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BOOK OF ABSTRACTS

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APPROACH TO ENERGY CROP CULTIVATION ON HEAVY METAL CONTAMINATED SITES - POLISH AND GERMAN CASE STUDY

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ABSTRACT

Beside delivering biomass yield, some energy crop species demonstrate capacities to absorb heavy metals which makes them an interesting alternative for phytoremediation driven energy crops production. A four-year field experiment has been carried out at heavy metal contaminated sites located in Poland (arable land) and in Germany (postindustrial site). It involves testing of 4 preselected plant species: miscanthus (*Miscanthus* x *giganteus*), virginia mallow (*Sida hermaphrodita*), cordgrass (*Spartina pectinata*), and switchgrass (*Panicum virgatum*) to find the optimum one with respect to both energy crop yield and phytoremediation capacity Differences between test sites as well as plant metal uptake after the first year of the experiments are presented.

The Polish test site is located in the Upper Silesia Industrial Region, in the outskirts of Bytom, an industrial city, in the proximity of a closed-down large lead/zinc/cadmium works consisting of the ore mining, enriching and smelting facilities. This metallurgical complex had been in operation for over 100 years contributing significantly to the pollution of local soils. During the last three decades the area of the site has been used for agricultural purposes, most recently for grain crops cultivation – mainly wheat. Lead and cadmium contamination levels in soil range from 357.6 to 646.3 and 13.42 to 26.41 mg/kg d.w. respectively. For zinc the range is from 1273 to 2505 mg/kg d.w. Heavy metal concentrations in soil exceed Polish limits for arable soil: total lead and cadmium concentration exceeds these limits 4 to 6 fold, whereas total zinc concentration exceeds the limits 4 to 7 fold. The pH-value is almost neutral, followed by moderate content of organic matter and low electric conductivity. The level of bioavailable forms of cadmium and zinc are high (about 5% and 2.5% respectively), whereas bioavailability of lead is low (below detection limit).

The German site (so called Schladitz) is a former sewage sludge dewatering plant, located in the north of the city of Leipzig . The creation and operation history of this plant is directly related to the main sewage plant of the city. Although both plants are about 9 kilometres away from each other, they formed a procedural unit from 1952 to 1990. During this time period the sewage sludge resulting from municipal and industrial waste water treatment was pumped to the dewatering plant. In 1990 the operation of the dewatering plant was abandoned and about 800,000 tonnes of sewage sludge remained in several basins. Lead and cadmium levels in soil range from 462.5 to 696.8 and 25.29 to 39.34 mg/kg d.w. respectively. In the case of zinc, the range is from 2864 to 4488 mg/kg. The pH-

value is neutral, followed by high (33 %) level of organic matter and electric conductivity. The bioavailability of metals contained in soil is very low mainly due to high level of organic matter (Pb below detection limit, Cd 0.25 mg/kg d.w. and Zn 16 mg/kg d.w.).

For both sites similar measures were applied in terms of fertilizing (NPK) and addition of a commercial inoculum promoting plant's growth.

At the end of the 1[st] vegetation season plant samples were taken to determine, among others, heavy metal uptake for tested species and to determine the differences in this process between the sites. As an example, differences between sites in cadmium uptake by tested plant species are presented on Fig.1.

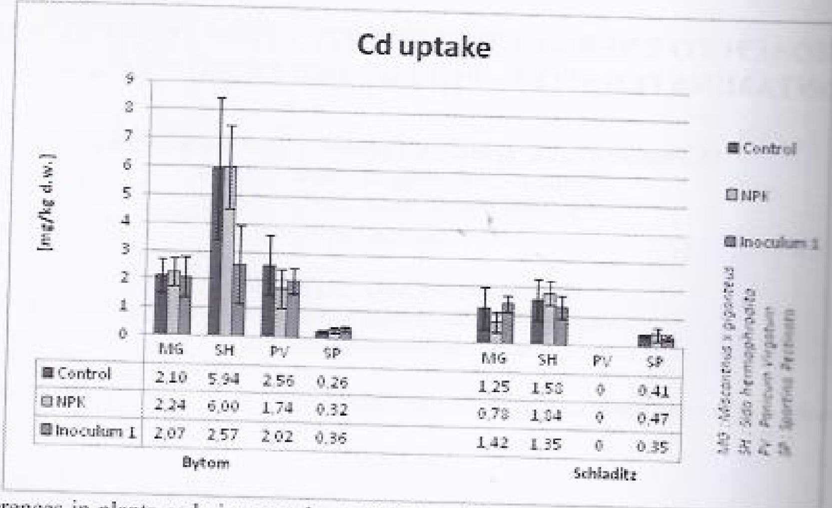

Fig 1. Differences in plants cadmium uptake at Polish and German site (no PV sampling possible at Schladitz due to crops damage).

In general, higher cadmium uptake was found in biomass collected at the Polish site. For *M.* x *giganteus* and *P. virgatum* cadmium uptake was on the level of about 2 mg/kg d.w., irrespectively from experimental option. The highest cadmium uptake was determined for *S. hermaphrodita* for control and NPK fertilized plots (6 mg/kg d.w.), whereas in the case of plots with inoculum it was 2-fold lower. The lowest cadmium uptake was found for *S. pectinata*. The obtained results suggest that this species is not a cumulative one. Cadmium uptake by plants at the German site was much more lower, correlated with low bioavailability of this element in soil. For *M.* x *giganteus* and *S. hermaphrodita* no differences were obtained in Cd uptake (about 1.5 mg/kg d.w.). In the case of *S. pectinata*, the Cd uptake was the level 0.4 mg/kg d.w. and no statistically significant when compared to the results from the Polish test site.

CONCLUSIONS

The data collected after the first year of the experiment demonstrate that almost every result of the Polish field trial is significantly higher than the uptake rates on German site. This situation might be attributed to the level of bioavailable content of metals in soil. Although soil pH value is important as it has an effect on the mobility of heavy metals, in this case however it was not the main influencing factor as the pH values for both sites did not differ significantly. This may imply that it was the soil bioavailability of heavy metals that was responsible for the uptake of heavy metals to the aboveground part of plants. The obtained results show that although the content of metals in soil was much higher at the German site, the accumulation of metals in plant tissues was lower than in plant tissues originating from the Polish site.

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