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Performance of Thompson Seedless Grapevine as Influenced by Organic Fertilizer, Humic Acid and Biofertilizers under Sandy Soil Conditions

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Abstract: The aim of this investigation is to evaluate the replacement of mineral nitrogen fertilization through using organic source [composted municipal solid waste (MSW)] and humic acid (HA) at 0.5, 1 and 2% with or without biofertilizers [*Pseudomonas fluorescens* + yeast (*Saccharomyces cerevisae*)] on leaf mineral content, yield, fruit quality and the residual NO_3^- and NO_2^- in berry juice of Thompson seedless grapevines. The study was carried out during two successive seasons (2004 and 2005) on 12 years old Thompson seedless grapevine planted on sandy soil under drip irrigation system in a private farm located at El-Sadat district, Minufiya governorate, Egypt. Results indicated that (MSW) fertilization reduced leaf mineral N and K compared with 100% mineral N fertilization, while P content was not affected. Applying HA with MSW increased yield significantly than those fertilized with MSW alone. However, adding biofertilizer with humic slightly and not significantly increased yield than without adding it. On the other hand, results did no show a constant trend due different treatments in respect with cluster weight and berry weight TSS was not affected, while acidity was decreased only in the second season by different treatments than 100% mineral N (control). Fertilizing vines with MSW alone or with HA significantly decreased nitrogen, nitrate and nitrite content in berries juice than those of mineral N fertilizer (control). Finally, it seems that fertilizing Thompson seedless grapevines with composted municipal solid waste (MSW) + 0.5% humic acid (HA) with or without biofertilizer are the promising treatments under this study conditions.

Key words: Thompson seedless, grapevine, fertilization, mineral, organic, biofertilizer, humic acid, nitrate, nitrite.

INTRODUCTION

Grape is considered the second fruit crop in Egypt. The total planted area of grapes in Egypt attained about 160,005 feddans (according to the statistics book of Ministry of Agriculture and Land Reclamation, 2005).

Pollution is one of the most problems affecting human health, especially when the edible part of the plant is polluted with any of pollution sources. In this respect, mineral nitrogen fertilization causes the accumulation of harmful residual substances like NO_3^- and NO_2^- in the edible portion, berries or leaves, of grapevines[9,14]. On the other hand, pollution is considered the major problem faces the exported process. The question is how to produce more save fruits for human health through avoiding mineral nitrogen fertilization?

Using organic and biofertilizers instead of the chemical forms could be the way to produce the natural clear fruits. In this respect, the organic fertilization improved vegetative growth, nutritional status and reduced the residuals of nitrate and nitrite in grape berries and the continuous fertilization with organic fertilizer is promising in the long run for grapevine[10,6]. On banana plants, using banana compost, chicken manure and biofertilizers induced similar results with the recommended dose of mineral nitrogen fertilizer and gave the best fruit characteristics[1,8]. On the other hand, many commercial products containing humic acid (HA), including K-humate (KH) have been promoted for use on various crops[12]. Benefits ascribed to the use of humic acid, particularly in low organic matter, alkaline soil, include increased nutrient uptake, tolerance to drought and temperature extremes, activity of beneficial soil microorganisms and availability of soil nutrients[18,16]. Humic materials may also increase root growth in a manner similar to auxins[18,3,19]. Liquid fertilizer containing humic acid increased apple fruit weight, yield and soluble solids content[11].

So, this investigation was done to evaluate organic and biofertilization treatments on leaf mineral content, yield, fruit quality and the residual minerals in Thompson seedless grapevine.

MATERIALS AND METHODS

This study was carried out during two successive seasons (2004 and 2005) on 12 years old Thompson seedless grapevine planted on sandy soil under drip irrigation system in a private farm located at El-Sadat district, Minufiya governorate, Egypt.

The vines were cane pruned with three wire trellis, supported by telephone system and irrigated via drip irrigation system.

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Table 1: Chemical and physical properties of soil at the trial location.

Mechanical Analysis							Cations meg/I					Anions meg/I		
Sandy%	Silt%	Clay%	Texture	pH	Ec ds/m	$CaCO_3$%	N%	P%	K	Ca	Mg	HCO_3	Cl	SO_4
90	5	5	Sandy soil	8.20	1.50	5.50	traces	0.44	0.57	2.65	2.40	3.85	5.3	5.65

Table 2: chemical analysis of composted municipal solid wastes organic fertilizer.

Moisturen (%)	Water Saturated capacity (%)	pH	Ec mmhos/cm	Organic carbon (%)	Organic matter (%)
27	350	7.7	4	16	40
Humic/dry O.M. (%)	Total N (%)	C/N ratio	Ash (%)	Ammonium N ppm	Nitrate Nppm
12	0.72	22.2	58	9	170
Total P (%)	K (%)	Fe ppm	Mn ppm	Cu ppm	Zn ppm
0.42	0.08	1620	115	130	320

Eight treatments were done to evaluate soil application of 100% organic fertilization (on nitrogen base) as composted municipal solid waste (MSW) and humic acid (HA) with or without biofertilizers [*Pseudomonas fluorescens* + yeast (*Saccharomyces cerevisae*)] compared with 100% mineral nitrogen fertilization (control) as follows:

- 100% mineral N.
- 100% MSW.
- 100% MSW + 0.5% HA.
- 100% MSW + 0.5% HA + bio fertilizer.
- 100% MSW + 1% HA.
- 100% MSW + 1% HA + bio fertilizer.
- 100% MSW + 2% HA.
- 100% MSW + 2% HA + bio fertilizer.

Each treatment was replicated four times with two vines per each and the randomized complete block design was arranged.

The texture of the soil is sandy; the physical and chemical properties of the experimental soil are presented in table (1).

As for mineral fertilization treatment, 100 gm N as ammonium sulphate (20.5% N) was added per each vine and placed 10 cm under the soil surface on both sides of the vine rows (50 cm from the trunk) at three equal doses (at bud burst, after fruit set and after harvest), while vines treated with MSW treatments received about 14 kg composted municipal solid waste compost (equal to the amount of mineral N added to the control treatment). The chemical analysis of composted municipal solid waste compost is shown in Table (2).

Pseudomonas aeruginosa and Yeast (*Saccharomyces cerevisae*) isolated and identified by Gomaa[7] were grown to the late exponential phase in a sterilized medium prepared in Microbiology Department, National Research Centre. The resultant cultures were contained 6.2 x 105 cell/ml and applied at the rate of one mixed liter of both Pseudo. + Yeast per each vine treated with biofertilizers.

The organic and biofertilizers were side dressed in a band of 50 cm wide on both sides of the vine rows and mixed with the soil surface. Vines treated with humic acid (HA) received a liter of Humix (12% humic acids) added on the soil surface and three concentrations (0.5, 1 or 2%) were tested. Both organic, biofertilizer and humic acid treatments were added in late January.The other cultural practices were the same for all treatments.

Leaf mineral contents (total N, P and K %) were determined in petioles from mature leaves (5-7th leaves from shoot top) opposite to basal clusters[15] according to the methods described in Wilde *et al.*[21]. At the commercial harvesting time (late July) the yield expressed in weight (kg) and number of clusters per vine was recorded and the average weight of cluster was estimated. A sample of 6 clusters per each treatment were randomly taken from each replicate to determine berries quality in terms of berry weight (gm), total soluble solids (TSS) and total acidity (expressed as gm tartaric acid/100 gm juice) percentages were determined as outlined in A.O.A.C[2]. Total N was determined as ppm in berry juice extract using the same methods of leaf mineral content determination. Also, nitrate and nitrite content in the berry juice was determined according the methods outlined by Sen & Donaldson[17].

The data were subjected to analysis of variance and Duncan's multiple range test was used to differentiate means[4].

RESULTS AND DISCUSSIONS

Leaf mineral content: Table (3) showed leaf mineral content of Thompson seedless grape as affected by MSW, HA and biofertilization.

Regarding nitrogen percentage in the leaf, it was significantly affected by treatments in both studied seasons. However, it is clear that 100% mineral N application recorded the higher N% in the leaves. On the other hand, it is observed that the treatments included biofertilizer recorded high N content comparing with those without it. Also there is a gradually increment with increasing HA concentration. This was true in both studied seasons. As for phosphorus content in the leaf, it was found that both tested bio and organic fertilizer treatments induced comparable results to the control treatment (100% mineral N) and no significant differences were detected. Potassium content in the leaf was significantly affected by different treatments in both studied seasons, where 100% MSW + 2% HA (treatment 7) followed by the control (treatment 1) gave the higher values in the first season, while in the second one, 100% MSW + 0.5% humic (treatment 3) followed by the control (treatment 1) gave the higher values. On the other hand, there is a slight decrease in the treatments included the biofertilizer than without it. The previous results are agreed with those obtained by El-Shenawy and Fayed[5] and Farag[6] on grapes.

Table 3: Leaf mineral content of Thompson seedless grape as affected by MSW, HA and biofertilizer in 2004 and 2005 seasons.

Treatments		N%		P%		K%	
		2004	2005	2004	2005	2004	2005
1	100% mineral N	1.56a	1.63a	0.12	0.12	1.39ab	1.37ab
2	100% MSW	1.30b	1.26c	0.12	0.14	1.32c	1.36ab
3	100% MSW +0.5% HA	1.33b	1.26c	0.14	0.14	1.36bc	1.41a
4	100% MSW +0.5% HA +bio	1.36ab	1.36bc	0.13	0.13	1.35bc	1.34b
5	100% MSW +1% HA	1.33b	1.36bc	0.13	0.13	1.36bc	1.35ab
6	100% MSW +1% HA +bio	1.46ab	1.53ab	0.12	0.13	1.32c	1.34b
7	100% MSW +2% HA	1.36ab	1.43abc	0.14	0.14	1.42a	1.36ab
8	100% MSW +2% HA +bio	1.50ab	1.60a	0.12	0.12	1.33c	1.35ab
	Significance at 5% level	S	S	NS	NS	S	S

Means having the same letters within a column for each cultivar are not significantly different at 5% level.
S: Significant, NS: Not significant

Table 4: Yield as number of clusters and weight (kg) per plant of Thompson seedless grape as affected by MSW, HA and biofertilizer in 2004 and 2005 seasons.

Treatments		No. of clusters/plant		Yield weight (kg)		Average of the two seasons
		2004	2005	2004	2005	
1	100% mineral N	19.0	32.6a	7.89ab	14.50ab	11.14a
2	100% MSW	19.6	24.3bc	6.57ab	10.94c	8.75c
3	100% MSW +0.5% HA	19.3	29.0ab	7.73ab	14.82a	11.27a
4	100% MSW +0.5% HA + bio	19.3	27.6ab	5.10b	15.69a	10.39ab
5	100% MSW +1% HA	20.3	20.6c	6.48ab	11.97bc	9.22bc
6	100% MSW +1% HA +bio	20.6	33.0a	8.65a	13.97ab	11.31a
7	100% MSW +2% HA	19.6	28.3ab	8.43a	14.90a	11.66a
8	100% MSW +2% HA +bio	19.3	24.0bc	6.56ab	10.71c	8.63c
	Significance at 5% level	NS	S	S	S	S

Means having the same letters within a column for each cultivar are not significantly different at 5% level.
S: Significant, NS: Not significant

Yield: Table (4) showed the effect of MSW, HA and biofertilization treatments on yield of Thompson seedless grape.

Yield as number of clusters per vine was significantly affected in the second season only, since treatment No. 6 (100% organic fertilizer + 1% HA + biofertilizer) recorded the highest number followed by the control, while treatment No. 5 (100% organic fertilizer + 1% HA) gave the lowest value. This was true in the second season.

Yield weight (kg) per vine was significantly affected in both studied seasons. However, results cleared that different treatments gave more or less similar yield values as those of the control in the first season. Meanwhile, yield in the second season or as average of the two seasons, a particular trend was noticed when vines fertilized with 100% MSW than those fertilized with 100% mineral N (control), however, applying HA with MSW increased yield significantly than those fertilized with MSW alone. However, adding biofertilizer with humic slightly and not significantly increased yield than without adding it. This means that adding HA with MSW had a beneficial effect on yield weight. On the other hand, all treatments gave the same statistical results except treatments number (2, 5 and 8). The previous results agreed with those obtained by Farag[6] and Malusa *et al.*[13] who found that yield in organic vineyards were lower than under conventional management. Also El-Shenawy and Fayed[5] concluded that adding humic acid with organic fertilizer increased yield of Crimson seedless grapevine significantly than organic fertilizer alone.

Table 5: Cluster weight, berry weight, total soluble solids and acidity content in the berry juice of Thompson seedless grape as affected by MSW, HA and biofertilizer in 2004 and 2005 seasons.

		Cluster weight (gm)		Weight of 50 berries (gm)		TSS (%)		Acidity(%)	
Treatments		2004	2005	2004	2005	2004	2005	2004	2005
1	100% mineral N	453a	446b	149ab	75.5bc	17.2	16.3	0.47	0.52a
2	100% MSW	322bc	451b	145ab	63.5d	16.4	16.8	0.49	0.50ab
3	100% MSW + 0.5% HA	377abc	503ab	140ab	77b	16.9	19.0	0.49	0.50ab
4	100% MSW + 0.5% HA + bio	263c	573a	158a	74bc	16.5	16.8	0.47	0.49abc
5	100% MSW + 1% HA	326bc	573a	150ab	78b	15.8	17.8	0.51	0.49abc
6	100% MSW + 1% HA + bio	417ab	431b	158a	74.5bc	15.8	18.3	0.49	0.48abc
7	100% MSW + 2% HA	443ab	530ab	119b	88a	15.8	18.0	0.48	0.45bc
8	100% MSW + 2% HA + bio	329bc	456b	147ab	68cd	17.5	18.3	0.49	0.44c
Significance at 5% level		S	S	S	S	NS	NS	NS	S

Means having the same letters within a column for each cultivar are not significantly different at 5% level.
S: Significant, NS: Not significant

Table 6: Total nitrogen, nitrate and nitrite content in the berry juice of Thompson seedless grape as affected by MSW, HA and biofertilizer in 2004 and 2005 seasons.

		Total N(ppm)		NO_3^-(ppm)		NO_2^-(ppm)	
Treatments		2004	2005	2004	2005	2004	2005
1	100% mineral N	795a	715a	20.4a	20.5a	0.31a	0.24a
2	100% MSW	517c	332d	13.0b	12.2bc	0.22b	0.18b
3	100% MSW +0.5% HA	598bc	555bc	10.8c	13.5bc	0.21b	0.21ab
4	100% MSW +0.5% HA +bio	621bc	522c	12.9b	10.3c	0.19b	0.20ab
5	100% MSW +1% HA	620bc	641ab	10.3c	12.7bc	0.19b	0.19ab
6	100% MSW +1% HA +bio	614bc	609abc	11.2c	12.7bc	0.20b	0.20ab
7	100% MSW +2% HA	654b	644ab	11.2c	14.1b	0.19b	0.19ab
8	100% MSW +2% HA +bio	657b	643ab	13.0b	13.6bc	0.18b	0.18ab
Significance at 5% level		S	S	S	S	S	S

Means having the same letters within a column for each cultivar are not significantly different at 5% level.
S: Significant, NS: Not significant

Fruit quality: Table (5) showed fruit quality as affected by MSW, HA and biofertilization treatments.

Cluster weight was significantly affected in both studied seasons. However, results did no show a constant trend due different treatments in respect with cluster weight and berry weight TSS was not affected, while acidity was decreased only in the second season by different treatments than 100% mineral N (control).

Total N, No_3^- and No_2^- in berry juice: Nitrogen content in the berry juice as shown in Table (6) was significantly affected in both seasons. Generally, all treatments decreased juice N significantly than those of the control (100% mineral N). This was true in the first season, similar trend was obtained in the second season by different treatments, specially MSW alone (treatment 2) or MSW + 0.5% HA with or without bio (treatments 3 and 4).

Concerning nitrate and nitrite in berries juice, results showed that it was followed the same trend obtained by treatments in juice N content but it was more pronounced by different treatments, where fertilizing with MSW alone or with HA significantly decreased nitrate and nitrite content in berries juice than those of mineral N fertilizer (control). These results are in harmony with those obtained by Ibraheem[9], Montasser *et al*.[14] and Farag[6] hwo concluded that mineral nitrogen fertilization causes the accumulation of NO_3^- and NO_2^- in the berries of grapevines.

From the abovementioned results, it could be concluded that treaded Thompson seedless grapevines with composted municipal solid waste (MSW) + humic acid (HA) + biofertilizer treatments had a positive effect, since applying HA with MSW increased yield than those fertilized with MSW alone. Also, adding biofertilizer with humic slightly increased yield than without adding it. This means that vines responded mainly to HA application not to the applied biofertilizer. On the other hand, all treatments decreased juice N, nitrate and nitrite content than those of the control (100% mineral N). However, it seems that fertilizing Thompson seedless grapevines with composted municipal solid waste (MSW) + 0.5% humic acid (HA) with or without biofertilizer are the promising treatments under this study conditions.

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