MASTER'S THESIS

Using organic amendments and chelates for remediation of metal-contaminated soils by vetiveria zizanioides

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Using Organic Amendments and Chelates for Remediation of Metal-Contaminated Soils by *Vetiveria zizanioides*

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Abstract

Vetiveria zizanioides (vetiver) has a massive finely structured and deep root system. Due to its unique morphological and physiological characteristics such as high tolerance to drought, extreme pH (3-10.5), and wide range of metals (vetiver) (As, Cd, Cu, Pb, and Zn ions), the utilization of vetiver in metal-contaminated soils can fulfill the dual purpose of site stabilization and soil properties for succession of other plant species. This study investigated the potential uses of vetiver in removing heavy metal pollution by stabilizing heavy metals and decontaminating mine tailings. The potential uses of vetiver in induced-phytoextraction by chelating agents to decontaminate low to moderate polluted soil were also studied.

Applications of manure compost or sewage sludge increased the water-soluble N and P of Pb/Zn mine tailings. They also decreased DTPA-extractable Pb and Zn concentrations. Sewage sludge improved both root and shoot biomass in vetiver and Phragmities australis (common reed), with the most significant improvement observed under the application of 10% sewage sludge (44.05 t/ha). However, manure compost did not improve the biomass of both species. Plant tissue analysis showed that applications of these organic amendments did not reduce Zn uptake and accumulation in the shoots of vetiver and common reed, but significantly decreased the uptake of Cu and Pb in the roots and shoots of both plant species.

Applications of manure compost and sewage sludge to Cu mine tailings amended with manure compost and sewage sludge could also improve nutrient levels (N and P), but resulted in a significant decrease of DTPA-extractable Cu and Pb content. However, both manure compost and sewage sludge could increase the root and shoot biomass of both plant species. Plant tissue analysis showed that the use of these organic amendments could significantly reduce Pb and As uptake and accumulation in shoots of vetiver and common reed.

The effects of chelating agents on the desorption of As-, Cu- and Zn-amended soil were investigated. It was revealed that nitrilotriacetic acid (NTA) could desorb higher concentrations of As and Zn, while N-(2-hydroxyethyl) iminodiacetic acid (HEIDA) could desorb higher concentrations of Cu, at the application rate of 20 mmol/kg. In addition, the surge time on metal accumulation was 20 days when chelates were applied before harvest. Although the chelates enhanced desorption from metal-amended soils, they did not enhance metal ion accumulation in the shoots of vetiver and maize. Therefore, the time that is required by both vetiver and

maize to remove heavy metals (As, Cu, and Zn ions) from soil by phytoextraction and achieve an acceptable level will require a long time (several hundred years).

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Chapter IV: Enhanced uptake of As(V), Zn(II) and Cu(II) by *Vetiveria zizanioides* and *Zea mays* using chelating agents