Role of Selenite and Selenate Uptake by Maize Plants in Chlorophyll A and B Content

F. Garousi, S. Veres, É. Bódi, S. Várallyay, B. Kovács

Abstract—Extracting and determining chlorophyll pigments (chlorophyll a and b) in green leaves are the procedures based on the solvent extraction of pigments in samples using N,N-dimethylformamide as the extractant. In this study, two species of soluble inorganic selenium forms, selenite (SeIV) and selenate (SeVI) at different concentrations were investigated on maize plants that were growing in nutrient solutions during 2 weeks and at the end of the experiment, amounts of chlorophyll a and b for first and second leaves of maize were measured. In accordance with the results we observed that our regarded Se concentrations in both forms of SeIV and SeVI were not effective on maize plants’ chlorophyll a and b significantly although high level of 3 mg.kg⁻¹ SeIV had negative affect on growth of the samples that had been treated by it but about SeVI samples we did not observe this state and our different considered SeVI concentrations were not toxic for maize plants.

Keywords—Maize, sodium selenite, sodium selenate, chlorophyll a and b.

I. INTRODUCTION

THE trace element selenium (Se) has been well recognized as an essential micronutrient for human and animals [1] and agronomic biofortification is reported to be an effective method to increase Se concentration in the edible portion of crops and hence dietary intake of Se [2]. Despite substantial literature on Se uptake by plants and crops such as wheat, little consideration has been given to maize (Zea mays), a low “Se-indicator” plant but the world’s most widely grown cereal. To date there have been few publications on Se uptake and assimilation in this plant [3] and parallel to that, investigation of its effects on maize leaves’ chlorophyll a and b.

Chlorophylls (Chl) are photosynthetic pigments that are widely distributed in nature. These pigments possess a basic skeleton structure of porphyrine with a magnesium ion in the centre and a long phytol group in the tail [4]. The major chlorophylls in plants include Chl-a and Chl-b. They differ only slightly, in the composition of a side chain (in Chl-a it is CHO). Both chlorophylls are genuine only slightly, in the composition of a side chain (in Chl-a it is CHO). Both chlorophylls are genuine only slightly, in the composition of a side chain (in Chl-a it is CHO). Both chlorophylls are genuine only slightly, in the composition of a side chain (in Chl-a it is CHO).

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D. Chlorophyll a and b Measurements

From each plant, first and second mature, intact and erect leaves were sampled for extraction and determination of the chlorophyll a and b. 50 mg of each leaf were collected and with 5ml N,N-Dimethylformamide (N,N-DMF) blended. This solution cooled at 4°C for 72 hours and finally, the extraction content of the pigment was determined using UV–vis spectrophotometry (Metertech SP-830 PLUS, Taiwan) at two characteristic wavelengths, 647 and 664 nm, which are the maximum absorption wavelengths for chlorophylls b and a, respectively. Calibration graph was obtained by using the wavelength of 480 nm and each concentration level was analysed in triplicate.

According to the formula that was proposed by Morgan and Porath (1981) [9], the following was processed mathematically for quantifying chlorophyll a and b:

\[
\text{Chlorophyll a (mg.g}^{-1}) = (11.65 \times a_{664} - 2.69 \times a_{647})
\]

\[
\text{Chlorophyll b (mg.g}^{-1}) = (20.81 \times a_{647} - 4.53 \times a_{664}).
\]

E. Weight Measurements

At the end of the experiment shoots were separated from roots. Plant shoots were dried at 85°C until constant weight was achieved, then cooled to room temperature and weighed by an electronic balance with an accuracy of 0.001g (OHAUS, Swiss).

F. Statistical Analysis

All data were statistically analyzed using SPSS 17.0 software, and the mean values of each treatment group were subjected to multiple comparisons analysis using the Two-Way ANOVA and a significance level of p < 0.05.

Significant differences in the mean value of each treatment group are indicated by different lowercase letters based on the Duncan test (p < 0.05, n=3).

III. RESULTS AND DISCUSSION

A. SeIV Uptake Effects on First Leaves’ Chlorophyll a and b

Fig. 1 displays chlorophyll a and b measurements in maize at different concentrations of SeIV for first leaves. According to our calculation, there was not any significant difference between the treatments.

B. SeIV Uptake Effects on Second Leaves’ Chlorophyll a and b

Fig. 2 displays chlorophyll a and b measurements in maize at different concentrations of SeIV for second leaves. According to our calculation, there was not any significant difference between the samples.

Table I shows changes of fresh weight of maize shoots by increasing the application of SeIV and as we see, SeIV has made significant differences between the treatments so that control samples have the freshest weights. Meanwhile 3 mg.kg\(^{-1}\) SeIV had a negative effect on maize growth and it was toxic for it.

<table>
<thead>
<tr>
<th>Applied SeIV (mg.kg(^{-1}))</th>
<th>Fresh weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3.4760±0.2637</td>
</tr>
<tr>
<td>0.1</td>
<td>2.7697±0.2815</td>
</tr>
<tr>
<td>0.3</td>
<td>2.9544±0.6297</td>
</tr>
<tr>
<td>0.9</td>
<td>2.6551±0.2834</td>
</tr>
<tr>
<td>3</td>
<td>0.5369±0.0264</td>
</tr>
</tbody>
</table>

Significant differences in the mean value of each treatment group are indicated by different lowercase letter based on the Duncan-test (p < 0.05 n = 3±s.e.).

Table II shows changes of dry weight of maize shoots by SeIV uptake effects on second leaves’ chlorophyll a and b.

<table>
<thead>
<tr>
<th>Applied SeIV (mg.kg(^{-1}))</th>
<th>Dry weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.2632±0.0255</td>
</tr>
<tr>
<td>0.1</td>
<td>0.2087±0.0234</td>
</tr>
<tr>
<td>0.3</td>
<td>0.2329±0.0319</td>
</tr>
<tr>
<td>0.9</td>
<td>0.2315±0.0183</td>
</tr>
<tr>
<td>3</td>
<td>0.0618±0.0036</td>
</tr>
</tbody>
</table>

Significant differences in the mean value of each treatment group are indicated by different lowercase letter based on the Duncan-test (p < 0.05 n = 3±s.e.).
increasing the application of Se IV and as we see, Se IV has made significant differences between the treatments so that control samples have the driest weights. Meanwhile 3 mg.kg⁻¹ Se IV had a negative effect on maize growth and it was toxic for it.

Fig. 3 shows different concentrations of Se IV effects on our maize samples and as we can see, sample that has been treated by 3 mg.kg⁻¹ Se IV has stayed small and this amount of Se IV has been toxic for it.

**C. Se VI Uptake Effects on First Leaves’ Chlorophyll a and b**

Fig. 4 displays chlorophyll a and b measurements in maize at different concentrations of Se VI for first leaves. According to our calculation, there was not any significant difference between the samples.

**D. Se VI Uptake Effects on Second Leaves’ Chlorophyll a and b**

Fig. 5 displays chlorophyll a and b measurements in maize at different concentrations of Se VI for second leaves. According to our calculation, there was not any significant difference between the samples.

Treatment by Se VI did not effect on both first and second maize plants leaves’ chlorophyll a and b significantly.

Table III shows changes of fresh weight of maize shoots by increasing the application of Se VI and as we see, samples that had been treated by 0.1 mg.kg⁻¹ have the most fresh weights but on the whole there is not any significant difference between all of the treatments.

Table IV shows changes of dry weight of maize shoots by increasing the application of Se VI and as we see, samples that had been treated by 0.1 mg.kg⁻¹ have the most dry weights but on the whole there is not any significant difference between all of the treatments.

The same lowercase letters after the mean values and standard deviations in both columns shows no significant difference between the treatments according to the Duncan-test (p < 0.05 n = 3±s.e.).
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REFERENCES


