POTENTIAL OF BIOCHAR DERIVED FROM PIG MANURE FOR CD-STABILIZATION AND IMPROVED PLANT YIELD

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Introduction

Large parts of Europe deal with severe historic pollution, including the Northern Campine region in Belgium, which is challenged with cadmium (Cd)-polluted soils. Upon absorption, Cd exerts its toxicity indirectly via the induction of oxidative stress (Cuypers et al., 2010). Cadmium thus negatively affects plant growth and quality, and poses a serious threat to human health. In order to use Cd-polluted soils for agriculture, Cd uptake in plants should be prevented to ensure plant, animal and human health. A novel strategy is the application of biochar, generated from pyrolysis of organic waste streams. Using agricultural waste for the production of biochar to produce crops of high yield and quality is a sustainable way to close the loop in agriculture. Preliminary results in our lab confirm the potential of biochar to stabilize metals and improve crop yield. Because of the broad range of interactions of biochar with different elements in the soil and the wide variety of waste streams that serve as input for biochar, effects may be complex and variable. This research aims to investigate the Cd-stabilizing and fertilizing effects of biochar derived from pig manure on the model organism *Arabidopsis thaliana.*

Methods

Arabidopsis thaliana were grown on sand, as well as on sand amended with 0,5% biochar (input: pig manure (Renovia bvba, Overpelt, België), pyrolysis temperature: 500°C, atmosphere: N_2) in 125ml pots placed on square bioassay dishes filled with modified Hoagland solution, which was routinely refreshed. Plants were exposed from sowing via the Hoagland solution to 0, 10 and 25 µM $CdSO_4$. Aboveground plant parts (rosettes) were harvested 24 days after sowing and biomass data were gathered. Element determination was performed via HNO_3 extraction of oven-dried samples, followed by ICP-OES analysis.

Data was checked for normality and homoscedasticity and analyzed by two-way ANOVA and Tukey post-hoc test or Kruskal-Wallis rank-sum, and Wilcoxon rank sum post-hoc test.

Results

Biochar did not increase biomass of plants grown under control conditions (Table 1). Exposure to 10 µM $CdSO_4$ significantly reduced rosette fresh weight by 21.27% ± 8,35 compared to the control in plants cultivated on sand substrate. However, amendment with 0.5% biochar significantly increased the weight

of the exposed plants by 46.36% ± 11.05 compared to the exposed plants cultivated on unamended sand substrate.

Table 1. Rosette fresh weight. ** ($p < 0.01$) indicate significant differences in treatment with $CdSO_4$ to the control, •• ($p < 0.01$) indicate significant differences within treatment conditions due to biochar addition.

Fresh weight (mg)	Control	10 µM $CdSO_4$
Sand	70.40 ± 5.1	55.42 ± 5.88**
Sand + 0.5% biochar	72.29 ± 5.96	81.12 ± 6.12••

Amendment of sand with biochar significantly lowered Cd contents of plants treated with 10 µM $CdSO_4$ by 92.26% ± 0.42 (Table 2). Significant increases in Cu, Zn, Mg, Na, and P uptake by plants grown on biochar were observed, as well as significant decreases in Ca and Mn.

Table 2. Rosette Cd content. * ($p < 0.05$) indicate significant differences in treatment with $CdSO_4$ to the control, • ($p < 0.05$) indicate significant differences within treatment conditions due to biochar addition.

Cd content (µg/kgDW)	Control	10 µM $CdSO_4$
Sand	1.13 ± 0.66	376.21 ± 54.59*
Sand + 0.5% biochar	2.24 ± 0.79	26.49 ± 1.59*•

Conclusion

At 24 days of age, no biomass increasing effect of biochar derived from pig manure was observed in control conditions condition. Rosette fresh weight was however significantly reduced by treatment with 10 µM $CdSO_4$. This effect was alleviated by biochar, which significantly increased biomass of treated plants.

Biochar derived from pig manure strongly reduced Cd content in the above-ground plant parts of plants grown on 10 µM $CdSO_4$ and can be a good candidate as potential soil amendment on polluted soils. In addition biochar is rich in macro- and micronutrients that are available for the plant, however, significant decreases in uptake of Mn and Ca were also observed. Whether this is an effect of interactions with the biochar or of plant homeostasis with other elements remains to be investigated.

The impact of Cd exposure and biochar amendment on plant quality will be further assessed through analysis of the transcript and total antioxidant level, because of the important role of Cd in oxidative stress and the suggested effects of biochar on antioxidative defense (Viger et al., 2014).

References

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