

## Root Anatomy and Growth of Three *Arabidopsis* Species Differing in Their Heavy Metal Tolerance

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### ABSTRACT

Seeds of *Arabidopsis thaliana*, *A. arenosa*, and *A. halleri* were collected in metallicolous and non-metallicolous localities. Root characteristics of their seedlings growing on agar medium with 10  $\mu\text{M}$  Zn (control) and 1000  $\mu\text{M}$  Zn concentrations were compared with the model *A. thaliana* ecotype Columbia. Root tissue patterns of all three species from both types of localities were similar to *A. thaliana* Columbia. Quantitative differences concerned root and stele diameter, and the number of cells in tissue layers. Under 1000  $\mu\text{M}$  Zn the root growth and the distance of root hair initiation from the root tip were reduced while length of root hairs increased. Root hair morphology was disturbed only in the sensitive *A. thaliana*. Root responses to Zn were similar in the plants originating from metalliferous and non-metalliferous localities.

KEYWORDS: *A. thaliana*, *A. arenosa*, *A. halleri*, zinc, tissue pattern, root hairs

### INTRODUCTION

Anatomy and cytological characteristics of the developing root of *Arabidopsis thaliana* ecotype Columbia have been researched (Dolan et al. 1993). In addition to this model species, the tolerant *A. arenosa*, and more frequently the hyperaccumulator *A. halleri* serve as experimental plants particularly with regard to heavy metal tolerance. This paper compares anatomical and histological traits of roots and their responses to enhanced Zn concentration in all three species differing in their heavy metal tolerance.

### MATERIAL AND METHODS

Seeds of *Arabidopsis* species were collected in the non-metallicolous (57-69  $\text{mg}\cdot\text{kg}^{-1}$  Zn) localities Ratkovo (*A. thaliana*), Richtárová Lúka (*A. arenosa*) and Úhorná (*A. halleri*), and metallicolous (277-2105 $\text{mg}\cdot\text{kg}^{-1}$  Zn) localities Kropachy (*A. halleri*) and Terézia (*A. arenosa*). Roots of the seedlings originating from these localities, and of the model *A. thaliana* ecotype Columbia were exposed to 10  $\mu\text{M}$  (control) and 1000  $\mu\text{M}$  Zn concentrations on MS culture medium. Root anatomy was investigated at the site of root hair initiation. For light microscopy Olympus BX61 was used. Root hair morphology was investigated with SEM JEOL–JSM–7401F.

### RESULTS

Anatomy of all three species from metalliferous and non-metalliferous soils showed a similar tissue pattern and trichoblast location (Figs. 1A,B,C). Cell numbers in both *A. thaliana* genotypes were 17 to 18 in epidermis, 8 in outer cortex, and 8 to 9 in endodermis. Roots of *A. arenosa* had higher number only in epidermis (22 to 26) and roots of *A. halleri* also in endodermis (10 to 12). Some endodermal cells in *A. arenosa* and *A. halleri* underwent tangential divisions (Fig. 1D). A greater diameters of both central cylinder and whole root were found in the tolerant species *A. arenosa* and *A. halleri* from each locality.

Under 1000 $\mu$ M Zn the root growth, and the distance of root hair initiation from the root tip were reduced (Fig. 2). Only in the sensitive *A. thaliana* the Zn-induced growth reduction was significant, and abnormalities in root hair morphology occurred (Fig. 3). Increase in cell number and root diameter occurred only in the tolerant species *A. arenosa* (Fig. 1D) and *A. halleri*.

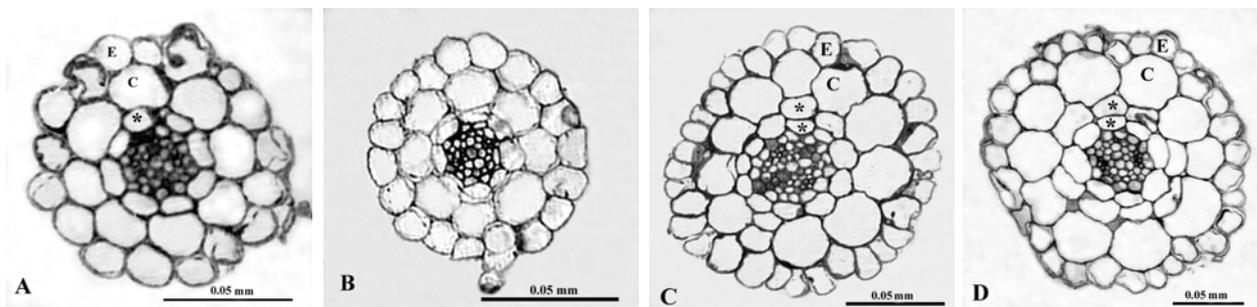


Figure 1. Root cross sections of *A. thaliana* atkovo (A), *A. arenosa* Richtárova Lúka (B), *A. halleri* Úhorná (C) at 10  $\mu$ M Zn, and *A. arenosa* Terézia at 1000  $\mu$ M Zn (D). E - epidermis, C - outer cortex, \* - endodermis

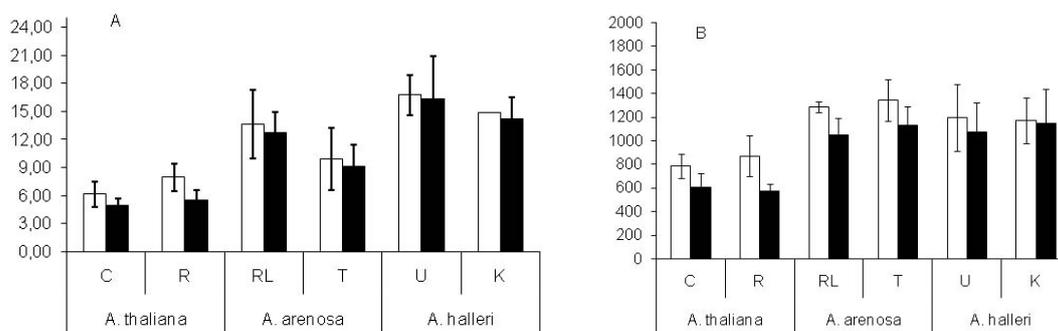


Figure 2. Length of roots (mm) (A) and distance of the first root hairs ( $\mu$ m) from the root tip (B) at 10  $\mu$ M Zn (control – white columns) and 1000  $\mu$ M Zn (black columns). C - Columbia, R- Ratkovo, RL- Richtárova lúka, T- Terézia, U- Úhorná, K- Krompachy

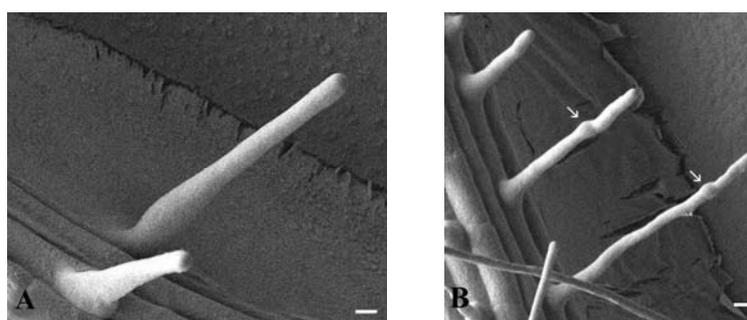


Figure 3. Root hairs of *Arabidopsis thaliana* (Ratkovo) under control 10 $\mu$ M Zn (A) and 1000  $\mu$ M Zn with root hair deformations indicated by arrows (B).

#### REFERENCES

Dolan L., Janmaat K., Villemsen V., Linstead P., Poethig S., Roberts K., Scheres B. 2002: Cellular organization of the *Arabidopsis thaliana* root. Development 119:71-84.

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