorrhizae rather than phosphorein alone. However, the combination of phosphorein and VA-mycorrhizae yielded the most favorable outcomes regarding certain berry quality metrics. Optimal results were achieved when the vines received an appropriate phosphate application of 148.0 g of rock phosphate, supplemented with 10.0 g each of phosphorein and VA-mycorrhizae per vine per year.

Phosphorus fertilization is a crucial strategy for enhancing soil fertility and boosting crop yields. It plays a vital role in metabolic processes, flowering, and flower development, as phosphorus is a key component of energy compounds, nucleic acids, phospholipids, nucleotides, and coenzymes (Ahmed *et al.,* 1995; Attia *et al.*, 2002).

These results are concordance with those obtained by (Ibrahim, 2009; Ahmed and Abada, 2012; Shaheen *et al.,* 2013; Shaaban, 2014. Ibrahim, 2015 and Dakhly and Abada, 2018).

Table 4. Effect of different sources of P and P- solubilizing microorganisms on the cluster length (cm) and the average berry weight (g.) of Flame seedless grapevines during 2022 and 2023 seasons.

Different sources of P (A)	The cluster length (cm.)									
	P- solubilizing microorganisms (B)									
	2022					2023				
	b_1	b_2	b_3	b_4	Mean (A)	b_1	b_2	b_3	b_4	Mean (A)
a_1	18.9	19.1	19.6	19.9	19.4	19.0	19.4	19.8	20.3	19.6
a_2	19.2	19.5	20.0	20.5	19.8	19.5	19.9	20.2	21.0	20.2
a_3	18.5	19.8	20.4	22.0	20.2	18.8	20.1	21.0	22.0	20.5
a_4	19.5	19.7	20.3	21.5	20.3	19.8	20.0	20.8	21.5	20.5
Mean (B)	19.0	19.5	20.1	21.0		19.3	19.9	20.5	21.2	
New L.S.D. at 5%	**A**	**B**			**AB**	**A**	**B**			**AB**
	0.5	**0.6**			**1.3**	**0.6**	**0.7**			**1.5**

Different sources of P (A)	The average berry weight (g.)									
	P- solubilizing microorganisms (B)									
	2022					2023				
	b_1	b_2	b_3	b_4	Mean (A)	b_1	b_2	b_3	b_4	Mean (A)
a_1	2.6	2.8	3.0	3.1	2.9	2.7	2.9	3.1	3.2	3.0
a_2	2.7	2.9	3.1	3.2	3.0	2.8	3.0	3.2	3.3	3.1
a_3	2.4	3.1	3.3	3.4	3.1	2.5	3.2	3.4	3.5	3.2
a_4	2.8	3.0	3.2	3.3	3.1	2.9	3.1	3.3	3.4	3.2
Mean (B)	2.6	3.0	3.2	3.3		2.7	3.1	3.3	3.4	
New L.S.D. at 5%	**A**	**B**			**AB**	**A**	**B**			**AB**
	0.2	**0.2**			**0.5**	**0.2**	**0.3**			**0.6**

A: Different sources of P, B: P- solubilizing microorganisms, AB: Interaction between treatments (A) and treatments (B). a1= 277.0 g superphosphate, b1= control (untreated), a2= 239.0 g Triple phosphate, b2= 10 g phosphorein, a3= 148.0 g Rock phosphate, b3= 10 g VA- mycorrhizae, a4= 54.0 ml orthophosphoric acid and b4= phosphorein plus VAM.

Table 5. Effect of different sources of P and P- solubilizing microorganisms on the berry longitudinal and equatorial (cm) of Flame seedless grapevines during 2022 and 2023 seasons.

Different sources of P (A)	The berry longitudinal (cm)									
	P- solubilizing microorganisms (B)									
	2022					2023				
	b_1	b_2	b_3	b_4	Mean (A)	b_1	b_2	b_3	b_4	Mean (A)
a_1	2.00	2.05	2.10	2.15	2.08	2.05	2.11	2.14	2.20	2.13
a_2	2.05	2.11	2.15	2.22	2.13	2.10	2.15	2.20	2.25	2.18
a_3	1.91	2.15	2.20	2.35	2.15	1.95	2.20	2.30	2.40	2.21
a_4	2.11	2.12	2.18	2.30	2.18	2.15	2.18	2.25	2.30	2.22
Mean (B)	2.02	2.11	2.16	2.26		2.06	2.17	2.22	2.29	
New L.S.D. at 5%	**A**	**B**			**AB**	**A**	**B**			**AB**
	0.04	**0.05**			**0.11**	**0.05**	**0.05**			**0.12**

Different sources of P (A)	The berry equatorial (cm.)									
	P- solubilizing microorganisms (B)									
	2022					2023				
	b_1	b_2	b_3	b_4	Mean (A)	b_1	b_2	b_3	b_4	Mean (A)
a_1	1.75	1.80	1.85	1.91	1.83	1.80	1.83	1.91	1.98	1.88
a_2	1.80	1.82	1.88	1.95	1.86	1.82	1.85	1.95	2.00	1.91
a_3	1.70	1.90	1.92	2.00	1.88	1.75	1.94	2.00	2.08	1.94
a_4	1.85	1.88	1.90	1.95	1.90	1.88	1.88	1.98	2.05	1.95
Mean (B)	1.78	1.85	1.89	1.95		1.81	1.88	1.96	2.08	
New L.S.D. at 5%	**A**	**B**			**AB**	**A**	**B**			**AB**

A: Different sources of P, B: P- solubilizing microorganisms, AB: Interaction between treatments (A) and treatments (B). a1= 277.0 g superphosphate, b1= control (untreated), a2= 239.0 g Triple phosphate, b2= 10 g phosphorein, a3= 148.0 g Rock phosphate, b3= 10 g VA- mycorrhizae, a4= 54.0 ml orthophosphoric acid and b4= phosphorein plus VAM.

Table 6. Effect of different sources of P and P- solubilizing microorganisms on berries TSS % and TSS/ acid ratio of Flame seedless grapevines during 2022 and 2023 seasons.

Different sources of P (A)	TSS %									
	P- solubilizing microorganisms (B)									
	2022					2023				
	b_1	b_2	b_3	b_4	Mean (A)	b_1	b_2	b_3	b_4	Mean (A)
a_1	17.5	18.0	18.5	19.5	18.4	17.8	18.5	19.0	20.0	18.8
a_2	18.0	18.4	19.0	20.0	18.9	18.5	19.0	19.5	20.5	19.4
a_3	17.0	19.5	20.0	20.5	19.3	17.5	20.0	20.5	21.0	19.8
a_4	18.2	19.0	19.5	20.2	19.2	18.5	19.5	20.0	20.8	19.7
Mean (B)	17.7	18.7	19.3	20.1		18.1	19.3	19.8	20.6	
New L.S.D. at 5%	**A**	**B**		**AB**		**A**	**B**		**AB**	
	0.4	**0.5**		**1.1**		**0.5**	**0.6**		**1.2**	

Different sources of P (A)	TSS / acid ratio									
	P- solubilizing microorganisms (B)									
	2022					2023				
	b_1	b_2	b_3	b_4	Mean (A)	b_1	b_2	b_3	b_4	Mean (A)
a_1	25.5	26.9	28.2	30.5	27.7	26.2	28.0	29.2	32.0	28.7
a_2	26.9	27.9	29.2	31.7	28.9	27.8	29.2	30.7	33.6	30.3
a_3	24.3	30.0	31.3	33.6	29.7	25.4	31.3	32.8	35.0	31.0
a_4	27.4	29.0	30.2	32.5	29.7	28.0	30.2	31.7	34.3	31.1
Mean (B)	26.0	28.4	29.8	32.2		26.9	29.7	31.2	33.8	
New L.S.D. at 5%	**A**	**B**		**AB**		**A**	**B**		**AB**	
	0.5	**0.6**		**1.3**		**0.6**	**0.7**		**1.5**	

A: Different sources of P, B: P- solubilizing microorganisms, AB: Interaction between treatments (A) and treatments (B). a1= 277.0 g superphosphate, b1= control (untreated), a2= 239.0 g Triple phosphate, b2= 10 g phosphorein, a3= 148.0 g Rock phosphate, b3= 10 g VA- mycorrhizae, a4= 54.0 ml orthophosphoric acid and b4= phosphorein plus VAM.

Table 7. Effect of different sources of P and P- solubilizing microorganisms on Reducing sugars % and total acidity % of Flame seedless grapevines during 2022 and 2023 seasons.

Different sources of P (A)	Reducing sugars %									
	P- solubilizing microorganisms (B)									
	2022					2023				
	b_1	b_2	b_3	b_4	Mean (A)	b_1	b_2	b_3	b_4	Mean (A)
a_1	15.5	16.0	16.5	17.4	16.4	15.6	16.5	17.0	18.0	16.8
a_2	16.0	16.5	17.0	18.0	16.9	16.4	17.0	17.5	18.4	17.3
a_3	15.0	17.4	17.8	18.4	17.2	15.4	18.0	18.5	18.8	17.7
a_4	16.3	17.0	17.5	18.1	17.3	16.5	17.4	18.0	18.5	17.6
Mean (B)	15.7	16.7	17.2	18.0		16.0	17.2	17.8	18.4	
New L.S.D. at 5%	**A**	**B**		**AB**		**A**	**B**		**AB**	
	0.2	**0.2**		**0.5**		**0.2**	**0.3**		**0.6**	

Different sources of P (A)	Total acidity %									
	P- solubilizing microorganisms (B)									
	2022					2023				
	b_1	b_2	b_3	b_4	Mean (A)	b_1	b_2	b_3	b_4	Mean (A)
a_1	0.685	0.670	0.655	0.640	0.663	0.680	0.660	0.650	0.625	0.654
a_2	0.670	0.660	0.650	0.630	0.653	0.665	0.650	0.635	0.610	0.640
a_3	0.700	0.650	0.640	0.610	0.650	0.690	0.640	0.625	0.600	0.639
a_4	0.665	0.655	0.645	0.620	0.646	0.660	0.645	0.630	0.605	0.635
Mean (B)	0.680	0.659	0.648	0.625		0.674	0.649	0.635	0.610	
New L.S.D. at 5%	**A**	**B**		**AB**		**A**	**B**		**AB**	
	0.033	**0.036**		**0.076**		**0.035**	**0.039**		**0.082**	

A: Different sources of P, B: P- solubilizing microorganisms, AB: Interaction between treatments (A) and treatments (B). a1= 277.0 g superphosphate, b1= control (untreated), a2= 239.0 g Triple phosphate, b2= 10 g phosphorein, a3= 148.0 g Rock phosphate, b3= 10 g VA- mycorrhizae, a4= 54.0 ml orthophosphoric acid and b4= phosphorein plus VAM.

Conclusion

To enhance both the quantity and quality of Flame seedless grapevines cultivated in the Minia region, it is recommended to apply 148.0 g of rock phosphate once during the first week of January. Additionally, 10.0 g of phosphorein and 10.0 g of VA-mycorrhizae should be added once in the last week of February.

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تأثير بعض مصادر الأسمدة الفوسفاتية والكائنات الحية الدقيقة المذيبة للفوسفات على إنتاجية وجودة عنب فليم سيدلس

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الملخص

خلال موسمي 2022، 2023 تم تقييم بعض مصادر التسميد الفوسفاتى (سوبر فوسفات والتربل فوسفات وصخر الفوسفات وحامض الفوسفوريك) أضيفت كلا منهما منفرداً أو مع بعض مذيبات الفوسفات (الفوسفورين وفطر الميكروهيزا والفوسفورين + فطر الميكروهيزا - والكنترول بدون معاملة) وتم دراسة تأثيرهما على كمية المحصول وخصائص العنقود وبعض الصفات الطبيعية والكيميائية لجودة حبات العنب الفليم اللابذرى.

كان هناك تحسن واضح في كمية المحصول وخصائص جودة الحبات عند استخدام الكمية الموصي بها من التسميد الفوسفاتى من المصادر الاربعة وهي 148 جرام من صخر الفوسفات أو 277 جرام من السوبر فوسفات او 239 جرام من تربل الفوسفات او 54 مل من حامض الفوسفوريك مرتبة ترتيبا تصاعديا

أدى استخدام مذيبات الفوسفات الى حدوث زيادة معنوية في كمية المحصول وخصائص الجودة للحبات وذلك بالمقارنة مع معاملة الكونترول وكانت أفضل المعاملات هي التلقيح بكلا من مصدري مذيبات الفوسفات معا بمعدل 10 جرام للكرمة في العام لكلا منهما.

التفاعلات بين مصادر الفوسفات ومذيبات الفوسفات كانت أكثر تأثيرا من استخدام كلا منهما منفردا

أمكن الحصول على أفضل النتائج بخصوص المحصول وجودة الحبات في كرمات العنب الفليم سيدلس عند التسميد الفوسفاتى بمعدل 148 جرام من صخر الفوسفات مع 10 جرام من الفوسفورين، 10 جرام من فطر الميكروهيزا وذلك للكرمة الواحدة خلال العام.

الكلمات المفتاحية: *التربل فوسفات، السوبرفوسفات، صخر الفوسفات، الفوسفورين، فطر الميكروهيزا.*