Essential Oil Production as an Incentive for Using Vetiver Grass in Phytoremediation of Soils Contaminated with Zinc or Copper

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Abstract:

Vetiver grass, *Chrysopogon zizanioides,* is a perennial grass with some unique characteristics that make it a plant of choice for phytoremediation of sites contaminated by heavy metals. Essential oil extracts from the extensive root system of vetiver grass are valuable to the perfumery, food and pharmaceutical industries. Economic returns from the commercialization of essential oil extracts obtained from vetiver grass used for phytoremediation purposes can offer a great incentive for recovery of contaminated sites. In this study, four levels of lead (0, 500, 2000, 8000 mg kg^{-1} dry soil), copper (0, 100, 400, 1600 mg kg^{-1} dry soil) and zinc (0, 400, 1600, 6400 mg kg^{-1} dry soil) were used to investigate their effects on vetiver growth, essential oil composition and yield. The effect of nitrogen on vetiver oil yield was also investigated. After six months of cultivation in a glasshouse trial, vetiver survived under all tested conditions except the highest lead level of 8000 mg kg^{-1}. Plant height and biomass decreased compared to the control at higher levels of Pb (2000 mg kg^{-1}), Cu (400 and 1600 mg kg^{-1}) and Zn (6400 mg kg^{-1}). The plant accumulated high concentrations of Pb, Cu and Zn in the roots (3341, 721, 2553 mg kg^{-1} dry weight, respectively). However, only small amounts of contaminants were translocated to the shoots (327, 55, 642 mg kg^{-1} dry weight, respectively). The oil content and yield decreased with increases of heavy metal levels in the soils, however oil yields were not affected at low and moderate concentrations of Cu (100 mg kg^{-1}) and Zn (400 and 1600 mg kg^{-1}). Only the application of lead had a significant detrimental effect on oil composition. The addition of nitrogen to the soil resulted in reduced oil yields. It was demonstrated that lead, zinc and copper were retained in the plant materials during extraction by hydro-distillation. The results show that phyremediation by vetiver of soils containing moderate levels of copper and zinc has the potential to generate revenue from the commercialization of oil extracts without requiring the addition of nitrogen to the soils.

Moreover, the high biomass of vetiver produced from phytoremediation, resulted from accumulation of CO_2, partly contributed to the reduction of CO_2 in the atmosphere. The above-ground biomass of vetiver can be used for biofuel production, electricity generation, mulch, handicrafts and other purposes that in turn increase profits for landholders.

Keywords: essential oil, economic incentive, heavy metals, phytoremediation