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Effect of soil pH, compost amendment and plant genotype on the accumulation of target elements in phytoremediation and phytomining research in shoots of Phalaris arundinacea

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Phytomining is a phytoassisted technique for the extraction of economically valuable elements from soils and offers a promising chance to improve the supply of critical raw materials such as germanium (Ge) and rare earth elements (REEs). The efficiency of phytoextraction depends on numerous soil-associated and plant-associated factors (e.g. concentrations of target elements in potentially plant available soil fractions, rhizosphere processes and uptake mechanisms of plants). The aim of this study was to evaluate the effect of different soil properties (pH, compost amendment) on the mobility of selected target elements for phytoremediation (As, Pb, Cd, Zn) and phytomining (Ge, REEs) in soil and accumulation in shoots of different genotypes and populations of Phalaris arundinacea. In a field experiment we cultivated 10 different genotypes and populations of Phalaris arundinacea on four different substrates with similar element concentrations but different pH-values (pH 6.6 – 7.8) and levels of compost amendment (5l /m^2 compost or without compost). On each of the substrates, we cultivated Phalaris arundinacea (genotypes) with two replicates on plots 4 m^2 each and installed suction cups to collect soil solution. After harvest concentrations of Ge, REEs, P, Fe, Mn, Zn, Pb, As and Cd in shoots and soil solution were determined with ICP-MS. Compared to the slight alkaline soil, acidic soil conditions significantly increased shoot concentrations of Fe, Mn, As, Cd, Pb and REEs. Under acidic soil conditions addition of compost further increased the concentrations of all investigated target elements in shoots of P. arundinacea except of As. In soil solution only concentrations of Fe and Mn significantly increased due to the compost amendment, while concentrations of P, Ge, REEs, Cd and Pb decreased. Shoot concentrations of all investigated elements, particularly REEs, showed remarkable differences among the genotypes and population and this responds of the plants was in turn influenced by substrate properties suggesting phenotypic plasticity during element acquisition in the rhizosphere. In future experiments the heritability of these traits will be rigorously tested in order to establish optimized seed material. We conclude that amendment of soil with compost seems to be a sustainable approach to enhance the uptake of plant nutrients and REEs into shoots of Phalaris arundinacea. However, the role of plant genetics and consequently processes during element acquisition in the rhizosphere and uptake remain field of further research but if proven this would have major implications for the optimization of phytoextraction techniques.