Application of Organic Fertilizers Based on Sapropel and Peat in Countries of Middle East

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Abstract
Recently, several studies on the application of organic-mineral fertilizers (OMF), based on sapropel and peat), were carried out in Middle East countries. The OMF named “Sapro Agro” (manufactured by LLC LATPOWER, Riga, Latvia) was tested in Saudi Arabia in organic agriculture, as a fertilizer as well as a soil conditioner, while the study of the OMF named “Humin Plus” was conducted in Jordan. Results of the effects of Humin Plus on the pre-treatment of soil in greenhouses showed that yield increased 24%. The study of the effects of Humin Plus on cucumbers in greenhouses showed yield increased by 31%. An experiment on plants which are lagging behind in their development caught up and surpassed other plants in appearance when treated with Humin Plus. Also, researches in Jordan showed that Humin Plus was very effective in the early stages of fruiting and the optimal application rate of this OMF in this case was 1 ltr/10000 m². In Jordan, several experiments were conducted with Sapro Agro and Sapro Elixir, which were mixed with mineral fertilizer (Kama-Eco+) at a ratio of 50/50. Results of these experiments showed that yield increased 28-35%.

Keywords: Humin Plus, Sapropelat, Sapropelat Uni, Sapro Agro, Sapro Elixir

1. Introduction

Application of organic-mineral fertilizers (OMF) based on sapropel and peat is of considerable interest. These include the products called “Humin Plus”, “Sapropeet”, “Sapropeat Uni”, “Sapro Agro”, and “Sapro Elixir”. Sapro Agro (manufactured by LLC LATPOWER, Riga, Latvia) is biologically active soil conditioner, produced on environmentally sound technology from natural ingredients: sapropel colloid and active peat (http://www.latpower.lv/index.php?page=2). Sapro Elixir (manufactured by SIA HUMIN VIT, Ogre, Latvia) is produced from natural fresh water lake sapropel with natural moisture. Sapro Elixir contains a full spectrum of natural biologically active ingredients. The product is balanced with limited amounts of NPK and nutrients (http://www.huminvit.lv/saproelixir?lang=eng). Sapro Elixir is a highly-efficient natural-organic fertilizer and soil enhancer that can be applied on all types of soils and all kinds of fruit and vegetables, sowing and decorative crops, trees, and bushes. Humin Plus/Sapropeet (manufactured by the German-Ukrainian Center for Innovative Agri-industrial Technologies – FuTech) is an organic mineral micro-fertilizer based on a sapropel extract (http://athdevelopments.co.uk/downloads/Humin%20Plus%20Brochure.pdf). A licensed technology based on new physical principles in the processing of raw materials (cavitation combined with magnetic treatment) is used to obtain micro fertilizers with new characteristics (i.e.: improved consistency and increased physiological and biological activity of the ingredients) (http://athdevelopments.co.uk/downloads/Humin%20Plus%20Brochure.pdf). Sapropeat Uni is a biologically active product aimed at rectifying soil health (http://www.sapropeatfrica.com/sapropeat.html). Recently, several studies on the application of these organic-mineral fertilizers (OMF), based on sapropel and peat, were conducted in Middle East and Africa countries. The objective of this paper is to summarize the results of these tests.

2. Application of organic fertilizers based on sapropel and peat in Saudi Arabia

Since 2009, the organic fertilizer named Sapro Agro (manufactured by LLC LATPOWER, Riga, Latvia) has been tested in Saudi Arabia as a fertilizer source as well as a soil conditioner for use in organic agriculture. The manufacturing process of Sapro Agro includes 4 steps:

1. Sapropel extraction from the lake,
2. Peat shredding and sterilization,
3. Sapropel mixing with the peat,
4. Packaging of the finished product,

The composition of Sapro Agro is given in Tables 1 and 2.

The first results of the test of Sapro Agro in Saudi Arabia shown prospects of this OMF for organic agriculture.
Table 1. Active ingredient of Sapro Agro, % (http://www.latpower.lv/index.php?page=2).

<table>
<thead>
<tr>
<th>Active Ingredient</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Humic Acids</td>
<td>20.7</td>
</tr>
<tr>
<td>1.2 Fulvic Acid</td>
<td>32.7</td>
</tr>
<tr>
<td>1.3 Humic Substance</td>
<td>29.9</td>
</tr>
<tr>
<td>1.4 Total Nitrogen (N_{total})</td>
<td>2.7</td>
</tr>
<tr>
<td>1.5 Amino Acids</td>
<td>9.0</td>
</tr>
</tbody>
</table>

Table 2. Inert Ingredients of Sapro Agro, % (http://www.latpower.lv/index.php?page=2).

<table>
<thead>
<tr>
<th>Inert Ingredient</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Phosphorus P (P_{2}O_{5})</td>
<td>0.9</td>
</tr>
<tr>
<td>2.2 Potassium K (K_{2}O)</td>
<td>0.5</td>
</tr>
<tr>
<td>2.3 Magnesium MgO</td>
<td>0.174</td>
</tr>
<tr>
<td>2.4 Calcium oxide CaO</td>
<td>0.7</td>
</tr>
<tr>
<td>2.5 Silicon as SiO_{2}</td>
<td>0.08</td>
</tr>
<tr>
<td>2.6 Water-soluble natural mineral carbonated trace elements (CaCO_{3}, MgCO_{3}, etc.)</td>
<td>2.646</td>
</tr>
</tbody>
</table>

3. Application of organic fertilizers based on sapropel and peat in Jordan

3.1. 2011 Studies

In 2011, a study was conducted using Humin Plus/Sapropel. The product is manufactured by the “German-Ukrainian Center for Innovative Agri-industrial Technologies - FuTech”, and is described in a brochure entitled “Organic mineral complex humic micro fertilizer based on a sapropel extract” (http://athdevelopments.co.uk/downloads/Humin%20Plus%20Brochure.pdf). In the brochure, we can read: “Modern nanotechnological extraction of sapropel by means of cavitation is employed in the production of Humin Plus. A licensed technology allowed us partially or even completely abandon the conventional reagent (chemical) technology. The main drawback of the traditional technology is a huge variation in quality, low speed of the processes and low output of nutrients. The quantity of water-soluble humic acids in the best conventional humic-containing fertilizers and growth stimulants is no more than 20 g/liter. Only by using new physical principles in the processing of raw materials (cavitation combined with magnetic treatment) we get micro fertilizers with new quality characteristics: improved consistency and increased physiological and biological activity of the ingredients”.

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The main chemical and physical characteristics of Humin Plus are given in Table 3.


<table>
<thead>
<tr>
<th>Appearance</th>
<th>Colloidal liquid, may precipitate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Brown, black</td>
</tr>
<tr>
<td>Smell</td>
<td>Weak or moderate smell of ammonia</td>
</tr>
<tr>
<td>Humidity, %</td>
<td>From 50 to 85 %</td>
</tr>
<tr>
<td>Density, g/cm²</td>
<td>Not less than 1,1</td>
</tr>
<tr>
<td>pH</td>
<td>From 6,0 to 8,5</td>
</tr>
<tr>
<td>Mass fraction of organic substance, %</td>
<td>Not less than 35</td>
</tr>
</tbody>
</table>

| Total soluble salts, g/l:                      | Total soluble salts, mg/l:               |
| Nitrogen (N)                                   | MgO                                       |
| Phosphorus (P₂O₅)                              | Mn                                        |
| Potassium (K₂O)                                | Zn                                        |
|                                                | Cu                                        |
|                                                | B                                         |
|                                                | Mo                                        |
|                                                | Co                                        |
|                                                | Si                                        |
| ≥8                                             | ≥0,9                                      |
| ≥9                                             | ≥2,5                                      |
| ≥16                                            | ≥0,9                                      |
|                                                | ≥0,5                                      |
|                                                | ≥0,8                                      |
|                                                | ≥0,5                                      |
|                                                | ≥0,3                                      |
|                                                | ≥20                                       |

Research in 2011 was carried out by the Jordanian company “Futech for Modern Fertilizers”, (Amman, Jordan) and included several experiments, which were conducted by Dr. Imad Zeidan and Eng. Fakhouri Muhammad.
3.1.1. Experiment 1

Experiment 1 study was location on a farm of Assarhan (near the city of Al Mafraq in North-East Jordan) where the climate is considered harsh continental. The study was conducted in a greenhouse utilizing moderately alkaline soil on cucumbers. The watering of was accomplished with the use of streamer (no drip), and fertilizer was applied with water. Experiment 1 included two parts.

3.1.1.1. Part 1

In the first part of the study, the effects of the use of OMF on the pre-treatment stage of soil were investigated. Specifically, 8 greenhouses were treated with OMF on 07/17/2011 with an application rate of 1 ltr/10000 m². Cucumber seedlings were planted on 07/20/2011. For comparison, 8 other identical greenhouses were selected as controls, where fertilizer was not applied at this pretreatment stage.

The result of the experiment showed that yield on greenhouses, where soil was treated with OMF was increased by 24%.

3.1.1.1. Part 2

In the second part of the study, the effects using OMF after planting on the yield of cucumbers were examined. Cucumber seeds were planted directly into the soil of eight greenhouses. The OMF applications (09/18/2011) were made 21 days later at an application rate of 0.5 ltr/10000 m². For comparison, 8 identical greenhouses were utilized as controls, where fertilizer was not applied.

Result of experiment showed that yields where cucumbers were treated by OMF were increased by 31%.

3.1.2. Experiment 2

Experiment 2 study was located on the farm of Hassan Farid (near Amman, Jordan) where the climate is considered moderate continental. In this study, beans were grown, with water applications made with streamer (no drip) and fertilizer was applied with water. In this study, OMF treatments were applied to roots using OMF solution at an application rate of 100 ml/1000 m². The goal of the experiment was to study the influence of OMF solution on plants which were lagging behind in their development. In this case, the experiment was carried out on field where plants were lagging behind in their development because of low soil fertility. Plants were treated on 08/27/2011 with the OMF solution.

Result of experiment: plants treated with OMF caught up and surpassed other plants in appearance, pace of development and productivity.
3.1.3. **Experiment 3**

Experiment 3 study was located on the farm of Ziad Tummole (near Amman, Jordan) where the climate is considered moderate continental. The study was conducted in a greenhouse on cucumbers. The watering of was accomplished with the use of streamer (no drip), and fertilizer was applied with water. In this study, OMF fertilizer treatments were applied to roots.

The goals of the experiment were to: 1) study the influence of OMF in the initial stage of fruiting of cucumbers; 2) find the optimal application rate of OMF for cucumbers planted into greenhouses; and 3) research the dynamics of the impact of OMF over time.

The experiment was carried out in three groups of the identical greenhouses. In the first group of greenhouses, the first treatment was applied on 06/30/2011 with the application rate of 2.7 ltr/10000 m². The second treatment was applied on 07/24/2011 with the application rate of 0.5 ltr/10000 m². Plants ceased fruit production on 09/11/2011.

In the second group of greenhouses, the first OMF treatment was applied on 06/30/2011, with the application rate of 1.3 ltr/10000 m². The second application treatment was on 07/24/2011, with the application rate of 0.5 ltr/10000 m². Plants ceased fruit production on 09/23/2011.

The third group of greenhouses was used as alternative, with no application treatments. Plants ceased fruit production on 09/07/2011.

Result of experiment:

- The treatment by OMF is very effective in the early stages of fruiting, when the plants need quick delivery of nutrients.
- The optimal application rate of OMF in this case was 1 ltr/10000 m².
- The correct application rate resulted in higher yields and extended the time of fruiting.
- Results indicate that repeat application every 10-14 days is needed for optimum results.
- Overdose application levels led to a temporary inhibition.
- In the first group of greenhouses, yields increased 7% compared to the alternative.
- In the second group of greenhouses, yields increased 27% compared to the alternative.

3.1.4. **Experiment 4**

Experiment 4 study was located on the farm of Yousef Kteyt (The Jordan River Valley near the Dead Sea (West Jordan)) where the climate is hot with limited precipitation. The watering of was accomplished with the use of streamer (no drip), and fertilizer was applied with water. In this study, OMF fertilizer treatments were applied to roots.
The goals of the experiment were to: 1) study the influence of OMF on the initial stages of cucumber growth under this climate conditions, 2) study the effectiveness of OMF compared to other growth stimulants that have been found to be most effective and are well-known in Jordan.

The experiment was carried out in two groups of identical greenhouses. In the first group of greenhouses, OMF was applied as treatments on 10/17/2011, with the application rate of 1 ltr/10000 m$^2$. In the second group of greenhouses, the treatment applications of a well-known (in Jordan) growth stimulant were made on 12/10/2011, with the application rate of 0.5 ltr/10000 m$^2$.

The result of experiment indicated that yields were increased by 8% with the OMF treatments.

### 3.1.5 Experiment 5

Experiment 5 study was located on the farm of Yousef Kteyt (the Jordan River Valley near the Dead Sea (West Jordan)), where the climate is hot with limited precipitation. The soil in greenhouses was moderately alkaline. The watering of was accomplished with the use of streamer (no drip), and fertilizer was applied with water. In this study, OMF fertilizer treatments were applied as leaf treatment. The goal of the experiment was to study the influence of OMF on the initial stage of fruiting of cucumbers under this climate conditions.

The experiment was carried out in two groups of identical greenhouses. In the first group of greenhouses, OMF treatments were applied to leaves, while the second group of greenhouses were used as alternative, with no treatment applications.

The result of experiment indicated that yields were increased by about 20% with the OMF treatments.

### 3.1.6. Experiment 6

In 2011, an experiment was carried out by the Green Cycle Agricultural Co. (Amman, Jordan) using the OMF named Sapro Agro and Sapro Elixir. In the experiment with Sapro Agro, the application rate was 100 ltr/1000 m$^2$ to grapes and a drip irrigation system was used. The results of this study indicated that with Sapro Agro application:

- The plant initial growth is faster.
- There were more vigorous plants, which increased the quantity and quality of grapes.
- Decrease soil salinity was observed which helped grape production.
- There were bigger leaves with a more shiny green color, increased cluster numbers, larger grape size and more grapes with high sugar percentage, and increased yields.

In the experiment with Sapro Elixir, the application rate was 4 ltr/1000 m$^2$ were made to grapes. With this material, the applications were repeated 4 times during the growing season. The results of the experiment using Sapro Elixir showed an increased number of flowers of the plants, which lead
to more vigorous plants and higher yields. The use foliar application of Sapro Elixir in combination with pesticides and other fertilizers indicated a positive response.

4.1. 2014 Studies

4.1.1 Experiment 1

Experiment 1 in 2014 was carried out by the Green Cycle Agricultural Company (Amman, Jordan), using the organic-mineral fertilizer Sapro Agro and Sapro Elixir. Sapro Elixir is manufactured by SIA HUMIN VIT, Ogre, Latvia, and is produced from natural fresh water lake sapropel and natural moisture. Sapro Elixir contains a full spectrum of biologically active ingredients. The product is balanced with limited amounts of NPK and nutrients (http://www.huminvit.lv/sapro-elixir?lang=eng). Sapro Elixir is recommended for use as a nutrient source for:

- saline, depleted and eroded soils with damaged structure,
- soils treated with chemical and mineral fertilizers for a long period of time,
- territories located near city roads and industrial zones with the soils polluted with heavy metals,

Sapro Agro and Sapro Elixir have been mixed with mineral fertilizer (Kama-Eco+) in a ratio of 50/50. The application rate used in the study of this combination was 120 ltr/1000 m².

Experiment 1 in 2014 was carried out on a potato plantation. The developed OMF combination material was used at three application times: first at flowering, and then following with a 15-20 day interval.

Harvest of potato is shown in figures 2 and 3. Result of the experiment showed that without treatment application, the crop production was about 4 kg/m². Using the developed OMF fertilizer combination resulted in yields of 5.2-5.4 kg/m², a yield increase of 28-35%.
4.2. **Experiment 2**

Experiment 2 was carried out by the European Fertil Co. LLC (Amman, Jordan). The Organic-mineral fertilizers Sapro Agro and Sapro Elixir were distributed among Jordanian farmers to use as a supplementation in different types of plantations. Polls of 11 different farmers showed the following:

- Farmers of plantations of sweet pepper, cucumber, and tomato found that crop yield production was increased by 18-20%, water for irrigation was reduced by no less than 15-20%, and there was a significant reduction of fertilizer utilization.

- Utilization of Sapro Agro and Sapro Elixir provided accelerated growth of seedlings. Also, seedling production could be achieved at least 15 days earlier than without the OMF treatments.

- Potato plantation farmers found a nematode reduction.

- Farmers of fruit plantations such as peaches, pears, grapes, lemons, and oranges indicated a reduction in irrigation water utilization and an increase in crop yields.

5. **Conclusions**

Several experiments on the effects of the application of organic-mineral fertilizers based on sapropel and peat were carried out in Middle East countries. Results of experiments using Sapro Agro and Sapro Elixir show that: a) yield of sweet pepper, cucumber, and tomato increased by 18-20%, water for irrigation was reduced by no less than 15-20%, and there was a significant reduction of fertilizer utilization; b) utilization of these OMF provided an accelerated growth of seedlings; c) yield of fruits such as peaches, pears, grapes, lemons, and oranges were increased, and water for irrigation was reduced. Results of experiments using Humin Plus/Sapropeet indicated that: a) yield of cucumbers in greenhouses, where there was a pre-treatment stage of soil, increased by 24%; b) yield of cucumbers treated by Humin Plus/Sapropeet were increased by 31%; c) OMF application was very effective in the early stages of fruiting when the plant needed quick delivery of nutrients; d) correct application rates resulted in higher yields and extended fruiting; and e) it is necessary to repeat the OMF treatment every 10-14 days for optimal results. Most of the farmers who conducted experiments indicated a desire to acquire the Humin Plus/Sapropeat products for future use.
References

