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Effect of Some Soil Conditioners and Organic Fertilizers on Vegetative Growth and Quality of Crimson Seedless Grapevines

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Abstract: This experiment was carried out during the two successive seasons of 2009 and 2010 on six years old Crimson seedless grapevines cultivar grown in a private orchard at Behaira Governorate. Two different compost types, plant residues (compost A) and plant + animal residues (compost B) at rates 3.26, 4.19 and 5.13 ton/fed., (equal 7.9 and 11 kg compost/vine) with two natural rocks, rock phosphate and feldspar at rates of 0.250 and 0.500 kg/vine respectively. All used treatments were applied with or without NPK biofertilizers and humic acid. Results clearly showed that the vegetative growth for treatments received compost (B) at rate of 11 kg compost (35 g N), 0.250 rock phosphate and 0.500 kg feldspar/ vine, inpresence of biofertilizers NPK and humic acid gave the highest values for main shoot length, leaf area, cane thickness and leaf nutrient content (N, P and K). At harvest, the same treatment gave a significant differences for fruit yield per vine, number of cluster, cluster weight as well as chemical properties of fruit, i,e T.S.S., total acidity and total sugars content as compared to mineral fertilizers (control) and received recommended doses of mineral NPK fertilizers. Therefore, these organic and neutral fertilizers in combination with NPK biofertilizers and humic acid can be recommended for Crimson grapevine to improve productivity and quality and produce a healthy product.

Key words: Grapevines · Crimson seedless · Organic · Compost · Biofertilizers · Humic · Natural rocks

INTRODUCTION

Grape is one of the most popular and favorite fruit crops in the world, for being of an excellent flavor, nice taste and high nutritional value. In Egypt, it ranked the second fruit crop and is consumed mainly as fresh fruits. Crimson seedless cv. is a late season and red table grape with attractive red, firm berries and the flesh is light yellow meaty and the skin is thick. The flavor is sweet. Furthermore, Crimson seedless is one of the most important table grape cultivars in the world. It holds a significant promises for producers and exporters due to its late maturity which required for creating more chances for successful exportation. Organic farming is a system of agriculture which avoids the use of synthetic fertilizers, environmental effects and human health risks that associated with synthetic chemicals. So, applying organic and biofertilizers become a positive alternative to chemical fertilizers. Organic fertilization is happening to have great importance addition of manure not only increases the organic matter content in the soil but also the available P and exchangeable K, Ca and Mg contents. Organic fertilization increased vegetative growth and nutritional status of fruit grapevine [1]. Nitrogen has a pronounced role in improving production and quality of fruits. Nitrogen plays a key role in the nutrition of plants. As a matter of fact, plant life would not be possible without this element. Nitrogen has many functions in the synthesis of proteins, protoplasm, enzymes, organic compounds such as nuclec- proteins, amino acids, polypeptides and chlorophylls [2]. Biofertilizers are the most importance for plant production and soil as they play an important role in improving fruit quality and yield grapevines [3]. Also, El-Naggar [4], showed that biofertilizers i.e. phosphorene (Mycrohyza and Phosphobacterium), microbein (Rhizobium) and biogein (Azotobacter) is favorable in improving nutritional, status of trees, yield, physical and chemical properties of grapevines. Cluster weights, volumes and berry weight of Thompson seedless grapevines were increased by using bio-fertilizers

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(*Azotobacter chroococcum, Bacillus megathrium* and *B. circulanse*) at 13.2 g / vine compared with the chemical fertilizers While, all tested bio-fertilizers gave significant differences on berry TSS, acidity and total sugar. Application of natural rocks (rock phosphate and feldspar) caused the release of macro elements and converted those to soluble fom of P, K, Ca and Mg in comparison with the compost without natural rocks [5]. Humic substances namely potassium humat, fulvic acid,potassium humat acts as conditioners for the soil and as bio catalyst and improve soil structureas as well as improved nutrient uptake, increased chlorophyll synthesis, increased fertilizer retention, stimulate beneficial microbial activity and produced healthier plants and improved yield [6]. This study aimed to investigate the effect of some organic composted manure with or without adding of bio-fertilizers and humic acid comparing with the chemical fertilizers on some vegetative characteristic, yield and fruit chemical characteristic of grapevines cv Crimson.

MATERIALS AND METHODS

This study was carried out during two successive seasons of 2009 and 2010 on six years old Crimson seedless grapevines grown in a private orchard at Behaira Governorate. The vines were planted at 3X3 meters (466 vines / feddan in sandy soil) under drip irrigation system. The vines were trellised on gabole system. Canes were pruned each season in the first week of Jan.at 10 buds/cane and 96 buds /vine . Physical and chemical properties of the soil of the experimental sit are given in Table (1) and analyses of used composted materials in Table (2).

The experiment was arranged in randomized complete blocks design, each treatment was replicated three times with one tree as a replicate. Two different compost types were used (A) plantresidues from herbs and medical plants and (B) plant and animal residues (60% rice strow and 40% cattle manure), at rates of 7, 9 and 11 kg/vine meaning addition of 25, 30 and 35g N/vine. Natural rocks as rock phosphate and feldspare were added at rates of 0.25 and 0.500 kg/vine respectively. Bacterial used as NPK biofertilizers were, *Azotobacter chroococcum for N, Bacillus megathrium* for P and *Bacillus. Circulanse* for K used as soil application at rate 10 g inoculuim /vine (each g have 10^{8-9} bacterial cell). Humic acid doses 12 liter /fed which prepared by water at the rate 1 L / 100 L water and used by rate of humic acid 1 liter/vine. Compost A and compost B were added to the soil (30 cm depth) at the second week of January, biofertilizer and humic acid added four times at first week of March, April, May and June during two seasons. In addition, Feldspar rocks that used in this study contained 8.5% K_2O. Also, phosphate natural rock contained 12 % P_2O_5. The chemical analysis of the soil, the compost and the natural rocks were carried out at laboratory of Soil and Water Research Institute, Agricultural Research Center according to the method of Jakson [7].

Treatments:

- Compost (A) Rate 1: 7kg (25 N g) + 0.178kg rock phosphate + 0.357kg feldspar / vine.
- Compost (A) Rate 2: 9 kg (30 N g) + 0.214kg rock phosphate + 0.428kg feldspar / vine.
- Compost (A) Rate 3: 11kg (35 N g) + 0.250kg rock phosphate + 0.5 kg feldspar / vine.
- Compost (B) Rate 1: 7kg (25 N g) + 0.178kg rock phosphate + 0.357kg feldspar / vine.
- Compost (B) Rate 2: 9 kg (30 N g) + 0.214kg rock phosphate + 0.428kg feldspar / vine.
- Compost (B) Rate 3: 11kg (35 N g) + 0.250kg rock phosphate + 0.5 kg feldspar) /vine.
- Compost (A) Rate 1 + biofertilizers + humic.
- Compost (A) Rate 2 + biofertilizers + humic.
- Compost (A) Rate 3 + biofertilizers + humic.
- Compost (B) Rate 1 + biofertilizers + humic.
- Compost B Rate 2 + biofertilizers + humic.
- Compost B Rate 3 + biofertilizers + humic.
- Control (NPK mineral) + biofertilizers + humic acid.
- Control (NPK mineral).

Vegetative Growth

Main Shoot Length (cm): Six new main shoots were randomly chosen per vine and their length were measured at the end of each season (September).

Leaf Area (cm^2): Leaf area (cm^2) was measured using the following equation [8]. Leaf Area (cm^2) = 0.45 (0.79 x maximum diameter^2) + 17.77. then average leaf area was registered.

Cane Thickness (cm): Average cane thickness (cm) was calculated in the five basal internodes of ten canes per vine just before winter pruning by using a vernier caliper.

Leaf Chemicals Content: Leaf nutrient content (NPK) were determined in the oven dried leaf samples collected (6^{th} leaf from the base) at the third week of July.

Table 1: Physical and chemical properties of the investigated vineyard soil

Mechanical analysis	Value	Chemical analysis	Value	Anion and cation (meq/1)	Value
Coarse sand %	47	$CaCO_3$ %	12.1	Ca^{2++}	0.15
Fine sand %	38	Field capacity %	11	Na^+	0.29
Silt	12	pH (1:2.5 soil water suspension)	8.82	K^+	0.21
Clay %	3	Organic matter %	0.31	Cl^-	0.47
Soil texture	Sandy	EC (dS/m)	0.92	-----	----
----------	-----	Total N %	0.13	-----	----

Table 2: Analyses of used composted materials

Analysis	Compost A	Compost B
M^3 Weight (kg)	790	420
Moisture Content (%)	30	29
Ph (1-10)	9.66	8.81
Ec(1-10) (ds/m)	6.67	6.13
NH_3^+ (ppm)	30	70
NO_3^- (ppm)	10	50
Total Nitrogen (%)	1.0	1.0
Organic Material (%)	35.2	45.6
Organic Carbon (%)	20.4	26.4
Ach (%)	70.4	71.3
C/N Ratio	20.14-1	26.4-1

All marked data were analyzed in dry weight compost

Nitrogen (%) was determined by the modified microkejldahl method as described by Wilde *et al.* [9]. Phosphorus (%) was determined by using Olsen method as reported by Chapman and Pratt [10]. Potassium (%) was flamephotometrically determined using the method outlined by Chapman and Pratt [10].

Yield: Harvesting took place when T.S.S./acid ratio in the berries of the check treatment reached at least 25:1 (at the first of septemer in the two seasons) according to Weaver [11]. The yield of each vine was recorded in terms of weight (in kg.), number of clusters per vine were counted and the average weight of cluster was recorded (g/ cluster).

Berries Chemical Characteristic: Five clusters from each teated were taken at random for determination of the following chemical characters of the berries:

- Total soluble solids (T.S.S.%) in the juice by hand refractometer.
- Total acidity (as g tartaric acid/ 100 ml juice) by titration against NaOH using phenolphthalein as an indicator [12].
- Total sugars (%) in the juice by Lane and Eynon [13] volumetric method as described in A.O.A.C. [12].
- Spectrophotometric detection of nitrite and nitrate according to Ridnour Lisa *et al*. [14].

Statistical Analysis: The randomized complete blocks design was applied to analyze the present data according to Steel and Torrie [15]. Means for treatments were compared by the least significant difference test (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

Vegetative Growth: Main Shoot Length: Data in Table 3 cleared that main shoot length increased in vines received compost B rate 3 plus biofertilizer and humic treatment in both seasons as comperd to control (vine received mineral NPK).

Leaf Area (cm^2): The highest value of leaf area was obtained with vines fertilized by compost B rate 1 plus biofertilizer and humic followed by compost B rate 3 plus biofertilizer and humic fertilizer. However, the least value of leaf area was noticed in vines of the control in both seasons.

Cane Thickness (cm): The cane thickness was significantly increased in the both seasons by using compost B rate 3 + biofertilizer + humic compare to the control.

These results are in agreement with those obtained by El-Shenawy and Fayed [16] on Crimson seedless grapevine growth as main shoot length, leaf area and cane thickness were increased after application of organic and biofertilizers compare to chemical application.

Leaf Chemicals Content

Nitrogen (%): The concerned results in Table 4 indictated that, leaf N content was significantly affected by vines received compost B rate 3 plus biofertilizer and humic as compared to mineral fertilizers (control) treatment. On the other hand, the treatment which recived 30g N gave the lowest values of leaf N content in both seasons comparing to all tested treatments.

Table 3: Effect of sources and rates of compost, biofertilzer,humic and natural rocks on main shoot length(cm), leaf area(cm^2) and cane thickness (cm) of Crimson seedless grapevines during 2009 and 2010 seasons

	Main Shoot Length (cm)		Leaf area (cm^2)		Cane thickness (cm/year) (cm)	
Treatments	2009	2010	2009	2010	2009	2010
Compost A rate 1	103.3	104.5	134.3	136.4	1.01	1.04
Compost A rate 2	108.9	108.3	140.1	142.1	1.03	1.08
Compost A rate 3	116.0	112.2	138.0	140.0	1.05	1.11
Compost B rate 1	119.6	116.5	140.0	141.2	1.08	1.12
Compost B rate 2	120.5	121.0	147.1	148.9	1.08	1.16
Compost B rate 3	125.0	129.3	150.1	151.9	1.12	1.18
Compost A rate 1 +Bio+Humic	125.0	131.3	154.1	155.9	1.16	1.21
Compost A rate 2 + Bio + Humic	129.3	134.0	185.2	159.9	1.20	1.26
Compost A rate 3 + Bio + Humic	131.3	136.0	163.5	164.9	1.22	1.29
Compost B rate 1 + Bio + Humic	133.3	138.0	174.0	176.1	1.26	1.33
Compost B rate 2 + Bio +Humic	133.5	140.0	169.5	171.3	1.29	1.36
Compost B rate 3+ Bio + Humic	136.0	142.0	170.2	174.5	1.30	1.37
Control+ Bio + Humic	126.0	130.0	152.1	150.5	1.10	1.16
Control	105.0	106.2	135.0	134.9	1.15	1.20
L. S. D at 5%	1.0	1.1	1.0	0.9	0.02	0.03

Compost A = (Herbs and medical plants residues) +rock phosphate and feldspar

Compost B = (40 % cattle manure + 60 % rice straw). +rock phosphate and feldspar

Biofertilizers = 10g of mixed inculant of (Bacillus megatherium, B. circulanse and Azotobacter chroococcum) /vine

Control = 30, 30 and 60 g/vine N, P and K respectively.

Rate l = 25 g Nitrogen/vine

Rate 2 = 30 g nitrogen/vine

Rate 3 = 35 g nitrogen/vine

Table 4: Effect of sources and rates of compost, biofertilzer,humic and natural rocks on nitrogen, phosphorus and potassium (%) in leaves of Crimson seedless grapevines during 2009 and 2010 seasons

	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
Treatments	2009	2010	2009	2010	2009	2010
Compost A rate 1	1.63	1.76	0.20	0.24	1.82	1.90
Compost A rate 2	1.70	1.94	0.25	0.28	1.86	1.96
Compost A rate 3	1.72	1.95	0.27	0.29	1.88	2.00
Compost B rate 1	1.74	1.83	0.24	0.27	1.85	1.98
Compost B rate 2	1.84	2.06	0.29	0.34	1.95	2.12
Compost B rate 3	2.02	2.07	0.32	0.39	2.09	2.16
Compost A rate 1 +Bio+Humic	2.15	2.20	0.32	0.40	1.98	2.15
Compost A rate 2 + Bio + Humic	2.28	2.33	0.34	0.44	2.09	2.18
Compost A rate 3 + Bio + Humic	2.30	2.34	0.38	0.46	2.23	2.35
Compost B rate 1 + Bio + Humic	2.46	2.52	0.40	0.45	2.22	2.42
Compost B rate 2 + Bio +Humic	2.48	2.58	0.44	0.52	2.60	2.70
Compost B rate 3+ Bio + Humic	2.56	2.70	0.45	0.55	2.66	2.74
Control+ Bio + Humic	2.22	2.25	0.35	0.40	2.20	2.30
Control	1.60	1.92	0.25	0.34	1.70	1.84
L.S.D at 5%	0.03	0.04	0.02	0.02	0.05	0.06

See footnote of Table 3

Table 5: Effect of sources and rates of compost, biofertilzer, humic and natural rocks on number of clusters/vine, cluster weight(g) and yield (kg) of Crimson seedless grapevines during 2009 and 2010 seasons

	Number of clusters/vine		Cluster weight (g)		Yield /vine (kg)	
Treatments	2009	2010	2009	2010	2009	2010
Compost A rate 1	30.0	30.0	312.0	315.0	9.4	9.5
Compost A rate 2	30.0	30.0	316.0	320.0	9.5	9.6
Compost A rate 3	30.0	31.0	325.0	333.0	9.8	10.3
Compost B rate 1	30.0	31.0	326.0	335.0	9.9	11.0
Compost B rate 2	31.0	32.0	333.0	337.0	10.3	10.8
Compost B rate 3	31.0	33.0	335.0	352.0	10.4	11.6
Compost A rate 1 +Bio+Humic	31.0	32.0	337.5	360.5	10.5	11.5
Compost A rate 2 + Bio + Humic	31.0	32.0	357.5	363.0	11.1	11.6
Compost A rate 3 + Bio + Humic	32.0	33.0	359.5	379.0	11.5	12.5
Compost B rate 1 + Bio + Humic	31.0	32.0	345.0	390.0	10.7	12.5
Compost B rate 2 + Bio +Humic	32.0	34.0	361.0	396.5	11.6	13.5
Compost B rate 3+ Bio + Humic	32.0	34.0	374.0	402.0	12.0	13.7
Control+ Bio + Humic	30.0	32.0	310.0	316.0	9.3	10.1
Control	31.0	31.0	330.0	350.0	10.2	10.9
L.S.D at 5%	N.S	2.0	20.0	19.2	0.4	0.5

See footnote of Table 3

These results are in line with those obtained by El-Naggar [4] and El-Shenawy and Fayed [16] as they reported that leaf N content was increased after application of organic and biofertilizers containing nitrogen fixation bacteria *Azotobacter chrooccum*.

Phosphorus (%): The results of phosphors leaves content are showen in Table 4 recorded the highest significant values by adding compost B rate 3 plus biofertilizer and humic treatment followed by compost B rate 2 plus biofertilizer and humic fertilizer in both seasons. These results are in agreement with those obtained by El-Karamany *et al*. [17] and El-Seginy [18] who reported that, the effect of bio fertilizers may be due to the effect of nutrients mobilizing microorganisms which help in availability of N, P and K menirals gave a significant increase in leaf P content.

Potassium (%): Results in Table 4 indicated that leaf K content was significantly affected by the tested sources, rates of compost, biofertilizers and humic. Mowever leaf K values recorded much higher for compost B rate 2 plus biofertilizer and humic treatment in both seasons as compared to untreated treatment. Treatment which recived recommended meniral dose of K gave the lowest values in leaf K content. The increases in N, P and K uptake might be due to the fact that biofertilization release N, P and K from the soil minerals and increase their solubility consequently N, P and K would be more available and abundant in the soil solution for root absorption. Their absorption through plant root would be higher and consequently, their concentration would be higher in the plant tissues. Many investigators indicated that, biofertilization increased plant nutrient content [5, 19, 18].

Yied Characteristics

Number of Clusters per Vine Data in Table 5 reveled that the sources and rates of compost (A and B), biofertilizer, humic and natural rocks gave no significant differances in 2009 season, while data showed that a significantly increase in number of cluster per vine in 2010 season. The highest number of cluster per vine were obtained with compost B rate 2 plus biofertilizer and humic treatment and compost B rate 3 plus biofertilizer and humic treatment.

Cluster Weight (g): As shown in Table 5 cluster weight was significantly increased in 2009 season more than 2010 season. The highest cluster weight was obtained by vines received compost B rate 2 + biofertilizer and humic fertilizer followed by compost B rate 3 plus biofertilizer and humic treatment in both seasons.

Yield Per Vine (kg): Data in Table 5 showed that yield/vine at treatment which recived compost B rate 3 plus biofertilizer and humic were the highest significant values compared to other treatments and control, from the provirus results it could be concluded that successive application of sources and rates of compost, biofertilizer, humic and natural rocks increased number of cluster per vine, cluster weight and yield/vine. This may due to the improvement of soil and physical properties after organic

Table 6: Effect of sources and rates of compost, biofertilzer, humic and natural rocks on total soluble solids (T.S.S%), total acidity (%) and total sugars (%) in berries of Crimson seedless grapevines during 2009 and 2010 seasons

	Total soluble solids (%)		Total acidity (%)		Total sugars (%)	
Treatments	2009	2010	2009	2010	2009	2010
Compost A rate 1	18.0	18.4	0.642	0.620	15.0	16.1
Compost A rate 2	18.2	19.2	0.630	0.614	16.1	16.8
Compost A rate 3	18.4	19.8	0.610	0.600	16.6	17.3
Compost B rate 1	18.2	19.6	0.600	0.590	16.8	17.0
Compost B rate 2	18.8	20.0	0.592	0.582	17.3	17.3
Compost B rate 3	19.0	20.2	0.580	0.574	17.5	17.5
Compost A rate 1 + Bio+Humic	18.8	20.3	0.570	0.549	17.4	17.8
Compost A rate 2 + Bio + Humic	19.7	20.5	0.580	0.510	18.5	18.5
Compost A rate 3 + Bio + Humic	20.0	20.9	0.565	0.502	18.8	19.6
Compost B rate 1 + Bio + Humic	20.1	21.0	0.549	0.490	18.8	19.8
Compost B rate 2 + Bio +Humic	20.6	22.3	0.520	0.481	19.4	20.1
Compost B rate 3+ Bio + Humic	21.2	22.5	0.515	0.472	19.5	20.6
Control+ Bio + Humic	19.0	20.2	0.590	0.570	18.2	18.0
Control	18.4	19.0	0.640	0.618	16.0	16.2
L.S.D at 5%	0. 2	0.2	0.010	0.011	0.2	0.2

See footnote of Table 3

Table 7: Effect of sources and rates of compost, biofertilzer, humic and natural rocks on nitrite and nitrate (%) in berries of Crimson seedless grapevines during 2009 and 2010seasons

	Nitrite (%)		Nitrate (%)	
Treatments	2009	2010	2009	2010
Compost A rate 1	2.4	2.3	9.2	8.3
Compost A rate 2	2.1	1.8	8.8	6.9
Compost A rate 3	2.0	1.8	6.8	6.4
Compost B rate 1	2.0	2.0	6.0	6.6
Compost B rate 2	1.7	1.8	5.4	5.9
Compost B rate 3	1.7	1.6	4.8	5.0
Compost A rate 1 +Bio+Humic	1.6	1.4	7.0	5.5
Compost A rate 2 + Bio + Humic	1.2	1.0	5.2	4.8
Compost A rate 3 + Bio + Humic	1.2	1.0	3.6	4.6
Compost B rate 1 + Bio + Humic	1.0	1.2	5.4	3.8
Compost B rate 2 + Bio +Humic	0.8	0.8	3.8	2.7
Compost B rate 3+ Bio + Humic	0.6	0.6	2.7	2.4
Control+ Bio + Humic	0.8	0.6	3.2	3.2
Control	2.2	2.0	9.0	8.0
L.S.D at 5%	0.8	0.9	0.9	1.0

See footnote of Table 3

and biofertilization application. The improvement occurred in vine growth and of the nutritional status certainly reflected their effect on improving yield as well as number of clusters per vine and cluster weight. Another interpretation of the positive role of compost as well as N is the beneficial effect of N inraising the number of reproductive shoots and berry set.The present results are in agreement with El-Shenawy and Fayed [19] as organic, biofertilizers and humic were effective in number of cluster per vine, cluster weight and yield per vine on crimson seedless grapevine. Also, Akl *et al.* [3] on biofertilizer as Nitrobeine as they gave positive action in improving vine productivity, this may be attributed to reducing plant requirements of N, improving the availability of carbohydrate content of grapevine canes and reducing pollution induced by the application of chemical fertilizers.

Berries Chemical Characteristics: Results presented in Table 6 indicated that all berry chemical characteristics, i.e.total soluble solids, total acidity and total sugars contents significantly increased by successive application of sources and rates of compost, biofertlizers, humic and natural rocks treatments for the two seasons comered to control. The compost B rate 3 plus biofertilizer and humic fertilizers improved fruit quality expressed by increasing TSS, total soluble sugars and decreasing acidity. The present results are in line with those of El-Shenawy and Fayed [19] who found that biofertilization and organic fertilization improved the fruit chemical properties of crimson seedless.

Nitrite and Nitrate: Data in Table 7 revealed that application of the compost B rate 3 plus biofertilizer and humic fertilizer significantly reduced nitrite and nitrate percentage in the berry juice comparing the control (mineral fertilizers) in both seasons. These results were emphasized by the results of Ahmed and Ibrahim [20] on Thopmson seedless grapes.

CONCLUSION

From the obtinted results it could be concluded that requirements for grapevines by organic Compost, bio-fertilization and humic acid are sufficient to improve nutritional status of grapevines and gave a suitable yield with high cluster and berry quality. In addition to minimize the roduction cost and the environmental Pollution which could be occurred by using excess of chemical fertilizers.

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