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ENZYME ACTIVITIES AND RESPIRATION AS BIOINDICATORS OF THE BIOLOGICAL QUALITY OF Pb-Cd-CONTAMINATED SOIL UNDER AIDED PHYTOSTABILIZATION

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Abstract

The ecological evaluation of recultivation and remediation management systems requires special attention to be given to the use of soil health bioindicators, based on soil biological properties. Specifically, microbial properties related to the size, structure, activity and biodiversity of the microbial populations are the most promising biological indicators. Microorganisms respond quickly to the different stressors, and they rapidly adopt to environmental conditions. This adaptation potentially allows microbial analyses to be discriminating in soil health assessment, and changes in microbial populations and activities may therefore function as an excellent indicator of change in soil health. Thus, microbiological measurements could be used as soil biomarkers for biomonitoring, soil remediation efficiency, and as tools for evaluation of soil quality criteria or Ecological Risk Assessment. Microbial indicators have been broader applied to describe of microbial communities in polluted sites and to evaluate the remediation processes, i.e., their capacity to restore soil health.

The aim of the study was to evaluate the short-term effect of aided phytostabilization on the microbial indicators such as respiration and key enzyme activities (dehydrogenase, acidic and alkaline phosphatases, protease, ß-glucosidase) in a pilot-scale (plot) experiment. Pb-Cd highly contaminated soil was amended with lignite and lime to reduce metals bioavailability and vegetated with Festuca arundinacea grass species. After amendments application the exchangeable metal concentrations significantly decreased. Cd and Zn bioavailable forms were reduced by about 70 % and 60 %, respectively. The reduction of As bioavailability was 69.3 %. Amendments increased the pH and organic matter content in the soil. Moreover, surface of amended soil was densely covered by tall fescue. The presented aided phytostabilization option significantly increased the enzymes activities. The activities of dehydrogenase, acidic and alkaline phosphatases were high (averages 17.10 µg TPF/g s.m. 24h., 128 µg PNP/g s.m. h. and 145 µg PNP/g s.m. h, respectively) in the treated soils, and significantly increased close to control soil values. Also, soil respiration, substrate-induced soil respiration and ß-glucosidase activity were significantly higher in the treated soil compared to the control soil, while the opposite was observed for protease activity. There were significant differences between enzymes activities and respiration in treated and untreated soils.

The in situ aided phytostabilization approach of Pb-Cd contaminated soil proposed in this study increased enzymes activities and respiration, and reduced microbial stress in remediated soil, showing that aided phytostabilization can be a suistainable option for heavy metals contaminated soil management.