Physiological response of zucchini squash (cucurbita pepo l. Var. Giromontia) to foliar fertilization

Dimka Haytova

Agricultural University, 12 Mendeleev str.t, 4000 Plovdiv, Bulgaria

Corresponding Author email: haitova@abv.bg

Abstract

The main aim of this study was to investigate the influence of various complex foliar fertilizers on the leaf-gas exchange parameters, and leaf pigment content of zucchini squash. The experiments were carried out during the period 2007-2009, on Experimental field of Department of Horticulture at the Agricultural University of Plovdiv, Bulgaria. Variety Izobilna F1 was used as an object of the experiments. The field experiments were done by randomized block design with four replications. Complex foliar fertilizers Fitona® 3, Hortigrow® and Humustim®, without soil fertilization and in background on soil fertilization N₂₀P₀₀K₀₀ were investigated. Leaf-gas exchange parameters and leaf pigment content were determined. The results of this experiment indicate that foliar fertilization with complex foliar fertilizers Fitona® 3, Hortigrow® and Humustim® influence leaf-gas exchange, especially photosynthetic rate and leaf pigment content. The lowest rates of photosynthesis and leaf chlorophyll content were observed in the non-fertilized zucchini plants (control). It was established that foliar fertilization with 0.3% Humustim® along with soil fertilization N₂₀P₀₀K₀₀ enhanced parameters of leaf-gas exchange and leaf pigment content.

Key words: foliar fertilizers; Leaf-gas exchange parameters; photosynthetic rate; leaf pigment content; stomatal conductivity; zucchini; Cucurbita pepo L. var. giromontia

Introduction

The main objective of scientific investigations in vegetable crop production is to increase plant productivity and obtaining quality yields. One of way to achieve this purpose is to optimize technologies for growing plants. Foliar application is considered as part of the agronomic techniques carried out during the period of cultivation as an opportunity to increase plant productivity (Bileva and Babricov, 2007; Fawzy et al., 2010).

For the assessment of effect of applied agro-technical events, ever more often used physiological indicators. Mainly studied are on the parameters of leaf gas exchange, and photosynthetic pigments content (Ivanova and Vassilev, 2002; Panayotov and Stoeva, 2005a; Panayotov and Stoeva, 2005b; Panayotov et al. 2005). According to Klamkowski et al. (2011), with these parameters it was possible to assess the physiological state of plants growth and evaluate the efficiency of application of different foliar fertilizers.

Despite the significant number of investigation on vegetables requirements of foliar fertilization, little is known about influence of different foliar fertilizers on the physiological response of zucchini squash. Information in Bulgarian and foreign scientific literature is limited.

The aim of the present investigation is to study effect of various complex foliar fertilizers on the leaf-gas exchange parameters, and content of photosynthetic pigments of zucchini plants.

Materials And Methods

The investigation was conducted in the period 2007–2009 in an open field condition with the zucchini cultivar Izobilna F1, on the experimental field of the Agricultural University of Plovdiv, Bulgaria. The soil is assigned as Molic Fluvisols (Popova and Sevov, 2010). The depth of the humus horizon is 28-30 cm. The soil is loamy (clay content from 30% to 41%). Chemically, the soil is characterized by a low content in organic matter (1.46%), pH neutral to slightly alkaline (7.17-7.37) and by the presence of large amounts of CaCO₃, which gives more favorable physical-chemical water and soil properties,
Results And Discussion

The results indicate that foliar fertilizers affect basic parameters characterizing leaf gas exchange (Tabl.1). In the beginning of the fruitfulness increase the rate of photosynthesis was observed in all tested variants compared with control. Less value the change in the rate of photosynthesis was in alone application with foliar fertilizers. It varies from 26.78 μmolm⁻²s⁻¹ to 28.42 μmolm⁻²s⁻¹, respectively for 0.3% Fitona® and 0.3% Humustim®. Increase compared to control was 4.69% and 11.10%. When used 0.2% Hortigrow® the rate of photosynthesis was 8.17% higher compared to non fertilized plants. When use of foliar fertilizers combined with soil fertilization, the greatest influence on photosynthesis rate had 0.3% Hortigrow®. Increase compared to control was 25.22%. Immediately after it ranks is N₁₆₀P₁₆₀K₁₆₀ + Hortigrow® -0.2% to 22.32% increase compared control.

In the beginning of fruitfulness was determined tendency to increasing of transpiration under the influence of foliar fertilizers combined with soil fertilization, the greatest influence on photosynthesis rate had 0.3% Hortigrow®. Increase compared to control was 4.69% and 11.10%. When used 0.2% Hortigrow® the rate of photosynthesis was 8.17% higher compared to non fertilized plants. When use of foliar fertilizers combined with soil fertilization, the greatest influence on photosynthesis rate had 0.3% Humustim®. Increase compared to control was 25.22%. Immediately after it ranks is N₁₆₀P₁₆₀K₁₆₀ + Hortigrow® -0.2% to 22.32% increase compared control.

In the beginning of fruitfulness was determined tendency to increasing of transpiration under the influence of foliar fertilization is comparable to that photosynthesis. After control, lowest transpiration of plants was sprayed with 0.3%Fitona®. The increase compared with the control was 4.89%. Fitona® used after soil fertilization with N₁₆₀P₁₆₀K₁₆₀ adds to the intensity of transpiration by 14.37%. Similar results were variants of fertilization with Hortigrow® and Humustim®. Changes in stomatal conductivity have not been established. In mass fruitfulness, the same trend was established, like in the beginning of fruitfulness phase. Values of the rate of photosynthesis were lower than in the previous phase. This peculiarity may be due to the fact that in this stage the photosynthetic apparatus is fully formed and vegetative growth gives in gradually increasing the reproductive events. At the same time, the intensity of photosynthesis in fertilizing variants remained higher the control, despite the fact that with alone foliar application the statistically differences are not significant.
Increasing of the rate of photosynthesis increasing transpiration and stomatal conductivity were observed. This feature is probably due to a better water status of the treated plants. The one hand, foliar fertilizers directly stimulate the vegetative development of plants, on other hand stimulate the function of the root system, wish not only improve the nutritional status of plants, improves water status them.

It is accepted that factors changing the photosynthetic rate have stomatal and non-stomatal nature. To what extent the increased transpiration enhances photosynthetic rate cold be explained after analysis of dependence of CO₂ assimilation on the intercellular CO₂ concentration. In this case we can only admit that the increased leaf gas-exchange, which also includes photosynthesis, is a result of the complex positive effect of foliar fertilization on the zucchini plants. According to Berova and Karanastidis (2008) the improved leaf gas exchange is a precondition for higher productivity of the plants.

The positive effect of foliar fertilization on the content of photosynthetic pigments was observed (Fig1.). The content of chl”a” and chl”b” and carotenoids were increased for variants N₁₆₀P₁₆₀K₁₆₀ + foliar fertilizer. The ratios between pigments were not changed and were within the limits on the norm. Increasing of photosynthetic pigments may be due both - to their intensive synthesis, and their more slowly degradation. The ground for this admission we have a comparatively constant levels of carotenoids in both phases of development. It is well known that the main function of the yellow pigments is chlorophyll prevention of oxidation. Any decrease in the content of carotenoids would break the stability of the green pigments in pigment-protein complex. Despite limited data in the literature confirming the results were obtained in publication of Sarhan et al.(2011), which established increased of total chlorophyll content in the leaves of zucchini after fertilization with organic and bio-fertilizers.

Increase of photosynthetic pigments content can be reason for the higher photosynthetic rate in variants with soil fertilization and foliar application. Berova and Karanastidis (2008) made similar conclusions by studying these physiological parameters in pepper. According to Anderson et al. (1995) and Klamkowski et al. (2011) this fact could be explained as an adaptation of photosynthetic apparatus to nutrient regime.

Table 1. Influence of different variants of fertilization on leaf gas exchange of zucchini squash average for the period 2007-2009

<table>
<thead>
<tr>
<th>Variants</th>
<th>Photosynthetic rate – A</th>
<th>Transpiration rate – E</th>
<th>stomatal conductivity g.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>beginning of fruitfulness</td>
<td>mass fruitfulness</td>
<td>beginning of fruitfulness</td>
</tr>
<tr>
<td></td>
<td>µmolm⁻²s⁻¹</td>
<td>%</td>
<td>µmolm⁻²s⁻¹</td>
</tr>
<tr>
<td>Control</td>
<td>25.58</td>
<td>100.00</td>
<td>17.57</td>
</tr>
<tr>
<td>Fitona-0.3%</td>
<td>26.78</td>
<td>104.69</td>
<td>18.14</td>
</tr>
<tr>
<td>Hortigrow-0.2%</td>
<td>27.67</td>
<td>108.17</td>
<td>18.51</td>
</tr>
<tr>
<td>Humustim-0.3%</td>
<td>28.42</td>
<td>111.10</td>
<td>18.63</td>
</tr>
<tr>
<td>N₁₆₀P₁₆₀K₁₆₀</td>
<td>29.32</td>
<td>114.62</td>
<td>19.26</td>
</tr>
<tr>
<td>Fitona-3%</td>
<td>31.29</td>
<td>122.32</td>
<td>19.57</td>
</tr>
<tr>
<td>Hortigrow-0.2%</td>
<td>32.03</td>
<td>125.22</td>
<td>21.66</td>
</tr>
<tr>
<td>Humustim-0.3%</td>
<td>32.03</td>
<td>125.22</td>
<td>21.66</td>
</tr>
<tr>
<td>GD - 5%</td>
<td>0.516</td>
<td>1.473</td>
<td>0.160</td>
</tr>
<tr>
<td>GD – 1%</td>
<td>0.707</td>
<td>2.018</td>
<td>0.219</td>
</tr>
<tr>
<td>GD-0.1%</td>
<td>0.963</td>
<td>2.751</td>
<td>0.298</td>
</tr>
</tbody>
</table>

Figure 1. Content of photosynthetic pigments, average for period 2007-2009 year
Legend: 1. Control (without fertilization); 2. Foliar fertilization with 0.3% Fitona®; 3. Foliar fertilization with 0.2% Hortigrow®; 4. Foliar fertilization with 0.3% Humustim®; 5. Soil fertilization with N160P160K160 + 0.3% Fitona®; 6. Soil fertilization with N160P160K160 + 0.2% Hortigrow®; 7. Soil fertilization with N160P160K160 +0.3% Humustim®.

Contradictory data about the relationship between photosynthetic intensity and chlorophyll content of leaves have been reported. Along with the reports for the lack of linear relation between two indices there are other reports that higher total chlorophyll content is one of the main factors stimulating the rate of photosynthesis and biological productivity of organisms (Berova and Karanastidis, 2008). Our results support this hypothesis.

Conclusions
The results of the assays on the influence of foliar fertilization on physiological behaviors of zucchini indicated that the use of Fitona®, Hortigrow® and Humustim® during the growing season influenced the functional activity of the photosynthetic apparatus. Measurements of leaf gas exchange were improved and the contents of plastid pigments were increased. More strongly when it was applied on a background of soil fertilization.

Use of 0.3% Humustim® after soil fertilization with N160R160K160 increased the rate of photosynthesis, transpiration intensity and content of photosynthetic pigments.

References
Bileva T, Babrikov T. 2007. Study the influence of Humustim on onion varieties from genus Allium cepa growed on open field in infested with Ditylenchus dipsaci soil. Proceedings of Scientific conference for students, PhD students and young scientists “Five years Federation of Education & Science” Technical University, Plovdiv. vol. 1: Medico-biological science, pp. 188 - 192. (in Bulgarian)