THE EFFECT OF AGRISPON ON EGYPTIAN CLOVER
[TRIFOLIUM ALEXANDRINUM L.] ON A FAYOUM SOIL IN EGYPT

Ali Abdel Razek Sayed

Introduction

Maximizing productivity of plants depends on optimizing various agronomic factors. Among these factors is mineral nutrition, since each crop must be supplied with optimum levels of essential minerals to produce maximum yields. It is critical to have sufficient levels of mineral nutrients, since plants may possess "hidden hunger", having insufficient mineral levels for maximum yields but yet showing no visual deficiency symptoms.

The important role of soil microorganisms in regard to plant nutrition cannot be overstated. Many of the essential nutrient elements found in the soil are complexed, and not readily available for absorption by plant roots. Soil microorganisms can easily change the complexed forms of elements to plant-available soluble forms. If these microorganisms are inhibited because of the excessive use of insecticides, fungicides, and herbicides, the essential nutrient elements will not be made as available for plant use, and the lack of them can be detected by plant and soil analyses (Mengel and Kirkby, 1979).

Agrispon metabolic stimulator is one of the best materials which can promote microorganism activity, increasing microbe numbers in the root zone and encouraging their total activity. Because of this mode of activity, the product has been shown to convert essential soil elements to available forms. This activity also improves the efficiency of added fertilizers, enhances nitrogen fixation by Azotobactor, Nitrobacter, and other nitrogen fixing organism. Farmers who have used Agrispon in past years have reported excellent results, including increased yields, faster plant maturation, reduced water usage, greater seed production, and lower usage of nitrogen fertilizers.

It was postulated by Mengel and Kirkby (1979) that oftentimes the proper bacteria and enzymes are missing in the soil, which normally chelate inorganic minerals prior to root absorption.

The present study is designed to elucidate the importance of using Agrispon on Egyptian clover [Trifolium alexandrinum L.], which is considered the main animal food in Egypt. Also explored in this study is the effect of Agrispon on physical and chemical properties of the soil.

Materials and Methods

Five different field areas growing Egyptian clover [T. alexandrinum L.] were selected on a dairy farm 10 km from Maidoom Pyramid in Fayoum Governorate. Each area (about one feddan) was divided into three subplots. The first subplot was the control treatment. The second one was treated with Agrispon as a foliar spray by diluting 400 cc of Agrispon in an amount of water sufficient to spray one feddan. The third subplot received a soil treatment. The soil treatment for the third subplot involved diluting 400 cc of Agrispon in about 20 liters of irrigation water. Approximately 200 kg of dry soil were collected and wetted thoroughly with this solution. The wetted soil was then spread over the surface of the cultivated soil of the third subplot. Both the foliar and soil treatments were applied one week after the first cutting, when the soil contained about 50% moisture to accelerate the function of Agrispon in increasing, activating, and enhancing soil microorganisms.

About three weeks after Agrispon treatment some growth characteristics such as plant height, fresh and dry

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1 Contribution of the Soil and Water Research Institute, Agricultural Research Center, Ministry of Agriculture and Land Reclamation, Egypt.
weights, moisture content, and leaf/stem ratio were studied on collected plant samples. Then, plants were thoroughly cleaned with water to remove any external contamination. They were air-dried, ground, and stored in clean, dry containers for chemical analyses later.

Soil samples were also collected three weeks after treatment. The upper 15 cm of soil was sampled. These samples were air-dried, ground, and stored in dry, clean jars for chemical analyses later.

Soil reaction was determined by the method described by Jackson (1958). Calcium carbonate percent and organic matter percent were determined according to Chapman's (1961) method. Mechanical analysis was carried out by the method of Jackson (1958). Total soluble salts as well as cation exchange capacity (CEC) were determined by the method of Chapman (1961). Exchangeable calcium, magnesium, and sodium were photometrically determined in the soil samples by the method of Jackson (1958).

Nitrogen, phosphorus, and potassium in the soil and in plant samples were estimated by the method of Ulrich and Albert (1978). Calcium and magnesium in the plant, as well as zinc, iron, manganese, copper, and boron in the soil and plant, were determined using the atomic absorption spectrophotometer (Mangel, 1979).

All data were collected and statistically analyzed.

**Results and Discussion**

About 3 weeks after Agrispon treatment the treated clover showed greater length and density, and had a darker green color. Representative plant samples were collected from each subplot.

**Plant growth characteristics**

a. **Plant length**
   From the average means of the treated and untreated plants (Table 1, Figure 1), it is obvious that using Agrispon as a foliar spray enhanced cell elongation, and increased plant height by 18%. Agrispon was applied as a foliar spray plus a soil application. The height increased by 34% over the control.

b. **Fresh weight per plant**
   From data in Table 1 and Figure 2, it is clear that there is a remarkable increase in the fresh plant weight (22%) when Agrispon was used as a foliar spray. The increase was 28% when it was used as a foliar plus a soil application.

c. **Dry weight per plant**
   Table 1 shows a noticeable increase in the dry weight of the clover that received Agrispon by spray on the foliage (31%). The plots that received Agrispon as a foliar spray as well as a soil application increased in dry weight by 36%, as compared with the untreated control (Table 1 and Figure 3).

d. **Moisture percentage**
   No change in the moisture percent of the clover was detected among the treatment (Table 1).

e. **Leaf/stem ratio**
   Table 1 and Figure 4 showed noticeable increases in the leaf/stem ratio resulting from supplying Agrispon as a foliar spray only, or as a foliar spray plus a soil application. The increases were 16% and 20%, respectively.
Table 1. The effect of adding Agrispon as a foliar spray or a foliar spray plus a soil treatment on some growth characters of clover grown on Fayoum soil.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant height cm incr.</th>
<th>Fresh wt./plant g incr.</th>
<th>Dry wt./plant g incr.</th>
<th>Moisture % incr.</th>
<th>Leaf/stem ratio incr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>33.2</td>
<td>--</td>
<td>28.3</td>
<td>--</td>
<td>4.26</td>
</tr>
<tr>
<td>Agrispon, Foliar only</td>
<td>39.1*</td>
<td>+18%</td>
<td>34.5*</td>
<td>+22%</td>
<td>5.58*</td>
</tr>
<tr>
<td>Foliar + Soil</td>
<td>44.5*</td>
<td>+34%</td>
<td>36.1*</td>
<td>+28%</td>
<td>5.79*</td>
</tr>
<tr>
<td>L.S.D. (.05)</td>
<td>5.1</td>
<td>4.4</td>
<td>0.95</td>
<td>n.s.</td>
<td>0.018</td>
</tr>
</tbody>
</table>

* Increase is significant at P=.05.

Chemical composition of the clover plants

a. Nitrogen, phosphorus, and potassium contents

It is clearly noticed from Table 2 that using Agrispon as a foliar spray increased the N, P, and K contents by 9, 64, and 73% respectively. When Agrispon was applied as a foliar spray plus a soil application, these increases were raised to 18, 21, and 38% for nitrogen, phosphorus, and potassium, respectively (Figures 5, 6, and 7). Embleton et. al. (1976) reported that the availability of macronutrients was substantially increased by increasing the microbial activity of the soil.
Table 2. The effect of adding Agrispon as a foliar spray or as a foliar spray and soil application on total N, P, K, Ca, and Mg contents of clover plants grown on a Fayoum soil.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th></th>
<th>P</th>
<th></th>
<th>K</th>
<th></th>
<th>Ca</th>
<th></th>
<th>Mg</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1.63</td>
<td>--</td>
<td>0.14</td>
<td>--</td>
<td>0.74</td>
<td>--</td>
<td>0.18</td>
<td>--</td>
<td>0.19</td>
<td>--</td>
</tr>
<tr>
<td>Agrispon Foliar only</td>
<td>1.78</td>
<td>9%</td>
<td>0.23</td>
<td>64%</td>
<td>1.28</td>
<td>73%</td>
<td>0.23</td>
<td>28%</td>
<td>0.21</td>
<td>11%</td>
</tr>
<tr>
<td>Foliar + Soil</td>
<td>1.92</td>
<td>*18%</td>
<td>0.31</td>
<td>*121%</td>
<td>1.76</td>
<td>*138%</td>
<td>0.38</td>
<td>111%</td>
<td>0.26</td>
<td>37%</td>
</tr>
<tr>
<td>L.S.D. (.05)</td>
<td>0.20</td>
<td>0.08</td>
<td>0.38</td>
<td>0.09</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Increase is significant at P = 0.5.
b. Calcium and magnesium contents

Data obtained from Table 2, and illustrated in Figures 8 and 9, clarify the positive effects of using Agrispon. Increases in calcium and magnesium contents of 28 and 11%, respectively, resulted from spraying Agrispon on the clover foliage. Larger increases were recorded when Agrispon was applied as a foliar spray plus a soil application: for calcium 11%, and magnesium 33% (see Figures 8 and 9). Hiwitte (1951) mentioned the important roles calcium and magnesium play in higher plants, and the effect of them on photosynthesis and standability of legume plants.

c. Zinc, iron, manganese, copper and boron contents

Data recorded in Table 3 show positive trends for these micronutrients in the clover. Greater absorption of nutrients from the soil necessarily results from a greater release of nutrients from the soil particles. It seems that Agrispon has the ability of changing the complexed forms of nutrients to readily available forms. Stevenson and Ardakani (1972) clarified the role of organic matter and microorganisms in converting nutrients, especially micronutrients, to available forms.

Table 3. The effects of adding Agrispon as a foliar spray or as a foliar spray and soil treatment on total Zn, Fe, Mn, Cu, and B contents of alfalfa plants grown on Fayoum soil.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Zn ppm increase</th>
<th>Fe ppm increase</th>
<th>Mn ppm increase</th>
<th>Cu ppm increase</th>
<th>B ppm increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>23</td>
<td>31</td>
<td>17</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Agrispon Foliar only</td>
<td>27* 17%</td>
<td>80* 158%</td>
<td>25</td>
<td>47%</td>
<td>5* 25%</td>
</tr>
<tr>
<td>Foliar + Soil</td>
<td>33* 44%</td>
<td>97* 213%</td>
<td>38* 124%</td>
<td>8* 100%</td>
<td>7* 133%</td>
</tr>
<tr>
<td>L.S.D. (.05)</td>
<td>3</td>
<td>24</td>
<td>6</td>
<td>0.8</td>
<td>0.9</td>
</tr>
</tbody>
</table>

* Increase is significant at P = 0.5.

Figure 10 Total Zn ppm

Figure 11 Total Fe ppm

Figure 12 Total Mn ppm

Figure 13 Total Cu ppm
It is clearly noted from Figures 10, 11, 12, 13, and 14 that applying Agrispon as a foliar spray increased Zn, Fe, Mn, Cu, and B contents of alfalfa leaves by 17, 158, 47, 25, and 67% respectively. When Agrispon was applied as a foliar spray plus a soil application these increases were raised to 44, 213, 124, 100, and 133% for the same minerals. Olsen (1970) mentioned that the presence of micronutrients in adequate amounts decreases their interactions, so these increased levels of micronutrients in response to Agrispon mean a greater availability of all of these elements for the clover.

Soil physical and chemical properties

Stevenson and Ardakani (1972), in their studies on the mode of reaction of organic matter additions to soils, mentioned that crop yields can be increased by overcoming the nutrient fixation problem. They said that in order for plants to utilize a mineral found in the soil, it first must be solubilized. Russell (1973) added that some of the metals occurring naturally in the soil and still unknown as nutritive elements are held as insoluble complexes and are not available to plants. Rixhan and Crohain (1965), in their study on growth regulating substances, mentioned that there are still some heavy metals not now recognized that seem to be essential for plant growth and production. Any biological factor that makes these metals more available for plants is considered, from the nutritional point of view, a factor to enhance increased crop yields and improved crop quality. Following the lead of the previous discussion, it is valuable to understand the role of Agrispon in improving soil properties as well as making nutrient elements more available for plant growth and production.

a. pH, CaCO₃%, electrical conductivity (E. C.), and organic matter

Table 4 contains data on the effect of adding Agrispon as a foliar spray on pH. A slight drop in soil pH resulted from increasing microorganism activity. pH value changed from 7.8 to 7.6 when Agrispon was applied as foliar spray, and to 7.5 when it was foliar sprayed plus added to the soil; see Figure 15.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>PH value</th>
<th>CaCO₃ decrease</th>
<th>E.C. decrease</th>
<th>Organic matter increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>7.8</td>
<td>--</td>
<td>2.49</td>
<td>1.42</td>
</tr>
<tr>
<td>Agrispon foliar</td>
<td>7.6</td>
<td>3%</td>
<td>2.26*</td>
<td>1.61*</td>
</tr>
<tr>
<td>Foliar + Soil application</td>
<td>7.5</td>
<td>4%</td>
<td>1.78*</td>
<td>1.68*</td>
</tr>
<tr>
<td>L.S.D. (.05)</td>
<td>n.s.</td>
<td>0.14</td>
<td>0.17</td>
<td>0.08</td>
</tr>
</tbody>
</table>

* Increase or decrease is significant at P = .05.

Calcium carbonate percent decreased from 5.92% to 5.31% when Agrispon was used as a foliar spray, and to 4.75% when Agrispon was used as a foliar spray plus a soil treatment (see Figure 16).
Electrical conductivity decreased from 2.49 umohs/cm to 2.26 umohs/cm when Agrispon was applied as a foliar spray, and to 1.78 umohs/cm when Agrispon was foliar sprayed plus added to the soil, as shown in Figure 17.

Agrispon proved to be a beneficial factor in increasing microorganisms and organic matter content as well. Spraying Agrispon on the alfalfa foliage resulted in a 13% increase in soil organic matter content. When Agrispon was applied as a foliar spray plus added to the soil, this increase was raised to 18%, as shown in Figure 18.

![Figure 15 Soil pH](image1)

![Figure 16. CaCO₃](image2)

b. C.E.C., Na⁺, Ca²⁺, Mg²⁺, and SAR% in the soil

Data recorded in Table 5, and illustrated in Figures 19, 20, 21, 22, and 23, clarify the effective role of Agrispon in improving various soil chemical properties. Using Agrispon as a foliar spray caused a 7% increase in the cation exchange capacity. This increase was raised to 14% when Agrispon was used as a foliar plus soil application, as shown in Figure 19.

Table 5. The effect of adding Agrispon as a foliar spray or as a foliar spray and a soil application on cation exchange capacity, Na⁺, Ca²⁺, and Mg²⁺ and sodium adsorption ratio of Fayoum soil.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>C.E.C.</th>
<th>Na⁺</th>
<th>Ca²⁺</th>
<th>Mg²⁺</th>
<th>S.A.R.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>meq/100g</td>
<td>% increase</td>
<td>meq/100g</td>
<td>% increase</td>
<td>meq/100g</td>
</tr>
<tr>
<td>Control</td>
<td>38.6</td>
<td>--</td>
<td>16.4</td>
<td>--</td>
<td>13.8</td>
</tr>
<tr>
<td>Agrispon Foliar only</td>
<td>41.4*</td>
<td>7%</td>
<td>15.7</td>
<td>4%</td>
<td>15.1*</td>
</tr>
<tr>
<td>Agrispon Foliar + Soil</td>
<td>43.8*</td>
<td>14%</td>
<td>15.1* 8%</td>
<td>15.7* 14%</td>
<td>5.4*  50%</td>
</tr>
<tr>
<td>L.S.D. (.05)</td>
<td>2.8</td>
<td>0.8</td>
<td>0.9</td>
<td>0.3</td>
<td>0.4</td>
</tr>
</tbody>
</table>

* Increase or decrease is significant at P = .05.

Cations such as sodium, calcium, and magnesium ions changed in concentration with Agrispon application. A slight decrease occurred in the level of sodium ions when Agrispon was foliar sprayed, or foliar sprayed plus added...
to the soil. These decreases were 4 and 8% respectively. Increases were observed in calcium and magnesium ions when Agrispon was applied as a foliar spray, and as a foliar spray plus a soil application. These increases were 9% and 14% for calcium and magnesium when Agrispon was foliar sprayed, and 14% and 50% when Agrispon was applied as a foliar spray plus a soil application; see Figures 21 and 22.

The Sodium Adsorption Ratio was remarkably decreased (by 11%) when Agrispon was applied as a foliar spray, and decreased by 18% when Agrispon was foliar sprayed plus added to the soil as shown in Figure 23. This means the Agrispon decreased the alkalinity of the soil.

c. Nitrogen, phosphorus, and potassium contents

Rabi (1974) mentioned that when plants have adequate and balanced mineral nutrition, they can perform their required functions more efficiently. Besides having sufficient energy, they are able to regulate physiological processes properly.
Nitrogen increased by 11% when Agrispon was applied as a foliar spray, and by 23% when it was used as a foliar plus soil application (Table 6, and Figure 24). Phosphorus showed an even greater increase than nitrogen in response to Agrispon. Phosphorus increased by 39% and 54%, respectively, when Agrispon was foliar sprayed or foliar sprayed plus applied to the soil. Potassium increased by 16% when Agrispon was added as a foliar spray, and by 26% when it was foliar sprayed plus applied to the soil as shown in Table 6 and Figures 25 and 26.

Table 6. The effect of adding Agrispon as a foliar spray or as a foliar spray plus a soil treatment on N, P, K and Zn contents of Fayoum soil.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>M ppm increase</th>
<th>P ppm increase</th>
<th>K ppm increase</th>
<th>Zn ppm increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>6.5</td>
<td>--</td>
<td>2.8</td>
<td>--</td>
</tr>
<tr>
<td>Agrispon, foliar only</td>
<td>7.2</td>
<td>11%</td>
<td>3.9*</td>
<td>39%</td>
</tr>
<tr>
<td>Agrispon, foliar + soil</td>
<td>8.0*</td>
<td>23%</td>
<td>4.3*</td>
<td>54%</td>
</tr>
<tr>
<td>L.S.D. (.05)</td>
<td>1.1</td>
<td>0.9</td>
<td>32</td>
<td>0.1</td>
</tr>
</tbody>
</table>

* Increase is significant at P = .05.

Figure 24 N ppm.

Figure 25 P ppm.

Figure 26 K ppm.

Figure 27 Zn ppm.

d. Zinc, iron, manganese, copper, and boron contents

Data in Table 6 and Figure 27 show increases in Zn concentration in Fayoum soil in response to using Agrispon. Increases were 17 and 83%, respectively, when Agrispon was applied as a foliar spray only, or as a foliar spray plus a soil application.

It is clear that micronutrient deficiencies do exist in Egypt, especially in newly reclaimed lands (Rasheed, 1965). Thus, Agrispon effects to increase micronutrient levels of crops are especially noteworthy.
The iron concentration increased by 89% when Agrispon was applied as a foliar spray only, and by 184% when Agrispon was applied as a foliar spray and to the soil as well; see Table 7 and Figure 28. Manganese, copper, and boron contents were also increased; 71, 40, and 60% respectively, when Agrispon was applied as a foliar spray only. These increases were raised to 105, 60, and 90% respectively, when Agrispon was used as a foliar application plus added to the soil as shown in Figures 29, 30, and 31.

**Table 7.** The effect of adding Agrispon as a foliar spray or as a foliar spray plus a soil treatment on the Fe, Mn, Cu, and B contents of Fayoum soil.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Fe ppm</th>
<th>Mn ppm</th>
<th>Cu ppm</th>
<th>B ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>increase</td>
<td>increase</td>
<td>increase</td>
<td>increase</td>
</tr>
<tr>
<td>Control</td>
<td>1.8</td>
<td>--</td>
<td>2.1</td>
<td>--</td>
</tr>
<tr>
<td>Agrispon, foliar only</td>
<td>3.4*</td>
<td>89%</td>
<td>3.6*</td>
<td>71%</td>
</tr>
<tr>
<td>Agrispon, foliar + soil</td>
<td>5.1*</td>
<td>183%</td>
<td>4.3*</td>
<td>105%</td>
</tr>
<tr>
<td>L.S.D. (.05)</td>
<td>1.2</td>
<td>0.7</td>
<td>0.8</td>
<td>0.16</td>
</tr>
</tbody>
</table>

* Increase is significant at P = .05.

From the foregoing discussion on Agrispon effects to Egyptian clover and a Fayoum soil, several things may be said about the product's nature:

1. It activates vegetative growth.
2. It increases the mineral content of clover plants.
3. It improves the physical and chemical properties of the soil.
4. It triggers the release of more available nutritive elements in the soil, which benefits the plants growing there.
Wallace (1953) mentioned that adequate levels of nutritional elements in the soil make plants grow faster, use less water, resist temperature extremes, fight diseases, resist insects, and achieve a higher nutrient content.

**Summary and Conclusions**

Agrispon was applied as a foliar spray a week after the first cutting of Egyptian clover grown on Fayoum soil. It was also applied as a combined foliar spray and soil treatment. This trial was carried out in 5 sites of a dairy farm, with an untreated control for each site. Some growth characteristics, mineral content in the plant and soil, as well as some physical properties were studied 3 weeks after the Agrispon treatments.

Data revealed that Agrispon application, by either of the two methods, caused remarkable increases in plant height, plant fresh and dry weights, and leaf/stem ratios. Agrispon decreased Na\(^+\) ions and the sodium adsorption ratio of the soil, and increased the cation exchange capacity as well as calcium and magnesium ions in the soil. Agrispon caused a noticeable increase in the solubility of nutritive elements already existing in the soil. Because of this, the mineral content of the clover leaves was also increased, making the clover a richer feed crop for animals.

**References**


