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Effects of different nanoparticles and biochar application on the biological indicators of a polluted mine soil

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In active mines areas without environmental management plans or abandoned mines, the mineral processing and mining-waste disposal are common sources of pollution that can affect large areas comprising soils and waters. Inevitably this situation leads to a degradation of plant cover whether natural or planted. Thus, a sustainable recovery of mine tailings and contaminated soils, located inside or surrounding the mine area is necessary, especially with innovative strategies for in situ elements stabilization. Within different stabilization options, nanoremediation, i.e. amending with nanomaterials (usually Fe-based nanoparticles) alone or combined with other amendments, is an interesting approach. Most of the studies are focused on the immobilization of metal(oid)s by nanoparticles, however only a few works assess the effects of these amendments on contaminated soils on their microbiology and plants. For these reasons, the main scope of this study was the assessment of some biological indicators, namely several enzymatic activities in soils and plant development, of a contaminated mine soil amended with two different types of commercial nanoparticles (iron nanoparticles nZVI and hydroxyapatite nanoparticles) and their combinations with biochar (by PYREG Carbon Technology Solutions, was made from wood following the PYREG® methodology). The studied soil belongs to a broad mining area in NW Spain and it revealed high total concentrations of Cu and As (5000 and 300 mg/kg, respectively). The mine soil was amended in a factorial experiment in pots assay, under controlled conditions in greenhouse, with iron nanoparticles (nZVI), hydroxyapatite nanoparticles (nHP), biochar, and the combination of nZVI+biochar and nHP+biochar. In these pots was sown a commercial mixture of herbaceous plant species for pasture being monitored for 45 days. Plant cover was determined and once this assay time had elapsed, four enzymatic activities (dehydrogenase, β-glucosidase, acid phosphatase and urease) of the soil and biomass weight was analyzed.

Only rye grass germinated. Same result was verified in the pot assay and independently of treatment. Plant cover in all treatments was similar reaching more than 80 %, however dry plant biomass varied. Notable differences were observed in the enzymatic activity among the soil amended only with nanoparticles, the soil amended with the combination of nanoparticles and biochar or biochar alone. In general, the application of studied amendments, alone or combined and compared to the control, increased the functioning of the overall microbial community and microbial communities associated to C and N cycling. The soil amended with biochar and biochar

combined with nanoparticles presented a greater enzymatic activities in the soil compared to the direct application of nanoparticles. A differentiation in the some enzymatic activities (e.g. dehydrogenase and urease) with the nanoparticles type was verified.

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