Differences in the root anatomical traits of three *Salix* L. clones in response to increased Cd concentrations

Zorana Hrkić Ilić[1], Milan Borišev[2], Lana Zorić[2], Jadranka Luković[2]

[1]Faculty of Forestry, University of Banja Luka, Bulevar Vojvode Stepe Stepanovića 75A, 78000 Banja Luka, Bosnia and Herzegovina

[2]University of Novi Sad Faculty of Sciences, Department of Biology and Ecology, Trg Dositeja Obradovića 2, Novi Sad 21000, Serbia

International BioScience Conference
25-26 November
Novi Sad, Serbia
2021

INTRODUCTION

Among heavy metals, cadmium (Cd) is one of the most widely distributed pollutant, whose concentrations increase in the soil, water and air, globally and over time. Numerous physiological, biochemical and morphological studies have shown that woody species from the genus *Salix* L. (willows), represent suitable tools for phytoremediation of the sites polluted by Cd. However, only a few studies have followed structural changes of the root tissues exposed to increased concentrations of Cd in soil and water. Previous physiological studies have established high Cd accumulation in the roots of several willow clones, *Salix alba* L. clone ´B-44´, *Salix viminalis* L. clone ´SV068´, and *Salix matsudana* Koidz. clone ´SM404´. The aim of our work was to assess the effects of two single applied Cd concentrations (10^{-3} and 10^{-6} M Cd) on the roots´ anatomical traits of these clones, grown in the soil contaminated with cadmium.

METHOD / DESIGN

One-year old stem cuttings of three willow clones were obtained from the Institute for Lowland Forestry and Environment in Novi Sad, Republic of Serbia. The cuttings were grown in greenhouse of the Department of Biology and Ecology, Faculty of Science, Novi Sad, by the soil culture method. Our study included three treatments: control (without Cd), and treatments with 10^{-3} M Cd and 10^{-6} M Cd, each single added to the soil. Plants were harvested after 4 months of applied treatments (May to September). The anatomical response of the selected *Salix* clones to Cd was investigated on the microscopic sections of the part of the roots at a distance of 3 cm from the root neck. Examined roots developed secondary anatomical structure. Measurements of roots´ cross-sections included following traits: root cross-section area, root diametar, thickness of the periderm, secondary phloem (cross-sectional area, percentage and thickness), secondary xylem (cross-sectional area, percentage and diameter), cross-sectional area of parenchyma cells, and cross-sectional area, number and diameter of vessels.

RESULTS

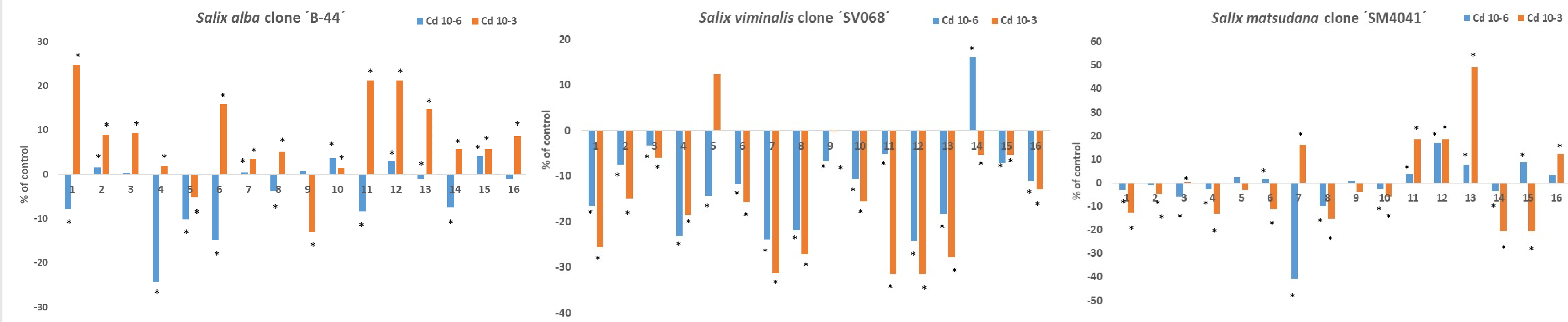

Fig. 2. Variations of measured roots' anatomical traits of Cd treated plants compared to the control plants: 1 root cross-sectional area (μm^2 x 10^5); 2 root diameter (µm); 3 thickness of the periderm (µm); 4 cross-sectional area of secondary phloem (μm^2 x 10^5); 5 percentage of secondary phloem; 6 thickness of secondary phloem (µm); 7 cross-sectional area of parenchyma cells in secondary phloem (μm^2); 8 cross-sectional area of secondary xylem (μm^2 x 10^5); 9 percentage of secondary xylem; 10 diameter of secondary xylem (µm); 11 total vessels area per treatment (μm^2 x 10^4); 12 total vessel area per xylem cross-section (μm^2 x 10^4); 13 cross-sectional area of vessels (μm^2); 14 total vessels number per treatment; 15 vessels number per xylem cross-section (N/μm^2); 16 diameter of xylem vessels (Duncan test indicated significant differences between Cd-treated and control plants; *p ≤ 0.05)

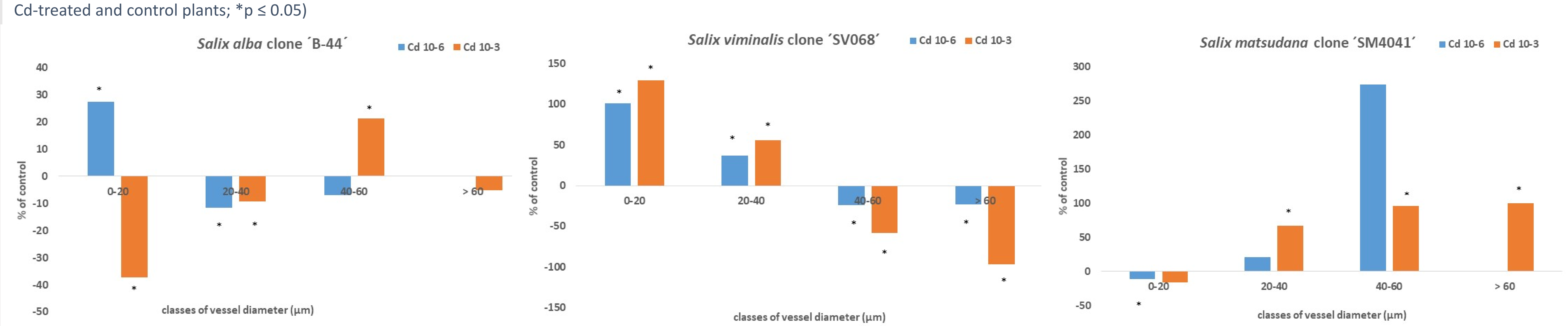

Fig. 3. Percentage of the vessel number across vessel diameter classes in roots of three *Salix* spp. clones; asterisk indicate significant differences between control and Cd-treated plants, according to the Duncan´s test at p≤0.05.

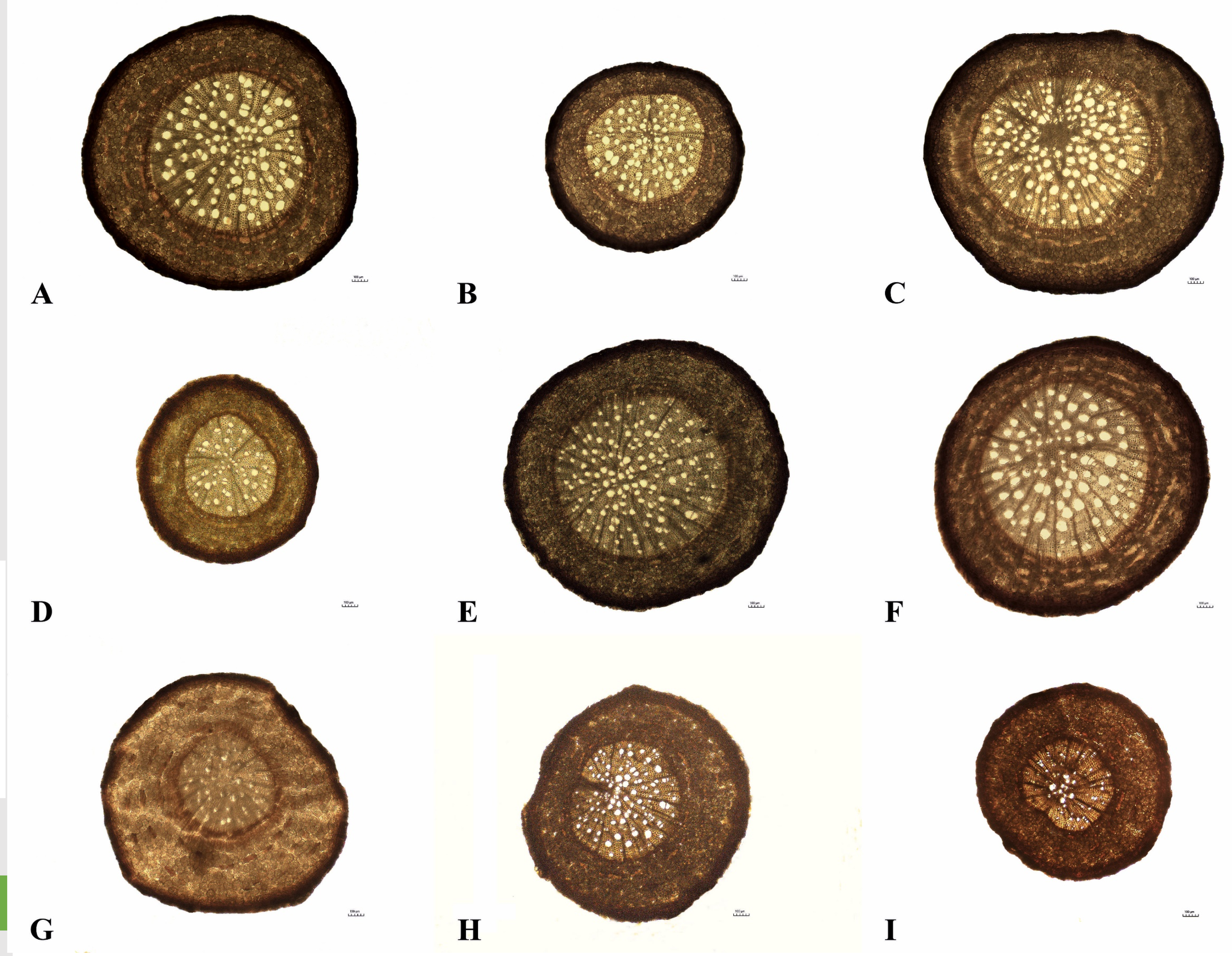

Fig. 1. Root cross-sectional area of three *Salix* clones: A-C *Salix alba* L. clone ´B-44´; D-F *Salix viminalis* L. clone ´SV068´; G-I *Salix matsudana* Koidz. clone ´SM404´ (A, D, G-control; B, E, H-treatment with 10^{-3} M Cd and C, F, I-treatment with 10^{-6} M Cd)

DISCUSSION AND CONCLUSION

Examined *Salix* clones expressed different response to increased concentrations of Cd. In root tissues of clone ´SV068´, concentration of 10^{-3} M Cd had more prominent negative effects on root anatomical traits than concentration of 10^{-6} M Cd, in comparison with control. On the other hand, clone ´B-44´ has shown increase in many root traits after treatment with 10^{-3} M Cd. Elevated root cross-sectional area in this clone, under treatment of 10^{-3} M Cd, can be explained by increased values of thickness of secondary phloem and cross-sectional area of vessels in secondary xylem. In clone ´SM4041´ applied Cd concentrations caused significant and opposite changes in values of thickness of secondary phloem, cross sectional area of parenchyma cells and number of vessels. Values of vessel areas were increased, while their number and percentage decreased. Significant differences in the vessels distribution were observed between the clones, that peaked at a diameter class of 20-40 µm. In this class of vessel diameter, values in clones ´B-44´ and ´SM4041´ decreased, while in clone ´SV068´ increased, compared to control.

Our results indicated genotypic-specific and further research associated with the possible use of clone ´B-44´ in phytoremediation strategies.

CONTACT: zorana.hrkic-ilic@sf.unibl.org