Study on the Absorption of a Number of Heavy Metals in the Soil by Vetiver Grass and Assessment of its Effectiveness in the Rehabilitation of Contaminated Lands

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In general as the concentrations of heavy metals (Cd, Zn, Cu and Pb) in the soils increased, growth of vetiver grass in glasshouse experiments decreased. However, within the range of Cd applied, 5-60ppm, (2.5 to 30 times higher than the acceptable Vietnamese Standard); Zn, 200-500ppm (1 to 4 times); Cu, 50- 100ppm (1 to 2 times) and Pb, 100-700ppm (1.5 to 10 times), vetiver still growing well. Growth parameters such as height, root length and new shoots of vetiver were less than 50% of that of uncontaminated soil.

The uptake ability of vetiver is different between Cd, Zn, Cu and Pb. The Zn absorption and translocation to the shoot and leaves are relative high (Bioconcentration factor (BF) varies between 0.74 -1.14 and translocation factor (TF) 0.56-0.89. So vetiver could be classified as a Zn accumulator plant. The Cu absorption and translocation to the shoot and leaves are at the medium level (BF varies between 0.20-0.47 and TF 0.24-0.86). The Pb absorption is relative low (BF varies between 0.04-0.13), but the translocation to the shoot and leaves is relative high (TF range from 0.16 to 0.88). The Cd absorption and translocation to the shoot and leaves are low (BF varied between 0.04 - 0.09 and TF 0.054 - 0.134).

Although the heavy metal uptake by vetiver grass is relative low (except Zn), due to its high biomass, the total amount of metal absorbed by vetiver in the vacuole is higher than other plants, including some hyperaccumulators. After 3 months of planting, the amount of metal uptake by vetiver accounted for 0.052-0.229mg of Cd; 19.778 – 39.511mg of Zn; 0.681 – 3.354mg of Cu and 0.275 – 5.873mg of Pb per pot. It is an ideal characteristics of this plant to reclaim heavy metal contaminated soil.

In the field, with the soil containing multi-metals (Cd, Zn, Cu and Pb) at the concentrations of 10ppm, 300pp, 100ppm and 300ppm, respectively, vetiver still growing well and absorbed heavy metals. However, the metal uptake potential is lower than in the case of a single metal. The metal uptake potential increased as follow: Cd (12.87%), Zn (14.53%), Cu (23.27%) and Pb (10.68%). The significantly negative correlations are found between Pb-Zn ($r = -0.80$) as well as Zn-Cd ($r = -0.65$). In contrast, Cu and Cd are showed relative significant positive correlation ($r = 0.56$). The correlations between Pb-Cd and Pb-Cu are not significant ($r = 0.37$ and $r = 0.21$).

On the study conducted on contaminated soils from:

- Khanh Son landfill (Zn, Cu and Pb are exceeded 1.3; 1.5 and 1.7 times higher than the acceptable Vietnamese Standard.

- mine tailing of Bong Mieu Gold mine (Cd, Zn, Cu and Pb are exceeded 7.75; 1.19; 1.01 and 1.56, times higher than the acceptable Vietnamese Standard respectively and
- Hoa Minh landfill (Zn and Pb are 1.17 and 1.2 times higher than the acceptable Vietnamese Standard respectively.

At these sites, vetiver grass grew well, even better than native plants such as Bermuda grass and honey grass. Although the metal uptake and translocation's abilities of vetiver are lower than these native plants, the total amount of the heavy metal uptake in the vacuole was absolutely higher than that of these native plants. The uptake by vetiver in comparison with native plants was 2-3 times higher for Zn, 3-10 times higher for Cu, 9-14 times higher for Pb and especially 5-186 times higher for Cd.

Vetiver could survive and grew in the contaminated soils of Khanh Son landfill and Hoa Minh waste disposal of Lien Chieu district, Danang City. The highest concentration of heavy metals accumulated in vetiver was found after 3 months. Thus, the application of vetiver grass in soil reclamation should be in a 3 month cycle. After 3 months, the grass should be cut and removed to stimulate the plant growth and metal uptake ability. After 12 months, the amounts of metal uptake per square meter for Khanh Son landfill were:

- 0.931g of Zn; 0.075g of Cu and 0.013g of Pb
  and for Hoa Minh wastes disposal site
- 1.469g of Zn and 0.026g of Pb

In addition, the soil quality of the sites also improved:

- The concentration of organic matters increased by 9 to 13%
- The concentration of total N by 23% to 68%

In contrast, the levels of heavy metals were reduced:

- Zn by 13 to 16%
- Pb by 7 to 12% and
- Cu by 17%

The socio-economic and environmental benefits from vetiver application are very significant. The use of vetiver to reclaim Khanh Son landfill could save up to 10-26 times as compared with other measures; the saving could be more than USD400 000.

This is in addition to:

- improving the soil quality,
- avoiding the risks of food contamination,
- controlling pollutant emissions in the aquatic and atmospheric environments
- creating an aesthetic landscape
- restoring the ecosystem and also
- gaining the economic benefit from biomass, which could be used for making handicraft, oil extraction and biofuel, thus

- contributing to the development of community's economic and environmental protection.