Minimizing the quantity of mineral nitrogen fertilizers on grapevine by using humic acid, organic and biofertilizers

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Abstract: The aim of this study is to evaluate the minimizing of mineral nitrogen fertilization through using humic acid (HA) and organic source [composted municipal solid waste (MSW)] with or without biofertilizer [yeast (Saccharomyces cerevisae)] on leaf mineral content, yield, fruit quality and the residual P, K, NO₃⁻ and NO₂⁻ in berry juice of Thomson seedless grapevines. The study was carried out during two successive seasons (2005 and 2006) on 12 years old Thomson 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 humic acid reduced N content in the leaves especially when presence with biofertilizer, while there was no differences between the other treatments, While, P and K content were not affected. Presence of HA alone or with bio + MSW increased yield and recorded the higher values especially in the second season. Berry weight recorded the higher value when the plants treated with 50% mineral nitrogen+ MSW followed by the control treatment. This was true in the first season only. On the other hand, results did not show any differences between treatments in respect with number of clusters/plant, cluster weight, TSS and acidity percentage. P content in berry juice was reduced with treatments included biofertilizer. While as, K content in the juice was reduced by treatment included biofertilizer+ humic acid. As for nitrate and nitrite content in the berry juice, all treatments reduced them compared with the control (100% mineral N).

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). Mineral nitrogen fertilization causes the accumulation of harmful residual substances like NO₃⁻ and NO₂⁻ in the edible portion, berries or leaves, of grapevines3,12. A great attention is focused on minimizing the intensive amounts of mineral nitrogen fertilization especially under sandy soils which are naturally poor either in nutrient elements or organic matter through using alternative organic N fertilization as well as using biofertilizers which had illustrated greater nutrient use efficiencies of crops and in particular fruit crops when such inoculates were added to either organic matter or soil9,10. 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 grapevine4,5.

On the other hand, many commercial products containing humic acid (HA), including K-humate (KH) have been promoted for use on various crops11,12. 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 nutrients6,9. Humic materials may also increase root growth in a manner similar to auxins8,10. Liquid fertilizer containing humic acid increased apple fruit weight, yield and soluble solids content11.

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 (2005 and 2006) on 12 years old Thomson seedless grapevine planted on sandy soil under drip irrigation system in a private farm located

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at El-Sadat district, Minufiya governate, Egypt. The vines were cane pruned with three wire trellis, supported by telephone system and irrigated via drip irrigation system.

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

Six treatments were done to evaluate soil application of 50% mineral nitrogen fertilization + 50% organic fertilization (on nitrogen base) as composted municipal solid waste (MSW) and humic acid (HA). with or without biofertilizer yeast (Saccharomyces cerevisiae) compared with 100% mineral nitrogen fertilization (control) as follows:

1. 100% mineral N.
2. 50% mineral N + 50% MSW.
3. 50% mineral N + 1% HA.
4. 50% mineral N + 50% MSW + bio fertilizer.
5. 50% mineral N + 1% HA + bio fertilizer.
6. 50% mineral N + 50% MSW + 1% HA + bio fertilizer.

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

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 7 kg composted municipal solid waste compost (equal to the half amount of mineral N added to the control treatment). The chemical analysis of composted municipal solid waste compost is shown in Table (2).

Yeast (Saccharomyces cerevisiae) isolated and identified by Gomaa [12] was 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 liter 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 at 1% concentration. 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[14] according to the methods described in Wilde et al.[14]. 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[11].

Total P and K were 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[18].

The data were subjected to analysis of variance and Duncan’s multiple range test was used to differentiate means[13].

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 the treatments, where humic acid reduced N content especially when presence with biofertilizer, while there was no differences between the other treatments. This was true in the both studied seasons.
Juice Mineral Content: Table 6 showed P, K, NO₃⁻ and NO₂⁻ in the berry juice of Thompson seedless grapevine.

As for P content, it is observed that treatments included biofertilizer tended to reduce P value compared with the other treatments.

Regarding K content in the berry juice, it is clear that treatment 5 (50% mineral N + HA+ biofertilizer) significantly reduced K value than the other treatments in the second season only.

Concerning NO₃⁻ and NO₂⁻ content, it noticed that all treatments reduced these parameters than the control (100% mineral N) which recorded the highest values for NO₃⁻ and NO₂⁻ in both studied seasons.

From the abovementioned results, it is clear that treatment 5 (50% mineral N + HA+ biofertilizer) followed by treatment 3 and 6 seem to be the most promising, since they increased yield weight (kg), reduced NO₃⁻ and NO₂⁻ content in the berry juice and finally decreasing the total amount of mineral nitrogen for fertilization grapevine.

These results are agree with those obtained by Elshenawy and Fayad [14] on Crimson seedless grapevine, Ibraheem [1], Montasser et al [2], Farag [3], Saleh et al [4], and Abd El-Migeeed et al [5].

The previous results concerning leaf mineral content, yield, fruit quality and juice mineral content showed that, using humic acid, organic and biofertilizer may be useful to minimizing the amount of mineral fertilization in grapevine and reducing the soil and water pollution resulted from these fertilizers.

### Table 6: Phosphorus, potassium, nitrate and nitrite content in the berry juice of Thompson seedless grape as affected by MSW, HA and biofertilizer in 2005 and 2006 seasons.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>P (ppm)</th>
<th>K (ppm)</th>
<th>NO₃⁻ (ppm)</th>
<th>NO₂⁻ (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 100% mineral N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 50% mineral N + MSW</td>
<td>248ab</td>
<td>251</td>
<td>1018</td>
<td>844ab</td>
</tr>
<tr>
<td>3 50% mineral N + HA</td>
<td>292a</td>
<td>281</td>
<td>874</td>
<td>1203a</td>
</tr>
<tr>
<td>4 50% mineral N + MSW + bio</td>
<td>248ab</td>
<td>266</td>
<td>764</td>
<td>1001ab</td>
</tr>
<tr>
<td>5 50% mineral N + HA + bio</td>
<td>212b</td>
<td>214</td>
<td>856</td>
<td>688 b</td>
</tr>
<tr>
<td>6 50% mineral N + MSW + HA + bio</td>
<td>241ab</td>
<td>227</td>
<td>830</td>
<td>1062ab</td>
</tr>
</tbody>
</table>

Significance at 5% level: S = Significant, NS = Not significant

Means having the same letters within a column for each cultivar are not significantly different at 5% level.


