Effects of Foliar Application of Fe and Zn on Seed Yield and Mucilage Content of Psyllium at Different Stages of Maturity

Saeid Zehtab-Salmasi, Saeideh Behrouznajhad and Kazem Ghassemi-Golezani

Abstract—In order to evaluate the effects of foliar application of micronutrients (iron and zinc) and different harvesting times during seed filling on yield and mucilage percentage of psyllium, a field experiment was carried out in 2009 at the Research Farm of the Faculty of Agriculture, University of Tabriz. The experiment was arranged as split plot based on randomized complete block design with four replications. The treatments were foliar application of Fe, Zn and Fe+Zn (using ferrous sulphate and zinc sulphate at the concentration of 0.35% for the both micronutrients) with control and four harvesting times during seed filling. The results showed that seed yield, seed swelling and mucilage percentage were increased by foliar application of Fe and Zn, compared with control (untreated). The highest seed yield (832.5 kg.ha-1), seed swelling (12.78 ml) and mucilage percentage (8.35%) were recorded for spray treatment by about 31.04, 21.71 and 41.52 % improvements in comparison with control, respectively. Different harvesting times had significant effect on seed yield, seed swelling and mucilage percentage. The highest seed yield was obtained at seed maturity stage. At this stage seed swelling and mucilage percentage were the lowest, but this was overcome by large improvement in seed yield. It seems that foliar application of iron and zinc can considerably improve seed yield, seed swelling and mucilage content of psyllium.

Keywords—Harvesting time, maturity, mucilage percentage, Psyllium, seed swelling, yield.

I. INTRODUCTION

Plantago belongs to the Plantaginaceae family with two valuable medicinal species of Isabgol (Plantago ovata) and Psyllium (Plantago psyllium). Psyllium is native to Mediterranean regions and is cultivated in a large scale in France and Spain [4]. Economic value of this species is related to mucilage content of the seed mainly used in medicine and industry. Mucilage content of Psyllium has been reported to reach between 10-15 % [1]. Some reports suggest that the secondary metabolites of medicinal plants can be improved by foliar application of micronutrients [2,9]. However, the effect of micronutrients on mucilage content of psyllium seeds is not investigated.

Micronutrient deficiency can greatly disturb plant yield and quality, and the health of domestic animals and humans. Foliar application of fertilizers is a particularly useful technique designed to meet plants specific needs for one or more micro or macro nutrients especially trace minerals. This enables us to correct deficiencies, strengthen weak or damaged crops, speed up growth and grow better and heal thier plants. Micro- elements as Fe, Zn, Mn and Cu are added to foliar fertilizers, in order to compensate their deficiency especially in arid and semi arid regions [9].

Zinc is an important micronutrient that is closely involved in the metabolism of RNA and ribosomal content in plant cells, leading to stimulation of carbohydrates, proteins and the DNA formation. It is also, required for the synthesis of tryptophan, a precursor of IAA which acts as a growth promoting substance. Zinc has three functions: catalytic, cocatalytic (coactive) and structural. Iron (Fe) is another micronutrient that is a cofactor for approximately 140 enzymes that catalyze unique biochemical reactions. Hence, iron has many essential roles in plant growth and development including chlorophyll synthesis, thylakoid synthesis and chloroplast development. Said-Al Ahl and Mahmoud [8] reported that basil plants sprayed with zinc and/or iron under normal and saline conditions were superior compared with non-sprayed plants. Also the highest plant height, branches per plant, fresh and dry biomass and essential oil yield obtained by foliar application of these elements in normal soil. Foliar spraying with zinc (100 ppm) in blue sage (Salvia farinacea L.) enhanced the length of peduncle, length of main inflorescence, number of inflorescence and florets, and fresh and dry weight of inflorescences/ plant. It was reported that flower yield, essential oil percentage and essential oil yield of chamomile (Matricaria chamomilla) increased by foliar application of Fe and Zn compared with control [7]. Foliar application of microelements increased fresh and dry mater, leaf area of plant, bush and leaf essential oil percentage and essential oil yield of peppermint (Mentha piperita) [9].

The purpose of this study is to investigate the effect of foliar application of some micronutrients and harvesting time on yield and mucilage content of psyllium.

II. MATERIALS AND METHODS

A field experiment was carried out in 2009 at the Research Farm of the Faculty of Agriculture, University of Tabriz, Tabriz (37°, 5´ N, 46°, 17´ E and 1360 m mean sea level), Iran. The physicochemical properties of soil are given in Table 1.
The treatments were foliar application of Fe, Zn and Fe + Zn (using ferrous sulphate and zinc sulphate at the concentration of 0.35% for the both micronutrients) with control and four harvesting times during seed filling. The experiment was arranged as split plot based on randomized complete block design with four replications. The plots were 4 × 1.8 m with 6 rows, 30 cm row distance and 7.5 cm seed distance. Soil moisture was kept at adequate levels to prevent water deficit and wilting. Weeds were controlled by hand as required. Foliar spray was done according to experimental treatments at flowering stage.

Plants were harvested four times (8, 15, 22 August and 5 September) from four central rows (0.9 m² each time) during seed filling. One gram seeds of each sample was put into a beaker with 25 ml capacity. Then, 20 ml distilled water was added to it. The swelling of seeds was calculated after 24h.

### III. RESULTS AND DISCUSSION

Seed yield, seed swelling and mucilage percentage significantly affected by Foliar application of iron, zinc and iron+ zinc (p≤0.05) and harvesting times (p≤0.01). Seed yield was significantly increased by foliar application of Fe + Zn. This improvement was 16.09, 17.47 and 31.04 %, compared with foliar application of Fe, Zn and control, respectively (Table 2).

#### TABLE I

**EFFECT OF FOLIAR APPLICATION OF ZN AND Fe ON YIELD AND MUCILAGE PERCENTAGE OF PSYLLIUM**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Seed yield (kg. ha⁻¹)</th>
<th>Seed swelling (ml)</th>
<th>Mucilage percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>635.3 b</td>
<td>10.50b</td>
<td>5.90b</td>
</tr>
<tr>
<td>Zn</td>
<td>708.7 b</td>
<td>11.94 ab</td>
<td>6.869ab</td>
</tr>
<tr>
<td>Fe</td>
<td>717.1 b</td>
<td>11.34 ab</td>
<td>7.338ab</td>
</tr>
<tr>
<td>Zn + Fe</td>
<td>832.5 a</td>
<td>12.78 a</td>
<td>8.350 a</td>
</tr>
</tbody>
</table>

Different letters shows significant difference at p≤0.05

#### TABLE II

**EFFECT OF HARVESTING TIME ON YIELD AND MUCILAGE PERCENTAGE OF PSYLLIUM**

<table>
<thead>
<tr>
<th>Harvesting stage</th>
<th>Seed yield (kg. ha⁻¹)</th>
<th>Seed swelling (ml)</th>
<th>Mucilage percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>23 Days after flowering</td>
<td>161.8 d</td>
<td>16.69 a</td>
<td>12.25 a</td>
</tr>
<tr>
<td>30 Days after flowering</td>
<td>360.5 c</td>
<td>12.66 b</td>
<td>7.169b</td>
</tr>
<tr>
<td>37 Days after flowering</td>
<td>807.7 b</td>
<td>9.496 c</td>
<td>5.363b</td>
</tr>
<tr>
<td>51 Days after flowering</td>
<td>1564 a</td>
<td>7.750 c</td>
<td>3.675c</td>
</tr>
</tbody>
</table>

Different letters shows significant difference at p≤0.01

The highest mean seed swelling of psyllium was obtained by application of Fe+Zn, 31.04 % improvement in comparison with control (Table 1). However, the highest mucilage percentage (% 8.350) was recorded for the foliar application of Fe and Zn. These results are in agreement with those reported for sweet basil [8] and peppermint [6,9]. Similarly, Nasiri et al. [7] reported that essential oil percentage and essential oil yield of chamomile increased by foliar application of Fe and Zn compared with control. The highest essential oil percentage (1.062%), and essential oil yield (20.835 kg ha⁻¹) were obtained for Fe + Zn spray treatment with about 24.64, and 81.77% improvements in comparison with control. Seed swelling for two last stages of seed filling was statistically similar, but it was significantly lower than that for early stages of seed filling. Mucilage percentage decreased with progressing seed development (Table 2). This may be resulted from suitable climatic conditions such as more sunny days and appropriate temperature during the seed filling. In general, the time of harvest is in close relation with the yield and quality of the essential oil and it varies from place to place and from plant to plant. Therefore, it is essential to determine the proper harvesting time for aromatic plants to obtain a better yield and...
quality. Foliar feeding is a relatively new and controversial technique of feeding plants by applying liquid fertilizer directly to their leaves. Thus, the foliar application of mineral nutrients offers a method of supplying nutrients to higher plants that are more efficiently than methods involving root application when soil conditions are not suitable for nutrients availability [3].

REFERENCES


