

Mapping of elements distribution in plant samples using LIBS

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Abstract

This work is focused on application of LIBS technique for the study of plant samples. The elemental mapping on cross section throughout the annual terminal twigs of *Picea abies* was performed using double pulse Laser Induced Breakdown Spectroscopy (DP LIBS). 2D maps were created, where distribution of Cu and Ca in the plant tissue was observed. After mineralization of twig parts originated in the vicinity of the implementation of cross section, ICP-MS analysis was used for determination of total content of investigated elements.

Keywords: Laser Induced Breakdown Spectroscopy (LIBS), *Picea abies*, heavy metals

Introduction

Heavy metals contained in soil are of great interest due to toxic metal accumulation in plants. Heavy metals can get to higher parts

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of food chain, even to human. There are some possibilities to remediate these soils. One of them is phytoremediation, which uses plants to accumulate heavy metals from soil. Monitoring of these metals in plant organs and tissues is important both, for protecting the human health and for checking the phytoremediation processes. In previous works, LIBS technique was successfully used for monitoring the distribution of elements in different parts of plants (Galiova et al. 2008; Galiova et al. 2007; Kaiser et al. 2009, Kaiser et al. 2007). Copper is an important trace element but its excess can have negative influence for plants, e.g. some nutrition elements intake can be affected. High Cu amount can cause specific toxicity symptoms also in human body.

Materials and methods

Annual terminal twigs of spruce (*Picea abies*) (cca 15 cm long) were cultivated in CuCl₂ solution at final concentrations of 1, 5, 10 and 50 mM; and in distilled water for a control samples. After 2, 4, 8, 16 and 24 hours cross sections in five places (A–E) with distance 2.5 cm from each other on twigs were made (A in the apex to E above solution surface). These slices were measured with DP LIBS in orthogonal reheating mode. Raster scanning with 150 μm spatial resolution was set. From LIBS data, 2D maps were created. Some twig parts originated in the vicinity of the implementation of cross sections were mineralized and subsequently analyzed by ICP-MS. The results give quantitative information about overall concentration of elements of interest.

Results and discussion

In the maps of Cu and Ca distribution, (Fig. 1) the transport of these ions throughout the plant via vascular bundles is observed. With increasing Cu²⁺ concentration, these ions are distributed also into surrounding tissues and less into the core.

ICP-MS showed indistinct trends of Ca. Nevertheless, visible trends of Cu were observed. The amount of Cu increases with increasing CuCl₂ concentration and duration of cultivation. With increasing distance from solution surface (E→A) the Cu amount decreases.

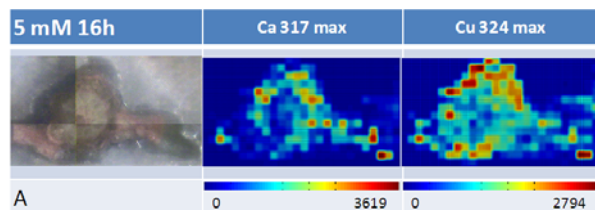


Figure 1: Maps of Cu and Ca distribution on twig slices of *Picea abies* – cultivated in 5 mM CuCl₂ 16 hours.

Conclusion

Maps of Cu and Ca distribution in twigs slices were made in this experiment. Results show that it is possible to use LIBS technique for observation of element distribution in plant tissues on twig slices. Data about the overall concentration of Cu and Ca in terminal twigs of *Picea abies* after different treatments were obtained by ICP–MS analysis. On the frame of ongoing work quantification of LIBS maps will be considered.

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