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Maximizing Fruit Quality and Quantity of Flame Seedless cv. Grapevine Using Natural Rocks and Effective Microorganisms

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ABSTRACT

This study was conducted during 2021and 2022 seasons on Five-year-old Flame seedless grapevines to look into the possibilities of employing natural rocks (rock phosphate and feldspar) and effective microorganisms (EM) under different application and concentration, and their combinations to reduce the amount of mineral fertilizers. Trees planted at 2 x 3 meter spacing grown in sandy soil under drip irrigation system. The results indicated that there is a possibility of using rock phosphate and feldspar, with effective microorganisms (EM) as a partial substitute of mineral fertilizers. As this study confirmed the optimum management strategy for attaining the maximum yield, enhancing the cluster's physical and chemical properties, and raising the mineral content of the leaves of Flame seedless grapevines was using the application of natural rocks with efficient microorganisms. Therefore, the most promising treatment to improve the characteristics, both chemical and physical of clusters, and achieve the best yield was ¼ kg rock phosphate plus ½ kg feldspar with 150 ml EM, while the highest leaf minerals content was achieved by ½ kg rock phosphate plus 1 kg feldspar with 300 ml EM.

Keywords: Flame seedless grapevine, Feldspar, rock phosphate, effective microorganisms, yield, fruit quality

1. Introduction

After citrus, grapes (*Vitis vinifera*, L.) are regarded as the second most important crop in Egypt and the world's first deciduous fruit crop. The number of vineyards has been steadily rising, particularly on recently reclaimed territory. Since, the total area of grape in Egypt reached about 112. 851 hectares producing about 1.137.075 tons according to Food and Agriculture Organization (FAO, 2022). Flame seedless is among the most widely used and with high export potential to foreign markets and local consumptions under Egypt conditions. Furthermore, according to Tagliavini and Marangoni (2002), fertilization is one of the most effective ways to boost output, and mineral nutrition is crucial for maximizing fruit yield and quality. Therefore, the main issues facing grape farmers are the high expenses associated with the enormous amounts of synthetic fertilizers required for grapes. In addition, these chemical fertilizers are thought to pollute the air, land, and water during the production and use phases. As a result, it has diverted researchers' and grape producers' attention from using mineral sources to partial replacement with safer fertilizers for people, animals, and the environment. Therefore, in order to prevent pollution and lower the expense of chemical fertilizers, it is preferable to use natural rocks and bio-fertilization. Hence, application of effective microorganisms (EM) as a beneficial soil microbial either alone or combined with natural nutrient sources such as rock phosphate and feldspar rock represent a promising strategy for improving leaf mineral contents, quantity and quality of grape fruit due to the ability of microorganisms to solubilizing phosphate and feldspar rocks in sustainable agriculture.

Recently, bio-fertilization is seen as a useful technique for increasing fruit trees' productivity and quality, and it's starting to take the place of artificial fertilizers. It is safe for both humans and the environment, and using them has helped to produce organic foods for export while also lowering the

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level of environmental contamination (Abdelaal *et al..,* 2010). Effective microorganisms (EM) are a commercial name for a sequence of products founded and developed in 1970's by Teruo Higa, Japanese horticulturist and scientist, and these are microbial inoculants, which are typically available in a liquid suspension made by a spontaneous fermentation process. They contain a broad range of advantageous and nonpathogenic aerobic and anaerobic microorganisms (such as photosynthetic bacteria, lactic acid bacteria, yeast, actinomycetes, and others) (Higa, 2000). These mixtures of advantageous microorganisms can produce useful substances, such as bioactive substances, amino acids, vitamins, sugars, lactic acid, enzymes, and hormones. These substances have a significant and positive impact on the growth and development of plants and their roots, as well as on the availability and uptake of nutrients, the effective microflora in the rhizosphere, the rate at which organic materials decompose, and the suppression of soil-borne diseases (Higa, 2004). It seems that EM's main function is to boost soil microflora biodiversity, which raises agricultural yields. In addition, in particular, phosphorus is essential for the production and translocation of carbohydrates, which are processes that lead to the development of fruits. P deficiency has a negative impact on fruit quality (Yagodin, 1990). So, it is usually least expensive to use natural rock phosphate. Furthermore, data available indicates that rock phosphate may also have potential agronomic value by providing some micronutrients, additionally, zinc and molybdenum, and some secondary nutrients, like calcium and magnesium. This is despite the fact that the phosphorus released from directly applied ground rock phosphate is frequently insufficient to provide enough phosphorus for crop uptake, particularly in alkaline soil (Vassilev *et al.,* 2001).

Potassium is an important element that affects grape quality since it is involved in many metabolic activities, including the synthesis of proteins and carbohydrates, enzyme activation, membrane transport, charge balance, and the production of turgor pressure. Berries with a greater sugar-to-acid ratio are produced in vineyards with optimal potassium levels. Additionally, adding potassium helped to increase the amount of total soluble solids (TSS) in Anab-e-Shahi (Faruqui and Satyanarayana, 1975) and on Thompson seedless (Khandagale, 1977). Potassium levels in feldspar rock range from 10 to 13%, making it difficult to apply directly. The structure of feldspar is aluminum silicate mixed with potassium to form orthoclase ($KAlSi_3O_8$). Since potassium is a slow-releasing fertilizer, it plays a significant role in a plant's ability to withstand environmental challenges, pests, and diseases (Marschner, 1993), additionally, it is necessary for the fruit's development (Marschner, 1995). Potassium influences the quantity and quality of dates (El-Deeb *et al.,* 2000). It does this by activating enzymes involved in sugar production and assisting in the translocation of sugars (Archer, 1988).

To this end, this investigations primary goal is to examine the impact of natural rock materials (rock phosphate and feldspar) as well as effective microorganisms (EM) and their combinations on leaf mineral contents, yield and fruits quality of Flame seedless cv. grapevines.

2. Materials and Methods

The purpose of the grapevine experiment was to assess the effects of beneficial microbes and naturally rocks on the quantity and quality of seedless Flame grape clusters. Over two seasons (2021 and 2022), the study was carried out at a private orchard in Wadi El Natrun city, Beheira governorate, Egypt. Five-year-old grapevines were planted in sandy soil with 2x3 meter spacing between each vine. Table (1) displays the soil's chemical analysis under a drip irrigation method. Table (2) displays the results of the irrigation water analysis. The chosen trees were all of the same shape and were cared for according to conventional horticulture methods.

Table 1: Analyzing the orchard soil's chemical composition.

Parameters	Soluble salts		Cations				anions			
	pH	EC	Ca^{+2}	Mg^{+2}	K^{+}	Na^{+}	HCO_3^{-}	CO_3^{-2}	Cl^{-}	SO_4^{-}
Unit		Ds/m	Meq/L	Meq/L	Meq/L	Meq/L	Meq/L	Meq/L	Meq/L	Meq/L
Sample	8.00	4.89	8.90	4.50	0.92	30.4	3.00	N.D	18.50	23.2

Table 2: Analysis of the orchard well water.

Parameters	pH	EC (micro mos)	Total soluble salts	Ca^{+2}	Mg^{+2}	K^{+}	Na^{+}	HCO_3^{-}	CO_3^{-2}	Cl^{-}	SO_4^{-}
Unit							**(mg/L)**				
Sample	7.68	1032	660	60	24.5	120	4.4	---	160	200	80

Experimental design and treatments

The experiment was designed as a factorial experiment containing two factors in a completely randomized block design (CRBD). The first factor was soil application with natural rocks at three concentrations as follows (0, 0.5, or 1 kg feldspar + 0, 0.25 or 0.5 kg rock phosphate). As for the second factor of the experiment, it was soil application with effective microorganisms (EM) at three concentrations as follows (0, 150 or 300 ml). The interaction between the factors of the study as follow:

1- Without rocks or bacteria (Control)
2- 150 ml EM
3- 300 ml EM
4- 0.25 kg rock phosphate + 0.5 kg feldspar
5- 0.25 kg rock phosphate + 0.5 kg feldspar + 150 ml EM
6- 0.25 kg rock phosphate + 0.5 kg feldspar + 300 ml EM
7- 0.5 kg rock phosphate + 1 kg feldspar
8- 0.5 kg rock phosphate + 1 kg feldspar + 150 ml EM
9- 0.5 kg rock phosphate + 1 kg feldspar + 300 ml EM

Nine treatments (3 x 3) total, with four duplicates of each treatment and one vine representing each replicate were used in the experiment. For mineral fertilization, the Egyptian Ministry of Agriculture suggests utilizing a ratio of 60-30-120 units for potassium sulfate (for K), phosphoric acid (for P), and ammonium nitrate (for N). With the exception of the trees under investigation, where chemical fertilization of potassium and phosphorus was reduced by 25%, all grapevines were treated according to the farm's horticultural program as recommended by the Ministry of Agriculture. Rock phosphate and feldspar obtained from the Al-Ahram Mining Company in Egypt. The effective microorganisms (EM) were obtained from the Agricultural Research Center (Affiliated to Egyptian Ministry of Agriculture), this is a microbial mixture that is sold commercially under the brand name (EM1) and contains a range of advantageous soil bacteria that are good for plant growth and development.

Measurements

Leaf petiole mineral content

Throughout July, leaf petiole samples were taken from mature leaves on the other side of the cluster as well as from all around of the tree. The leaf petioles were dried in a drying oven at 70 °C until her weight stabilizes. After that, the samples were digested using sulfuric and perchloric acids, and the mineral element content was measured as follow:

According to Pregl (1945), the nitrogen content was evaluated using the Kjeldahl method. The phosphorous element was calculated using spectrophotometric techniques (Chapman and Pratt, 1961). Moreover, the Flamephotometric device is used to test potassium in compliance with the protocols outlined by Brown and Lilleland, (1946). The elements iron, zinc, and manganese in leaves were measured using an atomic device (atomic absorption) in accordance with Jackson's (1973) methodology.

Fruit Yield

When the berry juice in the check treatment reached 14–16% brix during harvest time in May. Production per vine (kg): The average cluster number per vine multiplied by the average cluster weight was used to determine it.

Physical characteristics of grapes

After selecting three clusters at random from each vine, the following traits were determined: Cluster weight (g) and berry weight (g), In addition, berry size (cm3), length/diameter ratio of berry. In addition, juice volume of 100g berries (mL).

Chemical characteristics of grapes

A hand refractometer was used to measure the fruit juice's soluble solids content percentage (SSC%).

Juice acid content (%): determined by titrating 100 milliliters of juice (g tartaric acid) against 0.1 NaOH and using phenolphthalein (PhTh) as an indicator (A.O.A.C. 1995).

Soluble solids content / acid ratio (SSC/acid ratio): computed by dividing SSC percentage of by total Juice acidity percentage.

Total phenols (mg/100g fresh weight): The method outlined by Singleton and Rossi (1965) was used to measure the content of phenolic compounds in juice by using Folin- Ciocalteu reagents and sodium carbonate solution, using a spectrophotometer and the findings were presented as a tannic acid equivalent.

Anthocyanin (mg/100g fresh weight): Ethanolic HCL was used to calculate the total anthocyanin pigments in berries, according to Ranganna (1986). A spectrophotometer was then used to measure the absorbance at a wavelength of 535 nm, and the final result was shown as mg/100 g fresh weight.

Statistical Analysis

Utilizing the COSTAT software and the Barkley Co., USA User Manual, Version 3.03, the data was tallied, statistically assessed, and put through a variance analysis in accordance with Gomez and Gomez (1984). The means were compared using Duncan's multiple-range test (Snedecor and Cochran, 1980).

3.Results

Effect of naturally rocks and effective microorganisms (EM) on leaf petiole of macro and micro elements content of Flame seedless cv. grapevine

Macro elements content

Results regarding the effect of naturally rocks (rock phosphate and feldspar) and effective microorganisms (EM) on nitrogen leaf petiole content of Flame seedless cv. during 2021and 2022 seasons as show in Table (3) revealed that there was no significantly differences between different naturally rocks and control treatment in the first season meanwhile in the second one control treatment recorded the lowest one in this respect since it was (1.86%). On the other hand, there was no significantly differences was detect between naturally rocks. As for microorganism (EM) effect control treatment recorded the lowest one in this respect (1.80 and 1.99%) throughout the two study seasons. Conversely, there was no significantly differences between microorganisms (EM) was detect in both seasons of study. As for interaction between naturally rocks (rock phosphate and feldspar) and effective microorganisms (EM) results showed that there were significantly differences between naturally rocks and effective microorganisms (EM). Control treatment (without naturally rocks and effective microorganisms (EM) scored the lowest values in this respect (1.47 and 1.18%) during both seasons of study meanwhile ½ kg rock phosphate + 1kg feldspar 300 ml EM recorded the highest values in this respect (2.16 and 2.84%) in the first and second seasons respectively. Other treatments were in between range.

Concerning the effect of naturally rocks and effective microorganisms (EM) on phosphors leaf petiole content results in the same Table revealed that control treatment (without naturally rocks exhibited the lowest phosphorus content in both studied seasons (0.25 and 0.22%). On other hand, no significantly differences between different naturally rocks in both seasons of study. As for different application of microorganism (EM) the highest values in this respect were obtained when trees were applied with 300 ml EM (0.39 and 0.32%) followed by 150 ml EM (0.33 and 0.27%) meanwhile the lowest value was under control treatment (Without EM) since it was (0.28 and 0.21%) in the first and second seasons respectively. Regarding interaction between naturally rocks (rock phosphate and feldspar) and effective microorganisms (EM) results showed a positivity significant effect on phosphors

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Table 3: Effect of naturally rocks (rock phosphate and feldspar) and effective microorganisms (EM) on leaf petiole of macro elements content of Flame seedless cv. grapevine during 2021 and 2022 seasons.

Treatments	2021				2022			
	Without EM	150 ml EM	300 ml EM	Mean	Without EM	150 ml EM	300 ml EM	Mean
					N%			
Without rock natural	1.47 d	1.96 bc	2.06 ab	**1.83 A**	1.18 f	2.16 e	2.25 de	**1.86 B**
¼ kg rock phosphate + ½kg feldspar	1.86 c	2.06 ab	1.96 bc	**1.96 A**	2.45 c	2.74 ab	2.65 b	**2.61 A**
½ kg rock phosphate + 1kg feldspar	2.06 ab	2.06 ab	2.16 a	**2.09 A**	2.35 cd	2.25 de	2.84 a	**2.48 A**
Mean	**1.80 B'**	**2.03 A'**	**2.06 A'**		**1.99 B'**	**2.38 A'**	**2.58 A'**	
					P%			
Without rock natural	0.19 f	0.27 e	0.30 d	**0.25 B**	0.15 h	0.24 f	0.26 ef	**0.22 B**
¼ kg rock phosphate + ½kg feldspar	0.29 de	0.36 c	0.45 a	**0.37 A**	0.18 g	0.27 de	0.37 a	**0.27 A**
½ kg rock phosphate + 1kg feldspar	0.35 c	0.36 c	0.42 b	**0.38 A**	0.29 cd	0.30 bc	0.32 b	**0.30 A**
Mean	**0.28 C**	**0.33 B**	**0.39 A**		**0.21 C**	**0.27 B**	**0.32 A**	
					K%			
Without rock natural	1.12 f	1.23 de	1.36 bc	**1.24 B**	1.84 e	2.30 c	1.97 d	**2.04 C**
¼ kg rock phosphate + ½kg feldspar	1.22 e	1.47 a	1.41 ab	**1.37 A**	2.08 d	2.57 b	2.57 b	**2.41 B**
½ kg rock phosphate + 1kg feldspar	1.30 cd	1.30 cd	1.38 b	**1.33 AB**	2.24 c	2.65 b	3.02 a	**2.64**
Mean	**1.21 B'**	**1.33 AB'**	**1.38 A'**		**2.05 B'**	**2.51 A'**	**2.52 A**	

In every column, row, or interaction that has a similar letter or letters, the means do not differ significantly at the 5% level.

leaf petiole content The highest values in this respect were obtained when trees were applied with ¼ kg rock phosphate + ½kg feldspar with 300 ml EM since it was (0.35 and 0.37%) during both studied seasons respectively. Meanwhile control treatment (Without naturally rocks and EM) exhibited the lowest one in this respect (0.19 and 0.15%) in the first and second seasons respectively. On the other contrary other treatments were in between range. As regard to the interaction between.

Regarding the effect of naturally rocks and effective microorganisms (EM) on potassium leaf petiole content results in the same Table revealed that the highest potassium content was found when using ¼ kg rock phosphate + ½kg feldspar in the first season (1.37%) meanwhile in the second one using ½ kg rock phosphate + 1kg feldspar recorded the highest value in this respect (2.84%). On the other contrary control treatment (Without rock natural) scored the lowest values in this respect (1.24 and 2.04%) for both seasons of study. With regard to different application of microorganisms (EM) revealed that control treatment gave the lowest values in this respect (1.21 and 2.05%) in the first and second seasons respectively with no significantly differences between other treatments. As regard to the interaction between naturally rocks and effective microorganism's results in the same Table cleared that, control treatment (without naturally rocks and (EM) recorded the lowest values in this respect since it were (1.12 and 1.84%) for both seasons of study meanwhile application ¼ kg rock phosphate + ½kg feldspar with 150 ml EM gave the highest values (1.47%) followed by ½ kg rock phosphate + 1kg feldspar (3.02%) in the first and second seasons respectively. Furthermore, other treatments were in between range

Micro elements content

Results in Table (4) represented the effect of natural rocks and effective microorganisms (EM) on micro elements content of grapevine cv. Flame seedless during 2021and 2022 seasons. As for Zn ppm content results showed that application of **½** kg rock phosphate + 1kg feldspar scored the highest values in this respect (56.70 and 70.27 ppm) in both seasons of study with no significant differences occurred between control treatment (Without natural rock) and ¼ kg rock phosphate + ½ kg feldspar. Regarding effective microorganisms (EM) application results in the same table revealed that there is no significant differences occurred between all different applications of microorganisms (EM) in addition control treatment in the first season. Furthermore, in the second one application of 300 ml EM recorded the highest value in this respect. As regard to the interaction between natural rocks and effective microorganisms (EM) results revealed that application of ½ kg rock phosphate + 1kg feldspar with 300 ml EM gave the highest value in this respect (58.40 and 75.00 ppm) in the first and second seasons respectively. Meanwhile control treatment (without natural rocks and EM) recorded the lowest one in this respect (39.10 and 51.20 ppm) in both seasons of study. Other treatments were in between range.

Concerning the effect of natural rocks on Fe content ppm results in the same table indicated that, the lowest Fe content was found under control treatment (without natural rocks) since it was (59.16 and 59.16 ppm) during both study seasons. Meanwhile application ½ kg rock phosphate + 1 kg feldspar recorded the highest one in this respect (121.21 and 125.03 ppm) in the first and second seasons respectively. As for applications of different concentration of microorganisms (EM) it was clear that control treatment (without EM) recorded the lowest one in this respect (68.88 and 67.72 ppm) in both seasons of study. On the other side, there was no significant differences between (EM) in the first season meanwhile in the second one using 300 ml EM recorded the highest one in this respect (102.69 ppm). Regarding the interaction between natural rocks and effective microorganisms (EM) it can be noticed that, application of ½ kg rock phosphate + 1kg feldspar with 300 ml EM gave the highest values (142.05 and 161.84 ppm) in the first and second seasons respectively. On the other contrary, the lowest values in this respect was found under control treatment (without natural rocks, EM and 150 ml EM) in both seasons of study. Furthermore, other treatments were in between range.

Regarding the effect of natural rocks and microorganisms (EM) on Mn content ppm results in the same Table declared that Mn was significantly affected with different application with natural rocks and microorganisms (EM). As for effect of application of natural rocks it can be concluded that using ¼ kg rock phosphate + ½ kg feldspar gave the highest values (64.43 and 72.21 ppm) during both seasons of study. Meanwhile, the lowest one in the first season was found under control treatment (Without rock natural) since it was (49.58 ppm) meanwhile in the second one no significant differences occurred between treatment (Without natural rock) and using ½ kg rock phosphate + 1kg feldspa**r.** With regard to the effect of microorganisms (EM) application it was found that, using 150 ml EM gave the highest

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Table 4: Effect of naturally rocks (rock phosphate and feldspar) and effective microorganisms (EM) on leaf petiole content of micro elements of Flame seedless cv. grapevine during 2021 and 2022 seasons.

Treatments	2021				2022			
	Without EM	150 ml EM	300 ml EM	Mean	Without EM	150 ml EM	300 ml EM	Mean
				Zn ppm				
Without rock natural	39.10 f	39.50 f	53.30 cd	**43.97 B**	51.20 e	52.60 e	70.20 b	**58.00 B**
¼ kg rock phosphate + ½kg feldspar	45.00 e	45.20 e	52.40 d	**47.53 AB**	51.50 e	59.00 d	62.90 c	**57.80 B**
½ kg rock phosphate + 1kg feldspar	55.40 bc	56.30 ab	58.40 a	**56.70 A**	66.70 b	69.10 b	75.00 a	**70.27 A**
Mean	**46.50 A'**	**47.00 A'**	**54.70 A'**		**56.47 B'**	**60.23 B'**	**69.37 A'**	
				Fe ppm				
Without rock natural	55.92 f	58.00 f	63.56 e	**59.16 C**	53.48 f	56.61 f	67.38 d	**59.16 C**
¼ kg rock phosphate + ½kg feldspar	70.15 d	70.15 d	75.36 c	**71.89 B**	61.47 e	76.75 d	78.84 d	**72.35 B**
½ kg rock phosphate + 1kg feldspar	80.57 b	141.00 a	142.05 a	**121.21 A**	88.21 c	125.03 b	161.84 a	**125.03 A**
Mean	**68.88 B'**	**89.72 A'**	**93.66A'**		**67.72 C'**	**86.13 B'**	**102.69 A,**	
				Mn ppm				
Without rock natural	46.08 g	47.62 g	55.04 de	**49.58 C**	50.96 f	51.71 ef	54.27 de	**52.31 B**
¼ kg rock phosphate + ½kg feldspar	67.33 b	72.96 a	52.99 ef	**64.43 A**	67.87 b	82.18 a	66.59 b	**72.21 A**
½ kg rock phosphate + 1kg feldspar	51.46 f	64.26 c	57.09 d	**57.60 B**	51.71 ef	55.69 d	63.49 c	**56.96 B**
Mean	**54.95 B'**	**61.61 A'**	**55.04 B'**		**56.85 B'**	**64.05 A'**	**60.60 B'**	

In every column, row, or interaction that has a similar letter or letters, the means do not differ significantly at the 5% level.

values in this respect (61.61 and 64.05 ppm) in both seasons. Moreover, there is no significant differences occurred between control and 300 ml EM were detected. As for interaction between natural rocks and microorganisms (EM) using ¼ kg rock phosphate + ½kg feldspar with 150 ml EM recorded the highest values in this respect since it was (72.96 and 82.18 ppm) in the first and second seasons respectively. On the other contrary, the lowest one was found under control treatment (Without EM) it were (46.08 and 50.96 ppm) for both seasons of study. In addition, other treatments were intermediate.

Effect of naturally rocks (rock phosphate and feldspar) and effective microorganisms (EM) on Cluster weight (g) and Yield kg/vin of Flame seedless cv. Grapevine.

Cluster weight

Results in Table (5) represented the effect of natural rocks and effective microorganisms on cluster weight and yield of grapevine cv. Flame seedless during 2021 and 2022 seasons. It was clear that. during 2021, Flame seedless treated with ¼ kg rock phosphate + ½kg feldspar gave the greatest cluster weight (558.53 g) followed by ½ kg rock phosphate + 1kg feldspar which gave (504.87 g). Meanwhile, control treatment without natural rocks came at the last rank (378.55 g). Moreover, different concentrations of microorganisms (150 & 300 ml EM) reflected positively on cluster weight without no significant differences in between as it scored the greatest cluster weight (540.67-501.33g) respectively, compared with control (400,17g) (without EM). Significant interaction was obtained, as Flame seedless treated with both ¼ kg rock phosphate + ½kg feldspar and 150 ml EM significantly increase cluster weight (618.17g).

During 2022, it was obvious that natural rocks significantly increased cluster weight without no significant differences in between compared with control. Meanwhile, there are no significant differences occurred between all microorganism treatments in addition to control. Regarding the interaction, it was clear that, flame seedless treated with both ½ kg rock phosphate + 1kg feldspar and150 ml EM resulted in the greatest cluster weight (654.67g) compared with other treatments.

Yield Kg/vin

It was obvious that, during 2021, natural rocks treatment contains ¼ kg rock phosphate + ½kg feldspar scored the greatest yield (17.95 kg) followed by ½ kg rock phosphate + 1kg feldspar (15.15 kg) compared with control (without rocks 11.35). Meanwhile, all microorganism treatments (150 & 300 ml EM) significantly increased yield of Flame seedless (15.06 & 15.04 kg) without any significant differences in between followed by control (without EM) that recorded (10.81kg). Significant interaction was detected, as Flame seedless treated with both ¼ kg rock phosphate + ½ kg feldspar and 150 EM scored the greatest yield (18.55 kg) compared with other treatments. During 2022 season, all natural rocks treatments significantly increased yield without any significant differences in between (20.58 & 20.00 kg) compared with control scored (17.30 kg). The same trend was obtained during 2022 as no significant differences occurred between all microorganism treatments in addition to control. On the other hand, as for the interaction it can be noticed that, both ¼ kg rock phosphate + ½ kg feldspar and 150 ml of EM significantly increase yield as it scored (22.04 kg) compared with all the studied treatments.

Effect of naturally rocks (rock phosphate and feldspar) and effective microorganisms (EM) on Berry weight (g), Berry size (cm^3) and Length/diameter ratio of berry of Flame seedless cv. Grapevine

Berry weight

Results in Table (6) represent the effect of natural rocks treatments and different concentration of effective microorganisms on berry weight of Flame seedless. It was clear that during 2021, all natural rock treatments increased Berry weight without any significant differences in between (4.90 & 4.69 g) compared with control treatment (3.72g). Moreover, both effective microorganism treatments (150ml & 300 ml) increased significantly berry weight as it scored the greatest berries weight (4.61 & 4.69 g) respectively compared with control treatment (4.00 g). As for the interaction it was clear that, ¼ kg rock phosphate + ½ kg feldspar and 150 ml EM treatment cause a significant increase in berry weight (5.20 g) compared with other treatments. On the other hand, during 2022, it can be noticed that there were no

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Table 5: Effect of naturally rocks (rock phosphate and feldspar) and effective microorganisms (EM) on Cluster weight (g) and Yield kg/vin of Flame seedless cv. grapevine during 2021 and 2022 seasons.

Treatments	2021				2022			
	Without EM	150 ml EM	300 ml EM	Mean	Without EM	150 ml EM	300 ml EM	Mean
					Cluster weight (g)			
Without rock natural	268.33 f	420.00 e	447.33 d	**378.55 C**	517.67 cd	535.33 bc	468.00 e	**507.00 B**
¼ kg rock phosphate + ½kg feldspar	480.00 c	618.17 a	578.33 b	**558.83 A**	599.50 a	495.33 d	538.00 bc	**544.28 AB**
½ kg rock phosphate + 1kg feldspar	452.17 d	583.83 b	478.33 c	**504.78 B**	541.50 bc	654.67 a	557.00 b	**584.39 A**
Mean	**400.17 C'**	**540.67 A'**	**501.33 A'**		**552.89 A'**	**561.78 A'**	**521.00 A'**	
					Yield kg/vin			
Without rock natural	8.04 f	12.60 e	13.42 d	**11.35 C**	16.57 e	16.60 e	18.72 d	**17.30 B**
¼ kg rock phosphate + ½kg feldspar	14.40 c	18.55 a	17.35 b	**17.95 A**	19.78 bc	22.04 a	19.91 bc	**20.58 A**
½ kg rock phosphate + 1kg feldspar	13.57 d	17.52 b	14.35 c	**15.15 B**	19.76 c	20.73 b	19.50 cd	**20.00 A**
Mean	**10.81 B**	**15.06 A**	**15.04 A**		**18.70 A'**	**19.79 A'**	**19.38 A'**	

In every column, row, or interaction that has a similar letter or letters, the means do not differ significantly at the 5% level.

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Table 6: Effect of naturally rocks (rock phosphate and feldspar) and effective microorganisms (EM) on Berry weight (g), Berry size (cm^3) and Length/diameter ratio of berry of Flame seedless cv. grapevine during 2021and 2022 seasons.

Treatments	2021				2022			
	Without EM	150 ml EM	300 ml EM	Mean	Without EM	150 ml EM	300 ml EM	Mean
				Berry weight (g)				
Without rock natural	2.86 f	3.80 e	4.50 d	**3.72 B**	3.76 g	4.22 e	4.37 d	**4.12 A**
¼ kg rock phosphate + ½kg feldspar	4.47 d	5.20 a	5.02 ab	**4.90 A**	3.94 f	4.77 a	4.52 b	**4.41 A**
½ kg rock phosphate + 1kg feldspar	4.68 cd	4.83 bc	4.56 c	**4.69 A**	4.16 e	4.46 bc	4.41 cd	**4.34 A**
Mean	**4.00 B'**	**4.61 A'**	**4.69 A'**		**3.95 A'**	**4.48 A'**	**4.43 A'**	
				Berry size (cm^3)				
Without rock natural	2.67 f	3.65 e	4.40 cd	**3.57 A**	3.53 g	3.98 d	4.10 c	**3.87 A**
¼ kg rock phosphate + ½kg feldspar	4.17 d	5.10 a	4.91 ab	**4.73 A**	3.62 f	4.48 a	4.18 b	**4.09 A**
½ kg rock phosphate + 1kg feldspar	4.33 cd	4.58 bc	4.44 cd	**4.45 A**	3.90 e	4.17 b	4.02 d	**4.03 A**
Mean	**3.72 B'**	**4.44 A'**	**4.58 A'**		**3.68 B'**	**4.21 A'**	**4.10 A'**	
				Length/diameter ratio of berry				
Without rock natural	1.05 a	1.12 a	1.12 a	**1.10 A**	0.97 b	0.98 b	0.99 b	**0.98 A**
¼ kg rock phosphate + ½kg feldspar	1.14 a	1.14 a	1.11 a	**1.13 A**	0.99 b	1.06 a	1.03 ab	**1.03 A**
½ kg rock phosphate + 1kg feldspar	1.12 a	1.10 a	1.07 a	**1.10 A**	1.01 ab	1.03 ab	1.03 ab	**1.02 A**
Mean	**1.10 A'**	**1.12 A'**	**1.10 A'**		**0.99 A'**	**1.02 A'**	**1.02 A'**	

In every column, row, or interaction that has a similar letter or letters, the means do not differ significantly at the 5% level.

significant differences obtained between either natural rocks treatments or microorganism treatments in addition to control. On the other hand, significant interaction was obtained as ¼ kg rock phosphate + ½ kg feldspar and 150 ml EM treatment reflected positively on berry weight (4.77 g) compared with other treatments.

Berry size (cm^3)

As for the effect of natural rocks treatment in the same Table it was clear that, no significant differences were obtained between all treatment in addition to control during both season 2021 and 2022. It can be noticed that all EM treatments (150ml & 300 ml) significantly increased Berry size (4.44 & 4.58 cm^3) without any significant differences in between followed by control treatment (3.72 cm^3) during both seasons 2021 and 2022. Concerning the interaction, it was obvious that, ¼ kg rock phosphate + ½kg feldspar and 150 ml of EM treatment significantly increased berry size as it scored (5.10 & 4.48 cm^3) during both season 2021 and 2022 respectively.

Length/diameter ratio of berry:

Concerning Length/diameter ratio of berry results in the same Table point that, during both seasons 2021 and 2022 it was clear that, no significant differences were obtained between either natural rock treatments or EM in addition to control in terms of Length/diameter ratio of berry. Meanwhile, a significant interaction was detected as ¼ kg rock phosphate + ½kg feldspar and 150 ml EM treatment scored the greatest ratio of Length/diameter (1.14 & 1.06 cm) during both seasons respectively.

Effect of naturally rocks (rock phosphate and feldspar) and effective microorganisms (EM) on Juice volume, Total phenols, and Anthocyanin of Flame seedless cv. grapevine

Juice volume of 100 berries (ml)

Results in Table (7) cleared that, during 2021 season, as for natural rocks treatment it was obvious that, ¼ kg rock phosphate + ½ kg feldspar treatment significantly increased the amount of juice volume (357.22 ml) followed by ½ kg rock phosphate + 1kg feldspar (338.33 ml). It was clear that, treating flame seedless Grapevine with 150 ml of EM scored the greatest amount of juice volume (372.78 ml) followed by 300 ml of EM (322.77 ml). Meanwhile, control treatment came the last rank in this respect (298.33 ml). Significant interaction was obtained as the highest amount of juice volume was detected as a result of treating grapevine cv. Flame seedless with ¼ kg rock phosphate + ½ kg feldspar and150 ml EM treatment (405.76 ml). On the other hand, during 2022 season it can be noticed that no significant differences were obtained between all natural rock treatments in addition to control. All EM concentrations significantly increased juice volume (344.45 & 333.89 ml) respectively, without any significant differences in between compared with control treatment (296.11 ml). The greatest significant amount of juice volume was obtained with ¼ kg rock phosphate + ½ kg feldspar and150 ml EM treatment.

Total phenols (mg/ 100 g f.w)

As for total phenols data revealed that ,during 2021 season, as for the effect of natural rocks it was clear that, no significant differences were obtained between natural rocks treatments in addition to control in terms of total phenols. Although, there is no significant differences obtained between microorganism treatments during 2021 season, the greatest total phenol number was detected with both microorganism treatments (179.30 & 186.54) followed by control (169.47). As for the interaction, it was clear that Flame seedless grapevine treated with ¼ kg rock phosphate + ½kg feldspar and 300 ml of EM treatment resulted in the greatest total phenols number (191.75). During 2022 season, natural rocks treatment significantly affected total phenols without any significant differences in between (281.82 & 260.25) followed by control treatment (245.76). It was clear that no significant differences were obtained between all microorganism concentrations in addition to control. Moreover, as for the interaction, the greatest significant number of total phenols we recorded (305.46) with¼ kg rock phosphate + ½kg feldspar and 150 ml EM treatment.

Table 7: Effect of naturally rocks (rock phosphate and feldspar) and effective microorganisms (EM) on Juice volume, Total phenols, and Anthocyanin of Flame seedless cv. grapevine during 2021 and 2022 seasons.

Treatments	2021				2022			
	Without EM	150 ml EM	300 ml EM	Mean	Without EM	150 ml EM	300 ml EM	Mean
				Juice volume of 100 berries (ml)				
Without rock natural	218.33 e	371.67 b	305.00 d	**298.33 C**	276.67 e	331.67 b	326.67 b	**311.67 A**
¼ kg rock phosphate + ½kg feldspar	361.67 b	406.67 a	303.33 d	**357.22 A**	310.00 c	350.00 a	328.33 b	**329.44 A**
½ kg rock phosphate + 1kg feldspar	315.00 d	340.00 c	360.00 bc	**338.33 B**	301.67 d	351.67 a	346.67 a	**333.34 A**
Mean	**298.33 C**	**372.78 A**	**322.77 B**		**296.11 B**	**344.45 A**	**333.89 A**	
				Total phenols (mg/ 100 g f.w)				
Without rock natural	153.27 e	180.49 c	188.14 b	**173.96 A**	238.02 d	238.58 d	260.69 c	**245.76 B**
¼ kg rock phosphate + ½kg feldspar	166.92 d	188.90 ab	191.75 a	**182.52 A**	258.80 c	305.46 a	281.19 b	**281.82 A**
½ kg rock phosphate + 1kg feldspar	188.23 ab	168.51 d	179.73 c	**178.82 A**	260.89 c	262.38 c	257.47 c	**260.25 A**
Mean	**169.47 B'**	**179.30 AB'**	**186.54 A'**		**252.57 A'**	**268.81 A'**	**266.45 A'**	
				Anthocyanin (mg/ 100 g f.w)				
Without rock natural	5.00 j	6.42 f	8.61 e	**6.68 C**	4.92 g	5.99 f	6.16 e	**5.69 C**
¼ kg rock phosphate + ½kg feldspar	9.30 d	10.04 c	14.32 a	**11.22 B**	4.35 h	6.69 d	8.26 b	**6.43 B**
½ kg rock phosphate + 1kg feldspar	11.43 b	14.27 a	14.45 a	**13.38 A**	7.91 c	8.32 b	8.70 a	**8.31 A**
Mean	**8.58 C'**	**10.24 B'**	**12.46 A'**		**5.73 B'**	**7.00 A'**	**7.71 A'**	

In every column, row, or interaction that has a similar letter or letters, the means do not differ significantly at the 5% level.

Anthocyanin (mg/ 100 g f.w)

Regarding anthocyanin content in the same Table it can be noticed that, during 2021 season, the greatest significant anthocyanin content was obtained with ½ kg rock phosphate + 1kg feldspar (13.38) followed by ¼ kg rock phosphate + ½ kg feldspar treatment (11.22), control treatment came at the last rank in this respect. Results cleared that, 300 ml of EM significantly increased Anthocyanin content of flame seedless grape vine (12.46) followed by 150 ml of EM (10.24) compared with control treatment (8.58). As for the interaction, the greatest significant anthocyanin number (14.45) was obtained with½ kg rock phosphate + 1kg feldspar and 300 ml of EM treatment. During 2022 season it was noticed, natural rock treatment contains ½ kg rock phosphate + 1kg feldspar resulted in the greatest anthocyanin content (8.31) followed by ¼ kg rock phosphate + ½ kg feldspar treatment (6.43) meanwhile, control treatment scored the lowest anthocyanin content (5.69). That all microorganism treatments increased anthocyanin content compared with control treatment however, no significant differences were obtained between them. As for the interaction, the greatest significant anthocyanin content (8.70) was obtained with ½ kg rock phosphate + 1kg feldspar and 300 ml of EM.

Effect of naturally rocks (rock phosphate and feldspar) and effective microorganisms (EM) on SSC%, Juice acid content % and SSC/acidity ratio of Flame seedless cv. grapevine

Soluble solids contents (SSC %)

Results in Table (8) represent the effect of effective microorganisms and the natural rocks on soluble solids contents (SSC %), Juice acid content % and SSC/acidity ratio on flame seedless Grapevine. During 2021 season, it can be noticed that natural rock treatment (¼ kg rock phosphate + ½kg feldspar) surpassed other treatments that scored the greatest significant number of soluble solid content (16.38 %) compared with other treatments. However, no significant differences obtained between the other natural rock (15.09 %) and control treatment (15.14 %). Concerning the effect of effective microorganism (EM), it can be concluded that, using 300 ml of EM resulted in the greatest significant number of soluble solid content (16 .09 %). Meanwhile, no significant differences obtained between the other treatments (150 ml EM and without EM). As for the interaction, it was clear that, flame seedless grape vine received natural rocks treatment of (¼ kg rock phosphate + ½kg feldspar) and 300 ml of EM resulted in the greatest significant percentage of soluble solid content (18.00 %) compared with other treatments. Concerning the second seasons 2022, it can be cleared that, natural rock treatment (¼ kg rock phosphate + ½kg feldspar) resulted in the greatest significant number of soluble solid content % (15.68 %) followed by (14.22 %) for the second natural rock treatment (½ kg rock phosphate + 1kg feldspar). However, no significant differences were obtained between control and the first natural rock treatment. As for the effect of effective microorganisms, it was obvious that no significant differences were obtained between all the studied treatments. Regarding the interaction, the same trend was obtained the greatest significant number of soluble solid content (16.5 %) was obtained by using (¼ kg rock phosphate + ½ kg feldspar) and EM at 300 ml compared with all treatments.

Juice acid content %

It can be concluded that, from the results in the same Table that, natural rock treatment (½ kg rock phosphate + 1kg feldspar) scored the greatest significant juice acid content (0.74 %), however, no significant differences were obtained between the other treatments during the first season of study 2021. Flame seedless grape vine received 300 ml of EM proved to be better than150ml of EM in terms of juice acid content (0.69 & 0.63 %) respectively however, no significant differences obtained between 300 ml of EM and control treatment (without EM). While, no significant interaction was obtained between means of all studied treatments during 2021 season. During 2022 season, it was clear that natural rock reflected positively on juice acid content however no significant differences obtained between them. Meanwhile, no significant differences were obtained between the first natural rock treatment (¼ kg rock phosphate + ½kg feldspar) and control treatment. Moreover, no significant differences were obtained between all effective microorganism treatments compared with control (without EM). Significant interaction was observed during the second season as natural rock treatment contains (½ kg rock phosphate + 1kg feldspar) alone without it any effective microorganisms (without EM) resulted in the greatest significant juice acid content (0.98 %) compared with other treatments.

Table 8: Effect of naturally rocks (rock phosphate and feldspar) and effective microorganisms (EM) on SSC%, Juice acid content % and SSC/acidity ratio of Flame seedless cv. grapevine during 2021 and 2022 seasons.

Treatments	2021				2022			
	Without EM	150 ml EM	300 ml EM	Mean	Without EM	150 ml EM	300 ml EM	Mean
					SSC%			
Without rock natural	16.27 b	14.23 d	14.93 cd	**15.14 B**	13.83 e	15.67 bc	15.67 bc	**15.06 A**
¼ kg rock phosphate + ½kg feldspar	15.50 bc	15.63 bc	18.00 a	**16.38 A**	14.93 d	15.80 b	16.30 a	**15.68 A**
½ kg rock phosphate + 1kg feldspar	14.50 cd	15.33 bcd	15.43 bcd	**15.09 B**	15.33 cd	13.33 f	14.00 e	**14.22 B**
Mean	**15.42 B'**	**15.42 B'**	**16.09 A'**		**14.70 A'**	**14.93 A'**	**15.32 A'**	
					Juice acid content %			
Without rock natural	0.67 a	0.59 a	0.59 a	**0.62 B**	0.85 e	0.88 de	0.93 bc	**0.88 B**
¼ kg rock phosphate + ½kg feldspar	0.58 a	0.63 a	0.67 a	**0.63 B**	0.90 cd	0.91 cd	0.95 ab	**0.92 AB**
½ kg rock phosphate + 1kg feldspar	0.76 a	0.66 a	0.80 a	**0.74 A**	0.98 a	0.92 bc	0.93 bc	**0.94 A**
Mean	**0.67 A'**	**0.63 B'**	**0.69 A'**		**0.91 A'**	**0.90 A'**	**0.93 A'**	
					SSC/acidity ratio			
Without rock natural	24.16 cd	24.27 c	25.31 b	**24.58 B**	16.44 e	17.95 a	16.95 cd	**17.11 A**
¼ kg rock phosphate + ½kg feldspar	26.49 a	24.95 bc	26.87 a	**26.10 A**	16.60 de	17.42 b	17.26 bc	**17.10 A**
½ kg rock phosphate + 1kg feldspar	19.21 e	23.27 d	19.29 e	**20.59 C**	15.73 f	14.59 h	15.16 g	**15.16 B**
Mean	**23.29 B'**	**24.16 A'**	**23.82 A'**		**16.26 A'**	**16.65 A'**	**16.46 A'**	

In every column, row, or interaction that has a similar letter or letters, the means do not differ significantly at the 5% level.

SSC/acidity ratio

Results in the same Table cleared that, natural rocks treatment contains ¼ kg rock phosphate + ½ kg feldspar resulted in the greatest significant ratio of SSC/acidity (26.10) followed by control treatment without any natural rock (24.58), while the second treatment of natural rock came at the last rank in this respect (20.59). Regarding the effect of EM, it was clear that treated flame seedless Grapevine with effective microorganisms reflected positively on SSC/acidity ratio. However, no significant differences were obtained between them (24.16 & 23.82) respectively, followed by control treatment which scored the lost significant ratio of SSC/acidity (23.29). As for the interaction it was obvious that, treatment with natural rock contains ¼ kg rock phosphate + ½ kg feldspar and 300ml of EM resulted in the greatest significant ratio of SSC/acidity during the first season of study 2021. During 2022 it can be noticed that no significant differences obtained between natural rock treatments contains ¼ kg rock phosphate + ½kg feldspar and control treatments (17.10 & 17.11 respectively) followed by treatments contains ½ kg rock phosphate + 1kg feldspar (15.16). Results demonstrated that no significant differences were obtained between all effective microorganism concentrations in addition to control treatment. Significant interaction obtained between all studied treatments as flame seedless grape vine received 150 ml off effective microorganisms (EM) alone without any natural rock treatments resulted in the greatest significant SSC/acidity ratio (17.95).

4. Discussion

The present results, regarding the influence of different natural rocks (rock phosphate and feldspar) and different concentration of effective microorganisms (EM) on the leaf petiole of macro and micro nutrients content of Flame seedless cv. are in accordance with those found by Higa, 1989 and Formowitz *et al.* (2007) on Williams banana crop they reported that , improving macro and micro nutrients content of Flame seedless cv. were ascribed to EM1's beneficial effects on improving soil fertility, nutrient availability, organic matter, root development, organism activity, and N fixation. In additions, the obtained results are in harmony with these of Higa, (2004) who found that, Combinations of advantageous microorganisms can produce useful substances such as bioactive substances, antimicrobial substances, sugars, lactic acid, vitamins, amino acids, and hormones. These substances have a significant and positive impact on root development, nutrient availability, uptake, and the productive microflora in the rhizosphere.

Moreover, the obtained results of EM application regarding their positive effect on the leaf petiole of macro and micro nutrients content were consistent with those of Higa and Wididana, (1991), Formowitz *et al.* (2007) and Ibrahim, (2012), who reported that the beneficial effects of EM on lowering soil pH and increasing water and nutrient uptake, thereby enhancing soil fertility, may be responsible for the enhancement effect of EM on leaf minerals content. Furthermore, the application of EM increased the total number of soil microflora, or the total number of bacteria, actinomyces, and fungi that produce gibberellins, acetic acid, and indole. This increased number of microorganisms led to improved root system growth, which in turn improved nutrient uptake and improved leaf mineral content. In addition the results are in harmony with those reported by Zaghloul (2002), Abou-Hussein *et al.* (2002a and b) and Anwer (2005), they revealed that using EM as a biofertilizer is essential for N2 filiation and for changing P or K form into a soluble form that is ready for plant nutrition, which facilitates easier plant nutrient uptake. The results obtained with respect to the impact of naturally occurring rocks (rock phosphate and feldspar) on leaf mineral content are consistent with the findings of El Sayed *et al.* (2018), who reported that the use of naturally occurring rocks materials as slow release fertilizer for macro elements has become increasingly important due to their long-term conversion into soluble forms of P, K, Ca, and Mg. El Sayed *et al.* (2018) found that high availability and absorption nutrients may be obtained in sandy soil by applying natural P and K rock fertilizers along with P and K bio-fertilizers.

The obtained results are consistent with Nijjar 1985 and El-Nagar (2004) regarding the effects of natural rocks (rock phosphate and feldspar) and effective microorganisms (EM) on fruit yield, physical characteristics, and chemical components of juice. These researchers discovered that the advantages of using these natural resources on yield and its constituents may stem from their ability to supply vines with the nutrients they require over an extended period of time, as well as their ability to increase the availability of nutrients in the soil for plant uptake and improve the nutritional status of the vines, and enhances capacity to fulfill certain micronutrient needs as well. Furthermore, because they include macro and micro ingredients that improve photosynthesis, there is more sugar (glucose) available for fruit ripening and growth (Keller *et al.,* 1998). Moreover, EM significantly enhances crop growth and quality as well as soil fertility and quality. In effect mixed cultures of common microorganisms, including yeasts, lactic acid bacteria, and photosynthetic bacteria, are called microorganisms (Mohan, 2008). They have the ability to coexist with both anaerobic and aerobic microbial species. These are added to soil or plants to promote soil health and plant development, yield, and quality by increasing the microbial diversity of the soil. These findings corroborate those of studies on orange trees by Abdel-Hak *et al.* (2012) and Omar *et al.* (2012), on mandarin trees by El-Khayat and Abdel Rehiem, (2013) and Kumar *et al.* (2013), which also found that the physical characteristics of the fruits were enhanced by the combination of organic and bio-fertilizers.

Regarding the impact of feldspar on fruit quality and yield, our results concur with those of Ali and Taalab, (2008), who stated that feldspar is regarded as a potassium source that is important for promoting enzyme activity and improving the translocation of assimilated sugars, starch, and protein synthesis. Additionally, it promotes root development, strengthens resilience to drought, increases cellulose synthesis, and lessens stresses, all of which raise production and enhance fruit quality. The results regarding the impact of rock phosphate on fruit quality and yield are consistent with Yagodin's (1990) explanation that using rock phosphate as a source of phosphorus, which is important for most metabolic processes, particularly in the biosynthesis and translocation of carbohydrates, as well as growth and health of plants in addition, promotes root, flower and fruit development, it is very important for boosting yield and improves fruit physical and chemical properties.

5. Conclusion

Based on the aforementioned findings, it is possible to replace some of the mineral fertilizers as a partial substitute with various natural rocks and effective microorganisms (EM), such as feldspar and rock phosphate. Nonetheless, this study demonstrated that the most effective management strategy for attaining the maximum yield, enhancing the fruit's physical and chemical properties, and raising the mineral content of the leaves of Flame seedless trees was the application of various natural rocks (such as feldspar and rock phosphate) alone or in combination with effective microorganisms (EM). So, the promising treatment for reaching the maximum yield and enhancing the physical and chemical characteristics was ¼ kg rock phosphate plus ½ kg feldspar with 150 ml EM, while ½ kg rock phosphate plus 1kg feldspar with 300 ml achieving the highest leaf minerals content.

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