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Root anatomical responses of two *Salix caprea* isolates growing in different environmental conditions

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ABSTRACT

Root anatomic characteristics of cuttings of two *Salix caprea* isolates exposed to zinc (Zn) and cadmium (Cd) or both are compared to growth and heavy metals accumulation behavior.
KEYWORDS: Willows, Heavy metal accumulation, Cadmium, Zinc, Root anatomy, Casperian band

INTRODUCTION

S. caprea is a fast growing woody tree species which can accumulate relatively large amounts of trace elements, including Zn and Cd, and therefore it is a promising candidate for phyto-remediation. Previous studies on 170 natural *S. caprea* isolates showed that there is a high variability between isolates from heavy metal polluted and non-polluted sites concerning growth and accumulation behavior in standardized perlite cultures (Puschenreiter et al., submitted). Here we focused on the quantification of the root architecture and development between two *S. caprea* isolates of different accumulation behavior growing in presence of Cd, Zn and both heavy metals.

MATERIAL AND METHODS

KH21 was isolated from an old polluted mining site (Kutná Hora, Czech Republic) and F20 from a non-polluted site in Austria (Forchtenstein). Green cuttings were rooted in sand and exposed to 0.5 mg/l Cd, 5 mg/l Zn or both for 14 weeks in perlite cultures for root architecture measurements, biomass, Cd and Zn quantifications. Zn and Cd concentrations were measured with a flame atomic absorption spectrometer (AAS, Perkin Elmer 2100). Semi-thin sections of roots at a 15 mm distance from the apex were prepared and tissue area was quantified with Lucia G 4.80 (LIM) software. For the barrier analyses young cuttings were exposed to the same Cd and Zn concentrations but for 8 weeks in a perlite-sand mixture. The development of apoplastic barriers were analyzed from hand sections stained with Berberine hemisulphate and Fluorol Yelow 088 according to Lux et al., (2005). Significances were calculated with Student's t-test.

RESULTS AND DISCUSSION

In both *S. caprea* isolates metal treatment led to a decrease of the root biomass. While applications of Cd decreased the root biomass about 87 % in KH21 and 56 % in F20, Zn exposure affected root growth in both isolates similarly (46 % in KH21 and 53 % for F20 decrease) when compared to control. Application of both metals did not add to the root biomass decrease of KH21 while in F20 it was reduced by 85 %.

As expected from previous experiments KH21 was accumulating significantly more Cd in leaves than F20 (Fig. 1b) while the Zn concentration was similar in roots and shoots of both isolates

(Fig. 1a,b). Interestingly the accumulation of Cd in roots was stimulated by about 50 % when Zn was present (Fig. 1b).

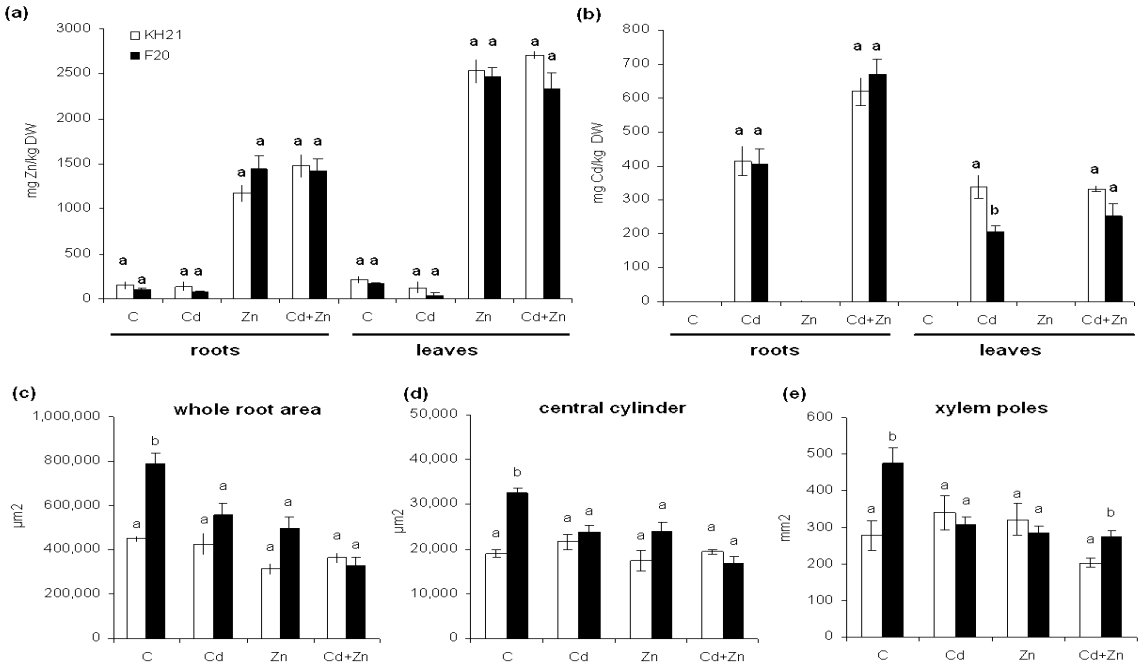

Figure 1. Concentration of Zn (a) and Cd (b) in roots and leaves of *S. caprea* isolates and anatomy parameters such as areas of the whole root (c), central cylinder (d) and all vascular elements in xylem poles (e). DW, dry weight

The majority of ions are transported to above ground organs through the xylem system. For the better understanding of the uptake process, we measured also the area of the xylem poles. While the whole root area, the central cylinder area and the xylem poles area were significantly larger in F20 than KH21 under control conditions, heavy metal treatment abolished this difference. This adjustment was because KH21 did not change the area of the whole root nor central cylinder while F20 responded strongly to the presence of Cd, Zn or both heavy metals decreasing all the parameters (Fig. 1c,d,e).

While the development of the Casparian band in the endodermis was similar in both isolates the development in the exodermis was later in F20 under control conditions. The presence of Cd and Zn shifted the development of apoplastic barriers closer to the root apex. Similar changes in the endodermis and exodermis maturation are known from other species after metal exposure (e.g. Zelko and Lux, 2004).

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