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Effect of Organic and Bio-Fertilizers as a Partial Substitute for NPK Mineral Fertilizer on Vegetative Growth, Leaf Mineral Content, Yield and Fruit Quality of Superior Grapevine

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Abstract: This study was carried out during the three consecutive seasons of 2009, 2010 and 2011 in sandy soil at 64 kilometer from Cairo on the desert road to Alexandria on ten years-old "Superior Seedless" grapevines to study the possibility of using the organic and bio fertilization partially instead of completed mineral fertilizers as applied at 25 to 100 % out of the recommended NPK rate. Organic fertilizers (compost) plant residues with two natural rocks, rock phosphate and feldspar were applied with or without biofertilizers (biogen, phosphorin and potassiumag) at 30g/vine. The results indicated that application of 50% (compost, rock phosphate and feldspar) + 50% of the NPK mineral recommended fertilizers N (157 g/vine), P_2O_5 (87 g/vine) and K_2O (112 g/vine) + bio-fertilizer was the best management system for ensuring the best vegetative growth parameters as shoots length, number of leaves/shoot and leaf area and leaf mineral content and achieving the best yield with its components as number of clusters per vine and weight of each individual cluster, improving the physical and chemical characteristics of berries as total soluble solids, total acidity, TSS/acid ratio and total sugars, but reducing nitrate and nitrite content of berries of Superior Seedless grapevines. Therefore, these organic and natural rocks fertilizers in combination with NPK bio-fertilizers can reduce the need for about 50% of NPK mineral fertilizers. In addition, minimized the production cost and the environmental pollution which could be occurred by excess of chemical fertilizers.

Key words: Biofertilizers · Fruit quality · Grapes · Leaf mineral content · Organic fertilizers · Vegetative growth · Yield

INTRODUCTION

Grape (*Vitis vinifera* L.) is considered the first major fruit crop in its production all over the world. In Egypt, grapes rank second among fruit crops while citrus being the first. Superior grapevine cultivar is considered a prime and popular grapevine cultivar, successfully grown under Egypt conditions. It ripens early in the last week of May under sandy soil conditions. In addition, it has a greater potentiality for exportation to foreign markets due to its early ripening and this reduces competition. Mineral fertilizers and other chemicals that commonly used in agricultural production, not only have harmful effects on the environment, but also they can alter the composition of fruits, vegetables and root crops [1]. Nitrogen is one of the major plant nutrients, being a part of protein, enzymes, amino acids, polypeptides and many other biochemical compounds in plant system i.e. encouraging cell division and the development tissue [2]. Phosphorus plays important roles in most metabolic processes particularly biosynthesis and translocation of carbohydrates. It is very important for developing all organic of fruit crops and deficiency of P clearly appeared in terms of decline on the yield and caused an adverse effect on quality of the fruits [3]. Potassium is essential in many plant metabolic processes, it plays many important regulatory roles in development [4].Organic fertilizers instead of mineral fertilizers has become potentially attractive because of the harmful effect and high cost of mineral fertilizers [5]. In addition, the organic materials

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improve soil structure, aeration and retention of moisture and reduce soil pH [6]. Organic fertilization is another option for supplying macro and micro nutrients necessary for plant growth [7]. Organic fertilization increased growth and improved nutritional status of grapevines [8]. Fertilizing various grapevine cultivars with organic manures beside the inorganic nitrogen source was accompanied by improving growth and leaf mineral content as well as yield and berry quality than using ntrogen as an inorganic source only [9,10]. Application of natural rocks (rock phosphate and feldspar) caused the release of macro elements and converted them to soluble form of P, K, Ca and Mg in comparison with the compost without natural rocks [7].

Recently, the biofertilizers became a positive alternative to chemical fertilizers. They are safe for human, animal and environment and using them was accompanied with reducing the pollution occurred in our environment. They may help in improving crop productivity and quality by increasing the biological N fixation, the availability and uptake of nutrients and stimulating the natural hormones [11]. Biofertilizers are the most important for plant production and soil as they play an important role in improving fruit quality and yield grapevines [12]. Phosphorene significantly increased P and K content of leaf petiole while nitrobeine or rhizobacterine increased N of leaf petiole [13]. Phosphorine is a biofertilizer which contains a phosphate dissolving bacteria (*Bacillus megaterium*) which hydrolyze the insoluble phosphorus into soluble one [14]. Biofertilizers are very safe for human, animal and environment and mainly comprise nitrogen fixers such as *Rhizobium*, *Azotobacter*, *Azosprillum*, *Azola*, phosphate dissolvers and silicate bacteria [15]. Furthermore, the combined application of biofertilizers with mineral N caused a significant increase in the percentage of N, P and K in the leaves as compared with the addition of mineral N only [16]. The application of biofertilizers, biogen rhyzobacterine and microbene; alone or in combination with the mineral N fertilizer on Flame seedless and Crimson seedless grapevines resulted in a positive significant effect on berry weight [17]. Also, El-Naggar [18] showed that biofertilizers i.e. phosphorene (Mycrohyza and Phosphobacterium), microbeine (*Rhizobium*) and biogein (*Azotobacter*) is favorable in improving nutritional status of trees, yield, physical and chemical properties of grapevines.

Therefore, the objective of this study was to investigate the possibility of using bio and organic fertilization partially instead of completed NPK mineral fertilizers on vegetative growth, leaf mineral content, yield and fruit physical and chemical characteristics and nitrate and nitrite content of berries of Superior Seedless grapevine.

MATERIALS AND METHODS

This study was carried out during three consecutive seasons of 2009, 2010 and 2011 in sandy soil at 64 kilometer from Cairo on the desert road to Alexandria, Egypt on ten years-old "Superior Seedless" grapevines. Experimental vines were chosen as to be similar in growth as possible; they were planted in a sandy loam soil at 1.5 x 3.0 m apart under drip irrigation system. The vines were cane-pruned and trellised by the gable system. The vines were pruned during the last week of December for the three seasons of the study, so as to leave 72 buds/vine (6 canes x 12 buds/each). The physical and chemical properties of the soil site were determined according to the method of Jakson [19] is presented in Table 1. The compost materials and the natural rocks were carried out at Laboratory of Soil and Water Research Institute Agricultural Research Center, Giza, Egypt according to the method of Jakson [19] as present in Table 2 and Table 3.

Table 1: Physical and chemical properties of the soil at experimental site.

	Values		
Soil properties	2009 season	2010 season	2011 season
Sand (%)	62.38	63.29	63.88
Clay (%)	14.75	15.07	15.29
Silt (%)	22.87	22.64	23.12
Soil texture	Sandy loam		
pH	7.34	7.22	7.14
Organic matter (%)	0.56	0.65	0.69
$CaCO_3$ (%)	2.20	2.27	2.28
Total N %	0.19	0.26	0.30
Available P (ppm)	11.8	14.7	13.4
Available K (ppm)	164.5	201.8	214.0

Table 2: Physical and chemical properties of the compost.

Properties	Values
Organic matter (%)	59
Organic carbon (%)	25.8
Moisture content (%)	28
Total nitrogen (%)	1.42
Soluble ammonium (ppm)	615
Soluble nitrate (ppm)	362
P (%)	0.57
K (%)	0.82
C/N ratio	18:13
pH value (1:10)	6.7
EC value (1:10) (mmohs/cm)	7.9

Table 3: Some components of the tested natural rocks.

Component (%)	L.O.I.	SiS_2	AL_2O_2	Fe_2O_2	CaO	MgO
Feldspar	0.72	71.94	13.92	0.09	0.32	0.08
Rock phosphate	Nil	Nil	Nil	Nil	Nil	Nil
Component (%)	K_2O	Na_2O	TiO2	MnO_2	P_2O_5	CL
Feldspar	10.1	1.94	0.01	0.01	0.48	0.03
Rock phosphate	0.02	Nil	Nil	Nil	19.32	Nil

Table 4: Effect of mineral, organic and bio-fertilizers on morphological characteristics of vegetative growth in Superior Seedless grapevine during 2009, 2010 and 2011 seasons.

	Characters								
	Shoot length (cm)			Number of leaves/ shoot			Leaf area (cm^2)		
Treatments	2009	2010	2011	2009	2010	2011	2009	2010	2011
100% M. (Control)	172.6	170.1	175.0	29.3	30.8	31.4	163.5	161.0	170.8
100% (Co. + R. + F.)	131.4	125.7	129.6	23.5	24.2	24.0	108.3	109.5	107.0
75% (Co. + R. + F.)	129.0	124.3	130.1	23.5	24.1	23.6	102.4	101.7	105.1
75% (Co. + R. + F.) + 25% M.	150.3	152.0	155.8	25.8	27.5	29.5	128.5	127.3	130.6
75% (Co.+ R. + F.) + Bio	134.6	151.2	150.1	24.1	26.9	29.3	106.8	118.5	120.7
50% (Co. + R. + F.) + 50% M.	163.7	159.0	162.9	26.7	27.8	30.4	139.1	140.4	144.8
50% (Co. + R. +F.) + Bio	148.8	150.4	150.2	24.0	26.5	29.1	102.5	113.6	120.9
75% (Co. +R. + F.) + 25% M. + Bio	154.9	162.8	173.6	26.1	28.7	32.1	131.3	152.4	167.0
50% (Co. + R. + F.) + 50% M. + Bio	165.2	178.4	190.5	27.4	31.5	33.5	145.9	160.1	192.6
New L.S.D. 0.05	5.2	4.8	4.3	0.8	0.5	0.7	4.3	3.5	4.8

M = (N P K) Mineral fertilizers, Co = Compost, R = Rock phosphate, F = Feldspar, Bio = (N P K) Bio-fertilizers.

The requirements doses of mineral fertilization NPK recommended by the Ministry of Agriculture as nitrogen were 60 units, phosphor 25 units and potassium 100 units per feddan (one feddan= 0.42 ha). Sources used were ammonium sulphate (20.6% N), calcium super phosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O) and added at three times: 25% was added at the beginning of bud burst till flowering, 50% after fruit set till harvesting and 25% after harvest in the three seasons. Besides, mineral fertilizers as ammonium sulphate (20.6% N) were added at rates of 79, 157, 235 and 314 g/vine meaning, addition of 15, 30, 45 and 60 g N/vine respectively. Calcium super phosphate (15.5% P_2O_5) was added at rates of 44, 87, 130 and 174 g/vine and potassium sulphate (48% K_2O) was added at rates of 56, 112, 168 and 224 g/vine which was divided through the season into three times: 25% was added at the beginning of bud burst till flowering, 50% after fruit set till harvesting and 25% after harvest. Compost was added to the soil (30 cm depth) at the second week of January. In addition, Natural rock phosphate that used in this study contained (19.3% P_2O_5) and feldspar natural rock contained (10.1% K_2O). They were applied in the form of finely (100-mesh) ground natural product. Compost was applied at rates of 3, 4.5 and 6 kg/vine meaning addition of 30, 45 and 60g N/vine. Natural rocks as rock phosphate were added at rates of 70, 105 and 140 g/vine. Feldspar was added at rates of 0.55, 0.82 and 1.1 kg/vine, respectively meaning addition of 30, 45 and 60 g N/vine, respectively. Compost, Natural rocks and bio fertilizer was added once after pruning at the second week of January. Biofertilizers namely biogen (*Azotobacter chrococcum*) for N, phosphorin (*Bacillus megaterium*) for P and potassiumag (*Bacillus circulans*) for K were used as soil application at rate 30 g/vine (per each addition) mixed with the organic matter then the mixtures were added to the soil before the beginning of bud burst at the second week of January in a circle around each vine then covered with the soil and irrigated with water. Compost, natural rocks and bio fertilizer was added once after pruning at the second week of January

The Treatments Were Carried out as Follows:

- 100% mineral fertilizers N (314 g/ vine/season), P (174 g/vine/season) and K (224 g/vine/season) (Control).

- 100% compost (6 kg/vine) + 100 % P (140g Rock phosphate/vine) + 100 % K (1.1 kg Feldspar/vine).
- 75% compost (4.5 kg/vine) + 75 % P (105g Rock phosphate/vine) + 75 % K (0.82 kg Feldspar/vine).
- 75% (compost, rock phosphate and feldspar) + 25% of the previous mineral recommended fertilizers N (78 g/vine/season), P 44 g/vine/season) and K (56 g/vine/season).
- 75% compost (4.5 kg/vine) + biofertilizers.
- 50% compost (3.0 kg/vine) + 50 % P (70g rock phosphate/vine) + 50 % K (0.55 kg feldspar/vine) + 50% of the previous mineral recommended fertilizers N (157 g/vine/season), P (87 g/vine/season) and K (112 g/ vine/season).
- 50% compost (3.0 kg/vine) + 50 % P (70g rock phosphate/vine) + 50 % K (0.55 kg feldspar /vine) + biofertilizers.
- 75% (compost, rock phosphate and feldspar) + 25% of the previous mineral recommended fertilizers N (79 g/vine/season), P (44 g/vine/season) and K (56 g/vine/season) + biofertilizers.
- 50% (compost, rock phosphate and feldspar) + 50% of the previous mineral recommended fertilizers N (157 g/vine/season), P (87 g/vine/season) and K (112 g/vine/season) + biofertilizers.

Experimental Design: The experiment was arranged in randomized complete blocks design, there were 9 treatments; each treatment was replicated three times with five vines as a replicate (9 x 3 x 5 = 135 vines for each season).

Measurement of Vegetative Growth Parameters:

- Average Shoot Length (cm): Six new main shoots were randomly chosen per each vine and their length was measured at the end of each season.
- Average number of leaves/shoot was recorded.
- Average Leaf Area (cm^2): was estimated during the second week of May through picking twenty mature of the apical 5^{th} and 7^{th} leaves from those opposite to the basal clusters on the shoots using a CI-203-Laser Area-meter made by CID, Inc., Vancouver, USA.
- Leaf Chemical Content: Leaf nutrient content (NPK) was determined in the oven dried leaf samples (6 leaves from the base) that collected at version stage. Nitrogen (%) was determined by the modified micro-kejldahl method as described by Wilde *et al*. [20]. Phosphorus (%) was determined by using Olsen method as reported by Chapman and Pratt [21].Potassium (%) was flame photometrically determined using the method outlined by Chapman and Pratt [21].
- Total Yield: Was carried out at the normal commercial harvesting time at the last week of May for this cultivar harvesting in the experimental region was when total soluble solids percentage reached about 16% in the berries of control vines, The number of clusters per vine was recorded. The average weight of each individual cluster was estimated (in grams) and the total yield per vine in kilograms was delivered.
- Berries Chemical Characteristics: Five clusters from each tested vine were taken at random for determining the following chemical characters of the berries:
- Total Soluble Solids (T.S.S. %): was determined in the juice by hand refractometer.
- Total Acidity (as g tartaric acid/100 ml juice): was determined by titration against NaOH using phenolphthalein as an indicator [22].
- TSS /acid Ratio %: were calculated.
- Total sugars %: was determined in the juice by using the method of Lane and Eynon, [23] and volumetric method as described by A.O.A.C. [22].
- Nitrate (NO_3) and Nitrite (NO_2) was determined according to the method of Sen and Donaldson [24].

Statistical Analysis: The statistical analysis of the present data was carried out according to Snedecor and Chocran [25]. Averages were compared using the new L.S.D. values at 5% level.

RESULTS AND DISCUSSION

Vegetative Growth: Data presented in Table 4 indicated that shoot length, number of leaves per shoot and leaf area were significantly affected by the applied fertilizers in the three seasons of the study. It was found that vines receiving 50% (Co.+R.+F.)+50% mineral fertilizer+Bio-fertilizer recorded the highest values of these parameters followed in a descending order by 100% mineral fertilizer in the second and third seasons. However, in the first season, data revealed that vines receiving 100% mineral fertilizer recorded the highest values followed in a descending order by 50% (Co.+R.+F.)+50% mineral fertilizer+biofertilizer. Mixed (Co.+R.+F.),biofertilizer and NPK mineral fertilizers recorded the best results as compared to these treatments separately in the three seasons of this study.

Table 5: Effect of mineral, organic and bio-fertilizers on leaf mineral content in Superior Seedless grapevine during 2009, 2010 and 2011 seasons.

	Characters								
	N (%)			P (%)			K (%)		
Treatments	2009	2010	2011	2009	2010	2011	2009	2010	2011
100% M. (Control)	1.36	1.40	1.45	0.31	0.30	0.33	1.71	1.70	1.74
100% (Co. + R. + F.)	0.99	1.10	1.12	0.19	0.21	0.23	1.36	1.35	1.38
75% (Co. + R. + F.)	1.00	0.98	0.94	0.18	0.20	0.22	1.34	1.32	1.35
75% (Co. + R. + F.) + 25% M.	1.14	1.21	1.20	0.24	0.28	0.27	1.57	1.62	1.63
75% (Co.+ R. + F.) + Bio	1.03	1.12	1.17	0.22	0.25	0.29	1.28	1.47	1.50
50% (Co. + R. + F.) + 50% M.	1.21	1.27	1.20	0.27	0.28	0.29	1.63	1.66	1.65
50% (Co. + R. +F.) + Bio	1.01	1.12	1.15	0.21	0.27	0.28	1.27	1.48	1.51
75% (Co. +R. + F.) + Bio									
25% M. + Bio	1.18	1.60	1.86	0.24	0.34	0.42	1.59	1.87	1.96
50% (Co. + R. + F.) +50% M. + Bio	1.24	1.93	2.44	0.28	0.45	0.64	1.66	2.00	2.32
New L.S.D. 0.05	0.05	0.03	0.02	0.02	0.03	0.01	0.03	0.02	0.02

M = (N P K) Mineral fertilizers, Co = Compost, R = Rock phosphate, F = Feldspar, Bio = (N P K) Bio-fertilizers.

Table 6: Effect of mineral, organic and bio- fertilizers on yield and physical characteristics of bunches in Superior Seedless grapevine during 2009, 2010 and 2011 seasons.

	Characters								
	Yield / vine (kg)			Bunch weight (g)			Number of bunches / vine		
Treatments	2009	2010	2011	2009	2010	2011	2009	2010	2011
100% M. (Control)	12.7	11.9	14.0	521.5	550.2	574.0	24.4	21.7	24.4
100% (Co. + R. + F.)	6.7	5.8	7.6	261.7	284.5	321.5	25.6	20.4	23.6
75% (Co. + R. + F.)	6.6	5.7	7.2	253.8	276.7	300.7	26.0	20.7	23.8
75% (Co. + R. + F.) + 25% M.	8.7	8.8	10.4	349.6	408.0	430.6	24.9	21.5	24.1
75% (Co. + R. + F.) + Bio.	6.7	9.0	10.6	280.5	391.5	442.8	23.9	22.9	24.0
50% (Co. + R. + F.) + 50% M.	10.1	10.8	11.9	453.7	495.6	487.2	22.3	21.8	24.4
50% (Co. + R. +F.) + Bio	6.7	8.9	10.2	278.3	388.1	421.7	24.0	23.0	24.2
75% (Co. +R. + F.) + 25% M. + Bio	9.2	11.3	14.3	365.4	481.8	558.0	25.2	23.5	25.6
50% (Co. + R. + F.) +50% M. + Bio	10.8	13.7	18.1	475.2	584.6	690.8	22.7	23.4	26.1
New LSD 0.05	0.9	1.1	0.8	34.7	24.5	30.9	N.S.	0.7	0.8

M = (N P K) Mineral fertilizers, Co = Compost, R = Rock phosphate, F = Feldspar, Bio = (N P K) Bio-fertilizers.

The beneficial effect of organic fertilizers on leaf area of plants could be related to the improvement of physical conditions of the soil, providing energy from microorganism activity, increasing nutrient supply and improving the efficiency of macro elements as well as its ability to meet some micronutrient requirements [26]. Samah [15] mentioned that the beneficial effect of biofertilizer may be attributed to its effect on increasing nitrogen fixation, production of growth promoting substances or organic acids, enhancing nutrient uptake. Biofertilizers such as phosphorene, biogen, rhizobacterine, microbene led to a significant increase in shoot length and leaf area of Flame Seedless grape cultivar [27]. Uwakiem [28] found that using suitable N (100g/vine) as 50% inorganic plus 50% organic and biofertilizers resulted in enhancing growth characters of Banaty grapevines rather than application of mineral N alone. El-Rawy [9] stated that replacing 50-75% of N requirements for grapevines by organic manures improved the vegetative growth. Combined application of inorganic N with biofertilizers as a partial substitute for chemical fertilizers was very effective in stimulating growth in Thompson seedless grapevines [29].

Leaf Mineral Content: Nitrogen, Phosphorus and Potassium (%): The concerned results in Table 5 indicated that, leaf N.P.K content was significantly affected in vines received 50% (Co.+R.+F.)+50% Mineral fertilizers + Bio fertilizers followed in a descending order by 50% (Co.+R.+F.)+25% mineral fertilizers + biofertilizers treatment in the second and third seasons while, NPK mineral fertilizers (control) treatment was the highest in leaf mineral content in the first season. On the other hand, the treatment which received only 75% (Co.+R.+ F.) gave the lowest values of leaf NPK content in the three seasons comparing to all tested treatments. These results are in agreement with those obtained by Nijjar [30], who reported that the improving effect of organic fertilizers on leaf content of nitrogen, phosphorus and potassium can be attributed to their influence manifested in

increasing the organic matter in the soil. Also, Kassem and Marzouk [31] stated that adding organic manure increase leaf mineral content due to availability of nutrients in the soil. However, El-Karamany *et al*. [32] found that biofertilizers help in availability of mineral and their forms in the composted material and increase levels of extractable NPK.

Yield and Physical Characteristics of Bunches: Data in Table 6 indicated that the yield, Bunch weight and number of bunches /vine of Superior grapevines were greatly affected by mineral fertilizers and/or (Co.+ R.+F.) plus bio-fertilizers in the three seasons of this study. The highest value of yield was obtained with vines receiving 50% (Co.+R.+ F.) + 50% Mineral fertilizers + Bio-fertilizers compared with 100% mineral fertilizers in the second and third seasons. However, in the first season, data revealed that vines receiving 100% mineral fertilizer recorded the highest values followed in a descending order by 50% (Co.+R.+F.) + 50% mineral + biofertilizers then 75% (Co.+R.+F.) + 25% mineral + biofertilizers. The beneficial effects of using organic fertilizers along with mineral NPK fertilizer on increasing yield and bunch could be due to their effect on providing vines with their requirements from different nutrients at a longer time as well as their effect on increasing the availability of nutrients in the soil for uptake by plants and enhancing the nutritional status of the vines in favour of yield and bunch weight [30]. These results confirmed the earlier findings of El-Naggar [18], who reported that biofertilizers i.e. phosphorene (Mycrohyza and Phosphobacterium), microbeine (*Rhizobium*) and biogein (*Azotobacter*) is favorable in improving nutritional, status of vines, yield, physical and chemical properties of grapevines. The application of biofertilizers, biogen rhyzobacterine and microbeine alone or in combination with the mineral N fertilizer on Flame seedless and Crimson seedless grapevines resulted in a positive significant effect on berry weight [33]. Also, El-Rawy [9] stated that replacing 50-75% of N requirements for grapevines by organic manures improved the yield. In addition, Mostafa [10] concluded that application N via mineral and bio form was improved the yield. Abd El-Monem *et al*. [33] reported that the average weight of berries significantly increased with increasing biofertilizer. Combined application of inorganic N with biofertilizers as a partial substitute for chemical fertilizers was very effective in stimulating yield and quality of berries in Thompson Seedless grapevines [29].

Chemical Characteristics of Berries: As shown in Table, 7, it is apparent that all berry chemical properties i.e. total soluble solids, titratable acidity, TSS/acid ratio; total sugars content of berries were significantly affected by fertilizer, treatments in the three seasons of this study. The highest values of total soluble solids, TSS/acid ratio, total sugars and the lowest values of acidity were obtained with vines receiving 50% (Co.+ R.+F.) + 50% mineral + biofertilizers followed by 100% mineral fertilizer in the second and third seasons. However, in the first season data revealed that vines received 100% NPK mineral fertilizers recorded the highest values of chemical characteristics of berries followed by 50% (Co.+R.+F.) + 50% mineral + biofertilizers. On the other hand, vines that received 50% (Co.+R.+F.) recorded the lowest values of total soluble solids, TSS/acid ratio and total sugars and the highest values of acidity in the three season of this study. This result may be due to that organic fertilizers are rich in their content of macro and micro elements which led to enhance photosynthesis, this means that more sugar (glucose) is available for growth and fruit ripening [34]. These results are in accordance with those reported by Belal [35], who found that the gradual increasing of organic nitrogen doses to 60 units with decreasing the dose of mineral nitrogen to 20 units gave the highest significant increase of TSS %, TSS/acid ratio and lowest significant decrease of total acidity of Thompson seedless grapevines. The promoting effect of organic and biofertilization on fruit quality was mainly attributed to their essential role in enhancing organic foods especially total carbohydrates and plant pigments which is reflected on advancing fruit maturity [30]. Also, El-Naggar [18] showed that biofertilizers i.e. phosphorene (Mycrohyza and Phosphobacterium), microbeine (*Rhizobium*) and biogein (*Azotobacter*) is favorable in improving nutritional, status of vines, yield, physical and chemical properties of grapevines. El-Rawy [9] stated that replacing 50-75% of N requirements for grapevines by organic manures improved berry quality. Mostafa [10] concluded that application N via mineral and bio form was improved the yield and berry quality. Combined application of inorganic N with biofertilizers as a partial substitute for chemical fertilizers was very effective in stimulating quality of berries in Thompson Seedless grapevines [29].

Nitrate and Nitrite Content (mg/kg): Data in Table 8 illustrated that the nitrate (NO_3) and nitrite (NO_2) content of berries were significantly decreased by reducing the

Table 7: Effect of mineral, organic and bio- fertilizers on chemical characteristics of berries in Superior Seedless grapevine during 2009, 2010 and 2011 seasons

	Characters											
	TSS (%)			Acidity (%)			TSS/acid ratio			Total sugars %		
Treatments	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
100% M. (Control)	17.2	17.1	17.4	0.66	0.64	0.65	26.01	26.72	26.77	15.4	15.2	15.5
100% (Co. + R. +F.)	15.6	15.4	15.3	0.74	0.80	0.83	21.08	19.25	18.43	13.7	13.6	13.2
75% (Co. + R. + F.)	15.5	15.0	15.3	0.85	0.87	0.84	18.24	17.24	18.21	13.4	13.0	13.5
75% (Co. + R. + F.) + 25% M.	16.0	16.2	16.5	0.78	0.71	0.77	20.51	22.82	21.43	14.1	14.4	14.6
75% (Co.+ R. + F.) + Bio	15.9	16.4	17.2	0.80	0.70	0.68	19.88	23.43	25.29	13.9	14.6	15.4
50% (Co. + R. + F.) + 50% M.	16.5	16.3	16.8	0.68	0.70	0.74	24.26	23.29	22.70	14.3	14.2	14.7
50% (Co. + R. +F.) + Bio	15.9	16.0	17.1	0.81	0.75	0.69	19.63	21.33	24.78	14.0	14.2	15.2
75% (Co. +R. + F.) + 25% M. + Bio	16.2	16.8	17.7	0.70	0.67	0.61	23.14	25.07	29.02	14.1	15.0	15.8
50% (Co. + R. + F.) + 50% M. + Bio	16.7	17.6	18.0	0.70	0.60	0.58	23.86	29.33	31.03	14.7	15.9	16.4
New LSD 0.05	0.2	0.4	0.2	0.03	0.02	0.04	0.72	0.97	0.84	0.4	0.5	0.5

M = (N P K) Mineral fertilizers, Co = Compost, R = Rock phosphate, F = Feldspar, Bio = (N P K) Bio-fertilizers.

Table 8: Effect of mineral, organic and bio- fertilizers on Nitrate and nitrite content (mg/kg) in Superior Seedless grapevine during 2009, 2010 and 2011 seasons.

	Characters					
	NO_3 (mg/kg)			NO_2 (mg/kg)		
Treatments	2009	2010	2011	2009	2010	2011
100% M. (Control)	34.2	33.9	34.1	8.6	9.2	8.8
100% (Co. + R. +F.)	24.0	11.5	5.2	6.0	4.0	1.3
75% (Co. + R. + F.)	20.5	13.4	5.0	5.4	3.5	1.3
75% (Co. + R. + F.) + 25% M.	32.1	20.6	15.8	7.0	5.4	3.3
75% (Co.+ R. + F.) + Bio	25.0	12.4	5.5	5.8	3.1	1.2
50% (Co. + R. + F.) + 50% M.	34.7	28.9	22.7	7.3	6.2	4.3
50% (Co. + R. +F.) + Bio	23.6	13.8	6.2	5.5	3.0	1.0
75% (Co. +R. + F.) + 25% M. + Bio	30.3	18.7	14.3	6.4	5.5	2.4
50% (Co. + R. + F.) + 50% M. + Bio	33.0	22.5	16.2	7.5	5.6	2.6
New LSD. 0.05	6.2	3.8	4.1	0.8	0.5	0.4

M = (N P K) Mineral fertilizers, Co = Compost, R = Rock phosphate, F = Feldspar, Bio = (N P K) Bio-fertilizers.

amount of mineral fertilizers. The highest values of nitrate and nitrite content of berries was obtained with vines receiving 100% NPK as mineral fertilizer followed in descending order by 50% (Co.+R.+F.) + 50% mineral fertilizers. While, vines received 75% (Co.+R.+F.) recorded the lowest values in the three seasons of this study. This may be ascribed to that using organic fertilizers are often considered as a desirable nitrogen source because the nitrogen is in the mineralization immobilization cycle longer and thus is more slowly available [36]. Moreover, the use of organic manure (as slow release for nitrogen) induced a further reduction in $N0_3$-N accumulation in the plant compared with mineral nitrogen (as fast release for nitrogen) [37]. The obtained results are in agreement with those obtained by Belal [35], who reported that the interactions of all combinations between organic nitrogen and mineral nitrogen doses gave a significant decrease in nitrate and nitrite content in the juice of berries as compared with mineral nitrogen alone for Thompson Seedless grapevines. Also, Farag [38] emphasized that high content of nitrate and nitrite was found in 100% mineral fertilization, while organic fertilization caused a sharp reduction of nitrate and nitrite of Flame Seedless grapes.

CONCLUSION

From the results obtained, it could be concluded that requirements for Superior Seedless grapevines by organic compost and bio-fertilization are sufficient to improve nutritional status of grapevines and gave a suitable yield with high bunch properties and quality of the berries. Hence, using 50% (Co.+R.+F.) + biofertilizers can reduce about 50% of recommended dose of mineral fertilizer and reduce the soil pollution resulted from these fertilizers.

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