THE INFLUENCE OF THE Mn$^{2+}$ IONS EFFECTS ON THE WHEAT (TRITICUM AESTIVUM L.) SEED GERMINATION

I. M. RÎŞCA*, L. FĂRTĂIŞ*, ANA LEAHU*

Abstract: The testing of the Mn$^{2+}$ ions on wheat seed were conducted in a growth chamber with controlled parameters and the results showed that germination rate and shoot length varies according to the ions concentration. Significant increases of the germination rate at high concentrations were observed as a probable consequence of the seed’s enzymatic system activation. The probable biochemical action mechanisms are discussed.

Keywords: manganese ions, wheat, germination rate

Introduction

The microelements have a complex role in the living structures, with both negative and positive effects, depending – inter alia – on the nature of the elements, their acting form and also their concentration. The essential role of some elements like Fe, Mg, Mn, Zn, Cu, B or Mo in the plant kingdom or Co, Se, Fe and I in the animal one, is well-known [2]. The role of other microelements is not yet well known.

The role of manganese in the unfolding of the oxidative processes at the cellular level and in the functioning of some enzymatic systems [2, 3, and 5] is also a matter of common knowledge; its action unfolds in direct connection with those of the iron [1]. Thus, as bivalent ion, the manganese is part of the superoxyd-dismutase (SOD) from the prokaryotes, an enzyme that annihilates – at the mitochondrial level – the super oxide anion which induces multiple negative biological effects, due to the formation of hydrogen peroxide, aggressive towards the cells [5]:

$$2O_{2}^- + 2H^+ \rightarrow H_2O_2 + O_2$$

Further, the hydrogen peroxide is removed by the metal enzyme:

$$2H_2O_2 \rightarrow 2 H_2O + O_2$$

Among the biological effects of the superoxyd against animals and humans we can enumerate: destruction of the endothelial cells, increase of the micro vascular permeability, formation of some chemotactic factors like leukotriene B4, peroxidation and oxidation of lipids, deterioration of AND singlet chains and formation of peroxynitrite anion (ONOO$^-$), a strong cytotoxic and pro-inflammation agent, according the reaction [5]:

$$O_{2}^\cdot + NO \rightarrow NOO_{2}^-$$

In the green plants, the photosystem II uses another manganoenzyme that is involved in the water dissociation and the production of molecular oxygen, of protons and neutrons. On the other side, manganese is cytotoxic in high concentrations, those effects were studied especially on the animal kingdom were it produces Parkinson-like effects (rhythmical

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trembling and muscular rigidity) but also effects at the psychical level like behavioural aggressiveness, probably due to the neurotoxic accumulations of manganese in globus pallidus. In fact it is well known that the professional exposure to manganese is a risk factor for the Parkinson disease.

The paper studies first of all the manganese effects on the wheat seed germination but also the effects on the wheat growth after the germination.

**Material and methods**

**Apparatus.** The germination was accomplished in a CONVIRON MP4030 - G30 growth chamber with the parameters settled as follows: temperature 20°C, humidity 90%, without illumination.

**Biological material.** The wheat samples (Triticum aestivum) we used came from the Magistral variety, 37.5 g/1000 seeds, harvested in 2005 at S.C.D.A Suceava. We measured the germination (FG), according to the standards [4] and also the hypocotyls length (LH) of the germinated plants.

**Reagents.** We used MnCl₂, analytical reagent (Chimopar) and bidistilled water.

**Applied treatments.** The wheat seeds were treated with MnCl₂ solutions; 7 concentrations were used: 1M, 0.5 M, 0.1 M, 5 x 10⁻³ M, 10⁻² M, 5 x 10⁻³ M, 10⁻³ M, 5 x 10⁻⁴ M and a blank with distilled water, 3 x 50 seeds for each concentration, the witness included, in Petri dishes on filter paper.

Two treatment schemes were used: 1. The seeds were immersed for one hour in the treatment solutions, washed thereafter and placed in Petri dishes with distilled water; 2. The seeds were maintained throughout the germination period in the treatment solutions.

After 7 days the number of germinated seeds and the hypocotyls length for the germinated plants were measured. The data obtained was statistically analysed with an application that makes a multiple variance analysis.

**Results**

The experiments were fulfilled in order to establish the biological answer of the wheat seed under the influence of mn²⁺ ions; the results are synthetically showed below (table I and figures 1 and 2).

**Table I. Germination and hypocotyl length values under the influence of the treatment with mncl₂ solutions**

<table>
<thead>
<tr>
<th>Concentration of Mn²⁺</th>
<th>Witness</th>
<th>1 m</th>
<th>0.5 m</th>
<th>0.1 m</th>
<th>0.05 m</th>
<th>0.01 m</th>
<th>0,005 m</th>
<th>0,001 m</th>
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<tbody>
<tr>
<td>Germination 1h (%)</td>
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<tr>
<td>88,00</td>
<td>90,67</td>
<td>78,00</td>
<td>91,33</td>
<td>90,67</td>
<td>94,67</td>
<td>93,33</td>
<td>96,67</td>
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<tr>
<td>Germination 7 d (%)</td>
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<tr>
<td>88,00</td>
<td>100,00</td>
<td>100,00</td>
<td>98,00</td>
<td>88,00</td>
<td>92,66</td>
<td>91,33</td>
<td>94,66</td>
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<tr>
<td>Hypocotyl length 1h (mm)</td>
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<tr>
<td>60,29</td>
<td>8,78</td>
<td>20,35</td>
<td>51,72</td>
<td>50,02</td>
<td>51,02</td>
<td>53,09</td>
<td>62,50</td>
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<tr>
<td>Hypocotyl length 7 d (mm)</td>
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<tr>
<td>60,29</td>
<td>1,00</td>
<td>1,00</td>
<td>8,69</td>
<td>26,71</td>
<td>56,82</td>
<td>65,27</td>
<td>64,60</td>
<td></td>
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</table>
Conclusions and discussions

A first finding is that the stimulation effects of the manganese becomes manifest at high dilution. Thus, beginning with the dilution of 10⁻¹M we observed an approach to the witness of the value of the hypocotyls length, especially for the short-term treatment (fig. 2). The drastically inhibition of the hypocotyls, especially at high concentrations and long-term treatment, could be generated by the secondary toxicity of the manganese ions on the plantlets.

On the other hand, analysing the influence of the manganese ions on the germination, an obvious positive reaction at high concentrations and long-term treatments (fig. 1) comes out, so that, for concentrations of 1M and 0.5 M, the germination is – practically – 100% and for the concentration of 0,1M – 98%. At lower values of the concentration the effect of manganese ions on the germination is not so obvious; the obtained differences are not so significant (table I).

The probable action mechanism is as follows: the high concentrations and the long action times of the manganese ions on the seed permits the diffusion of the ions through the seed tegument in a sufficient high concentration to permits the activation of the enzymatic systems controlled by the Mn²⁺ ions. At low concentrations and/or short action times this process does not take place any longer, according to the obtained results.

In the case of the action of manganese ions on the hypocotyls, this mechanism is no longer valuable (the plantlet has not a protection teguments like the seed) so that the higher Mn²⁺ ions concentrations act aggressively and therefore the growth of the wheat embryos is inhibited (fig. 2).

REFERENCES