A. thaliana and *A. halleri* root and root hair characteristics under control and high zinc concentrations

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Introduction

Zinc is an essential element for plants but its excess or deficiency have negative effects on growth and development of plant roots and root hairs. Root hairs are highly polarized tubular extensions from the root epidermis. They play a role in water and nutrient uptake. *Arabidopsis thaliana* is a species sensitive to heavy metal soil contamination. On the contrary, *Arabidopsis halleri* belongs to the plants which can tolerate and hyperaccumulate zinc.

Plant material and methods

We investigated seedlings from natural populations originating from Slovak localities: *A. thaliana* growing on non-metalliferous soil in the locality Ratkovo situated near the city of Martin, and *A. halleri* growing on metalliferous soil in the locality Krompachy situated in the region Spiš.

Seedlings of *A. thaliana* and *A. halleri* were compared under control (10 μM) and high (1000 μM) Zn concentrations in agar Murashige – Skoog medium with 1 % sucrose at pH 5.8. Extreme concentration (10 000 μM) of Zn was tested with respect to root morphology and anatomy. The growth and anatomy of roots, and the length of root hairs were investigated using light microscope Olympus BX61. Root and root hair morphology were investigated using cryo Scanning Electron Microscope JEOL–JSM–7401F. Root anatomy was studied in semithin sections taken from the primary roots at the site of the first root hair outgrowth. A routine preparation of epoxy resin blocks was used. Apical segments of the roots were fixed with 3% glutaraldehyde and postfixed in 1% OsO_4 in the same 0.5M Na-cacodylate buffer (pH 7.2), dehydrated in ethanol series followed by propylene oxide, and embedded in Spurr medium. Semithin sections were cut with Reichert Ultrotome and stained with Toluidine blue.

Results

The amount of zinc in *A. thaliana* root (22.6 ± 1.2 mg/kg) and leaf (49.2 ± 0.4 mg/kg) was smaller than in *A. halleri* root (6796 ± 371 mg/kg) and leaf (12164 ± 1723 mg/kg). High (1000 μM) Zn concentration significantly inhibited root growth in *A. thaliana*. The inhibition of root elongation was accompanied with a shorter distance of root hair initiation from the root tip. In the root length of *A. halleri* we noticed statistically insignificant difference between the seedlings grown at control and 1000 μM Zn concentrations. The root hairs in control were shorter than at 1000 μM Zn concentration for both investigated species. Cryo-scanning electron microscopy has shown morphological deformations of the root hairs in 1000 μM zinc for the sensitive species *A. thaliana*. Such deformations did not occur in the tolerant *A. halleri* (Figure 1.).

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Light microscopy of semithin sections showed disturbances in pattern and integrity of primary root tissues at the site of the first root hair outgrowth. Also the morphology, and structure of *A. thaliana* root cells were adversely affected by the extremely high zinc concentration (Figure 2.).

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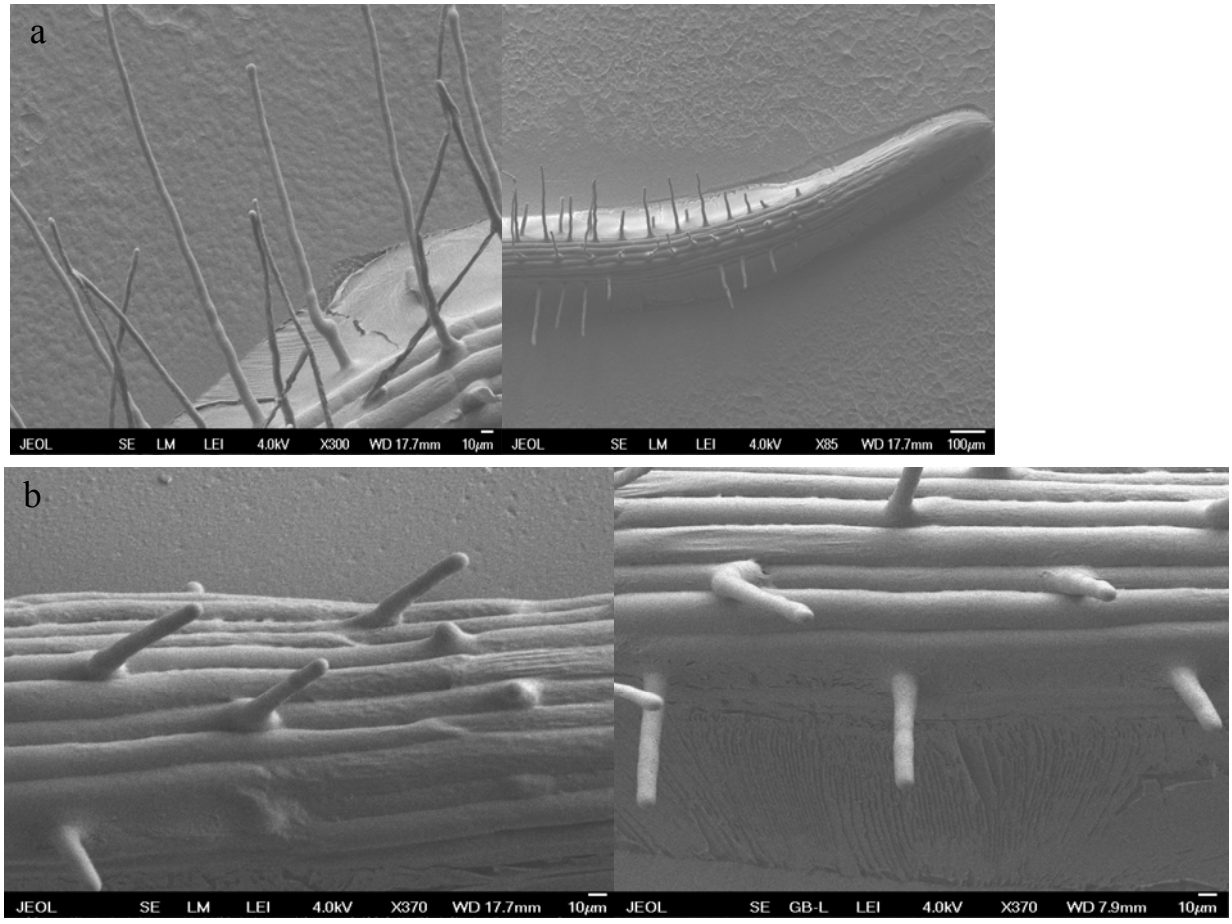

Figure 1. Cryo SEM
a 1000 μM Zn *Arabidopsis thaliana* b 1000 μM Zn *Arabidopsis halleri*

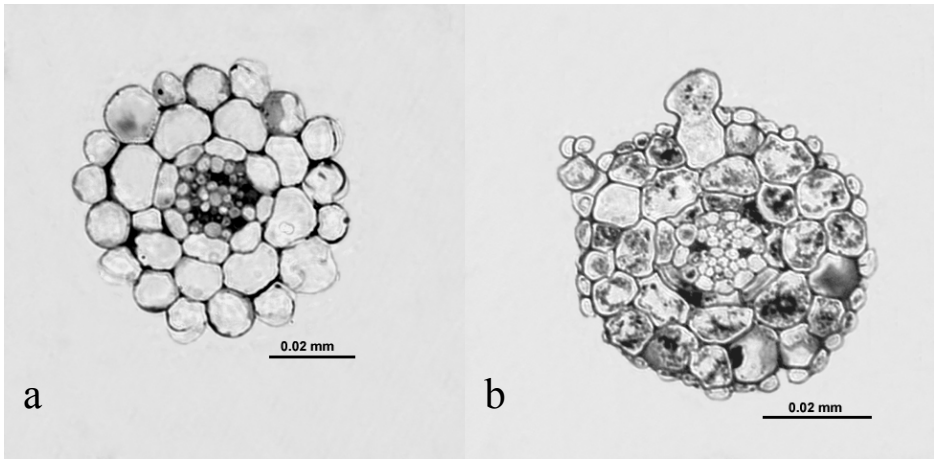

Figure 2. Semithin sections of *Arabidopsis thaliana* roots
a control b extremely high zinc concentration

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