Influence of Lead and Cadmium on Some Physiologic Indices of *Allium Cepa*

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Abstract. The influence of the two heavy metals (Pb and Cd), in different concentrations, on the seeds germination and roots growing of *Allium cepa* of the two varieties (yellow onion and red onion), was studied. Sterilized Petri boxes were used; the germination substratum was cotton wool; the seeds were disinfected and wetted in appropriate solutions. For every working variant, 50 seeds of yellow onion and red onion were put in every Petri box. The following variants were used: \(V_1\) – control, distilled water; \(V_2\) – 0.1% Pb acetate; \(V_3\) – 0.4% Pb acetate; \(V_4\) – 0.1% Cd sulphate; and \(V_5\) – 0.4% Cd sulfate. In order to determine the germinative energy, the counting was performed after 5 days and for the germinative faculty after 11 days. The obtained results proved that the germinative energy and the germinative faculty were much more reduced for the red onion than for the yellow onion. As about lead, the best tolerance is that of the yellow onion; and for cadmium, the best tolerance is that of the red onion. The presence of heavy metals in the germination environment determines a reduced growing pace for the roots. By comparison, we may state that the most toxic is lead; for concentrations of 0.4% the roots of the yellow onion appeared only in the 18\(^{th}\) culture day.

Keywords: variant, concentration, heavy metals, germination, roots.

INTRODUCTION

The issues linked to the presence of heavy metals in the environment require an increasing interest. The origin of these elements is less predictable. To the soil natural concentrations with various metals (concentrations that depend on the rock origin and on its composition), is added the contribution generated by a series of human activities, such as combustibles burning, ore treatment, gasoline additives, as well as some other industrial activities (Pacyna, 1987).

Heavy metals are known as less mobile, it means that once within an ecosystem, it is extremely difficult to eliminate them. They are partially absorbed by plants through their roots and they accumulate in tissues, being up taken trough ingestion by herbivorous animals and subsequently by carnivorous animals (Popa and Incze, 2003).

Due to their reduced mobility, heavy metals concentrate at every trophic level, the highest concentration being achieved at the ends of the trophic chains, respectively at the ultimate predators and implicitly at humans (Banu, 1982).

The absorption and translocation of heavy metals into plants is highly dependant of their physiologic condition. The absorption of heavy metals through the plants roots and the translocation towards the aerial parts varies depending on season; the increase of concentration for all metallic ions in the vegetal material was noted from June to September.

Thus, the metallic ions contamination is high in the moment of harvesting and utilization (Voica, 1983).
Ingestion of cadmium contaminated vegetables, supplied from polluted farmlands, represents the main way of exposure of human population to this heavy metal (Derache, 1986).

Lead is eliminated into the atmosphere as vapor which relatively quickly condensates, forming suspensions that set onto the soil (Burzo et al., 1999).

Heavy metals have negative influence on livings, and through long term effects they can determine sometimes irreversible deteriorations with direct impact on human, vegetal and animal life (Trifu and Barbat, 1997).

**MATERIALS AND METHODS**

The aim of this paper has been the calculation of the germinative energy and the germinative faculty of *Allium cepa* seeds under the influence of heavy metals (Pb and Cd). In order to achieve this aim, seeds belonging to two onion varieties were used, namely yellow onion and red onion, represented by the Spanish and respectively Turda red varieties. Petri boxes were used in order to determine the germination sample; this allowed the cultivation of the onion seeds within a water vapor saturated space. We used new, packed, sterile Petri boxes. The seeds were put on a germination substrate, which in this case was cotton wool with a good capacity of liquids absorption, and thus the premature evaporation was avoided during the experiments.

The seeds were disinfected and ready-sterilized before the start of the experiment. The disinfection was achieved with water and chlorine 1:1 for 15 minutes, and then they were washed 5 times with distilled water for 5 minutes. The seeds were sterilized with 0.1%HgCl$_2$ for 3 minutes, and afterwards they were washed 3 times with distilled water for 5 minutes.

The seeds preparation was achieved by wetting them in solutions corresponding to the work variants for 10 minutes. Fifty pieces were selected for each heavy metal concentration; subsequently they were placed with forceps onto the substrate surface in straight and equidistance lines. For each work variant, 250 seeds of yellow onions and red onions were used. The experimental variants were as it follows: $V_1$ – control (wetted with distilled water); $V_2$ – 0.1%(CH$_3$COO)$_2$Pb; $V_3$ - 0.4%(CH$_3$COO)$_2$Pb; $V_4$ – 0.1%CdSO$_4$; $V_5$ – 0.4%CdSO$_4$.

The seeds placed to germinate in the Petri boxes, wetted with different concentrations of heavy metals, were covered with the lid on which the identification data were recorded. In a notebook we recorded the following information: experiment beginning date, used substrate, environment temperature, and the determining time of the germinative energy and of the germinative faculty. The readings were performed after 5 days from the experiment beginning in order to set the germinative energy, and after 11 days for the germinative faculty. Thus, the treated material was kept in the dark at 19°C.

In order to achieve the second objective regarding the dynamics of growing of the *Allium cepa* roots in the presence of heavy metals, five pieces of germinated seeds were removed for each work variant; they were wiped with filter paper; they were measured with a millimeter rule, and they were marked with a marker. The values were recorded in the notebook. Four measurements were made: after 12 days, after 13 days, after 14 days and respectively after 16 days since the germination. The differences that appeared between the variants with heavy metals and their ratio versus the control variant with distilled water were recorded in the notebook, for all four measurements.
RESULTS AND DISCUSSIONS

Varied results were obtained from the observed data, these results depending on the used heavy metal and its concentration in the germinative environment. The germinative energy was observed at 5 days since the experiment beginning, counting the seeds which started to germinate, in percentage, resulting the germinative speed for every experimental variant (Tab. 1).

<table>
<thead>
<tr>
<th>Variants</th>
<th>V₁</th>
<th>V₂</th>
<th>V₃</th>
<th>V₄</th>
<th>V₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solutions</td>
<td>H₂O</td>
<td>Pb 0,1%</td>
<td>Pb 0,4%</td>
<td>Cd 0,1%</td>
<td>Cd 0,4%</td>
</tr>
<tr>
<td>Red onion</td>
<td>1,5%</td>
<td>1%</td>
<td>1%</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>Yellow onion</td>
<td>4,5%</td>
<td>3%</td>
<td>3,5%</td>
<td>2,5%</td>
<td>2%</td>
</tr>
</tbody>
</table>

From the results shown in Tab.1, one can note that the germinative energy in the case of the red onion is much lower than that of the yellow onion. Even in the case of the control (V₁), one can note that for the yellow onion the values of germinative energy are higher than for the red onion. In the case of heavy metals, the best tolerance is that of the yellow onion versus lead at concentrations higher than 0.4%, where it has a germinative energy of 3.5%, quite close to that of the control of 4.5%. Among the two onion varieties a higher tolerance of the red onion at concentrations of 0.4% cadmium is found, comparatively with the yellow onion, even if overall, the germination is much less than that of the varieties of the yellow onion. As about the germinative faculty of Allium cepa seeds in the presence of heavy metals, this aspect was noted after 11 days since the experiment beginning, for all the experimental variants. The number of seeds that germinated on the 11th germination day was added to the number of germinated seeds of the first counting.

The values obtained for the germinative faculty, for all the experimental variants are shown in Tab. 2.

<table>
<thead>
<tr>
<th>Variants</th>
<th>V₁</th>
<th>V₂</th>
<th>V₃</th>
<th>V₄</th>
<th>V₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solutions</td>
<td>H₂O</td>
<td>Pb 0,1%</td>
<td>Pb 0,4%</td>
<td>Cd 0,1%</td>
<td>Cd 0,4%</td>
</tr>
<tr>
<td>Red onion</td>
<td>42%</td>
<td>32%</td>
<td>18%</td>
<td>10%</td>
<td>22%</td>
</tr>
<tr>
<td>Yellow onion</td>
<td>84%</td>
<td>48%</td>
<td>66%</td>
<td>28%</td>
<td>20%</td>
</tr>
</tbody>
</table>

The same as in the case of the germinative energy, Tab.2 shows that the values of the germinative faculty are much higher for the yellow onion comparatively with the red onion. As about lead, the best tolerance is that of the yellow onion comparatively with the red onion, especially for concentrations higher than 0.4%, the difference versus the control variant being small enough, 18%.

A higher tolerance of the red onion at 0.4% Cd concentrations was also observed, as it had a germinative faculty with 2% higher than the yellow onion, even if overall, the germination was much less than that of the yellow onion variety.

Among the variants with heavy metals, the less germinative percentage was recorded with 0.1% cadmium concentrations for the red onion, in a ratio of 10%.
A significant difference of 48% between the two onion varieties was observed for the V₃ variant with 0.4% Pb, where the germinative faculty percentage of the red onion was 18%, and that of the yellow onion of 66%.

The observations are also obvious in the following visual presentation (Fig.1).

Following the dynamics of Allium cepa roots growing, we found out that there were certain modifications induced by the heavy metals (Tab. 3).

<table>
<thead>
<tr>
<th>Number of days</th>
<th>12 days</th>
<th>13 days</th>
<th>14 days</th>
<th>16 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variant</td>
<td>red onion</td>
<td>yellow onion</td>
<td>red onion</td>
<td>yellow onion</td>
</tr>
<tr>
<td>V₁ – control</td>
<td>0.10</td>
<td>0.20</td>
<td>0.30</td>
<td>0.40</td>
</tr>
<tr>
<td>V₂ – Pb 0.1%</td>
<td>0.10</td>
<td>0.30</td>
<td>0.10</td>
<td>0.20</td>
</tr>
<tr>
<td>V₃ – Pb 0.4%</td>
<td>0.00</td>
<td>0.00</td>
<td>0.20</td>
<td>0.00</td>
</tr>
<tr>
<td>V₄ – Cd 0.1%</td>
<td>0.00</td>
<td>0.10</td>
<td>0.00</td>
<td>0.20</td>
</tr>
<tr>
<td>V₅ – Cd 0.4%</td>
<td>0.14</td>
<td>0.28</td>
<td>0.17</td>
<td>0.38</td>
</tr>
</tbody>
</table>

The presence of heavy metals in the germination environment determines a reduction of the roots growing rate. Comparing the two metals, one can state that lead is the most toxic one. For high concentration, of 0.4%, the roots of the yellow onion became visible only on the 18th culture day. The length of the yellow onion roots was 0.31 cm, comparatively with the control, whose length was 0.68 cm after 16 days of culture in the presence of 0.1% lead concentrations.

The obtained data prove that the presence of cadmium slowly stimulates the roots growing, comparatively with the other studied heavy metal. For a high concentration of cadmium, 0.4%, the roots medium length is higher than that of the control during the first 12 days, for both onion varieties, after which a slow decrease versus the control is recorded until the measurement of the 16th day, but significantly superior to the values recorded for the lead variants.

In Fig. 2 one can observe the percentage growing of the red onion and of the yellow onion roots, in the presence of heavy metals, after 16 days since their germination.
Studies regarding the influence of heavy metals on onion were made by Abdullahi et al. (2009), but unlike our experience, they studied the contamination degree with Cd, Pb and Cr in leaves. They concluded that the analyzed onion leaves were noticeably contaminated with these metals, drawing up the following accumulation series: Pb > Cr > Cd.

CONCLUSIONS

- Under the influence of heavy metals, lead and respectively cadmium, the germinative energy and the germinative faculty, in the case of the red onion recorded much lower values than for the yellow onion.
- In the case of lead, the calculation of the germinative faculty proved that the best tolerance was that of the yellow onion, comparatively with the red onion; at high concentration of 0.4% the difference versus the control which was small enough, that is of 18%.
- A higher rate tolerance, with about 2%, for the red onion, at 0.4% Cd concentration comparatively with the yellow onion, even if overall, the germination was much less than that of the varieties of the yellow onion.
- Among the variants with heavy metals, the less germinative percentage was recorded with 0.1% cadmium concentrations for the red onion, in a ratio of 10%.
- The presence of heavy metals in the germination environment determines a reduction of the roots growing rate.
- Comparing the two metals, one can state that lead is the most toxic one. For high concentration, of 0.4%, the roots of the yellow onion appeared only on the 18th culture day.

REFERENCES