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Assessment of heavy metal tolerance in native plant species from soils contaminated with electroplating effluent

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Heavy metals concentrations of (Cr, Zn, Fe, Cu and Ni) were determined in plants and soils contaminated with electroplating industrial effluent. The ranges of total soil Cr, Zn, Fe, Cu and Ni concentrations were found to be 1443–3240, 1376–3112, 683–2228, 263–374 and 234–335 mg kg^{-1}, respectively. Metal accumulation, along with hyperaccumulative characteristics of the screened plants was investigated. Present study highlighted that metal accumulation in different plants varied with species, tissues and metals. Only one plant (*Amaranthus viridis*) accumulated Fe concentrations over 1000 mg kg^{-1}. On the basis of TF, eight plant species for Zn and Fe, three plant species for Cu and two plant species for Ni, could be used in phytoextraction technology. Although BAF of all plant species was lesser than one, these species exhibited high metal adaptability and could be considered as potential hyperaccumulators. Phytoremediation potential of these plants can be used to remediate metal contaminated soils, though further investigation is still needed.

1. Introduction

Heavy metal concentrations in past few years have reached to a promising toxic level due to consequences of anthropogenic activities and urbanization. Nowadays it is well-known that cities suffer from considerable pollution due to a wide array of substances that contaminate the air, water and soil (Rucandio et al., 2010). Metal persistence in soil for much longer periods than in other compartments of the biosphere is a matter of serious concern. International Agency for Research on Cancer (Beyersmann and Hartwig, 2008) has classified heavy metals like arsenic, cadmium, chromium, nickel, lead, etc. to be carcinogenic to humans and wildlife. Over recent decades, the annual worldwide release of heavy metals reached 22,000 t (metric ton) for cadmium, 939,000 t for copper, 783,000 t for lead and 1,350,000 t for zinc (Singh et al., 2003; Sarma, 2011). Conventional techniques that are used for remediation for contaminated soil are costly, disruptive and labor intensive (Raskin and Ensley, 2000; Butcher, 2009). For example the cost of cleaning up contaminated sites is extremely high, in the USA alone, $6–8 billion is spent annually in remediation efforts, with global costs in the range of $25–50 billion (Tsao, 2003). Recently there is considerable interest in developing sustainable, cost-effective technologies for remediation of heavy metal-contaminated soil and water (Chatterjee et al., 2010). Therefore, plants can be used to ameliorate heavy metal pollutants from the soil and this cost effective approach is called phytoremediation also referred as "green solution" (Willey, 2007; Butcher 2009). Phytoremediation is approximately 10 times less expensive than conventional strategies (Chappell, 1998). Phytoextraction is one of the most widely investigated approaches of phytoremediation, which involves the use of plants to remove the contaminants from the soil into above ground biomass. Phytoextraction is an effective means of remediating a site because it reduces the overall mass to be treated from tons of widespread contaminated soil to plant tissue that can be dried to a small volume (Doty, 2008). Hyperaccumulators may be one of the best choices for this application because they can accumulate excessively high amounts of metals in their harvestable part which are easy to dispose. According to Baker et al. (2000) metal hyperaccumulator is defined as a plant that can accumulate the metal to a leaf of 0.1% of nickel, cobalt, chromium, copper and lead, 1% of zinc and 0.01% of cadmium. Over 500 plant species comprising of 101 families have been reported, including members of the Asteraceae, Brassicaceae, Caryophyllaceae, Cyperaceae, Cunouniaceae, Fabaceae, Flacourtiaceae, Lamiaceae, Poaceae,

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