

## ABSTRACT

Industrialization, agriculture modernization, and urbanization have increased the contaminant levels in the ecosphere which has led to environmental decline. Heavy metals are considered to be a serious threat to agriculture, natural fauna, flora, and the environment. These are silent, non-biodegradable and indirect killers that can alter ecosystem structure, diversity, and function. One of the main concerns of environmental biotechnologists in Pakistan has been finding a solution for the decontamination of heavy metals (HMs) contained in tannery solid waste (TSW). The current study is focused on phytoextraction of heavy metals from TSW using phytoextraction bio reinforced with autochthonous saprophytic fungus *Trichoderma* spp. In pots trial, 64 treatments (containing fungal strains and TSW + soil mixtures) were used with three replicates of each treatment. The results of various investigations revealed that TSW contain high pH (9.13), electrical conductivity (306  $\mu\text{S}/\text{cm}$ ), and organic matter (25 %) with very low bulk density (0.3 g  $\text{cm}^{-3}$ ). In TSW+ soil combinations compared to garden soil, category-I and II metals were substantially higher. The highest level of Cr concentration was found in the TSW+ soil mixtures across all treatments compared to other category-II metals.  $\text{Cr} > \text{Pb} > \text{Mg} > \text{Cd} > \text{Ni} > \text{Cu}$  was the trend for metal concentration across all treatments. In comparison to 5, 10, 20, and 40% TSW-soil mixtures, the plants grown on soil mixtures with a TSW concentration of 60% and above exhibited less pronounced growth. The treatments containing fungal combinations (*T. citrinoviride*, *T. longibrachiatum*, *T. harzianum*) were determined to have the highest metal extraction efficiency. According to the fungal inoculum, the metal extraction efficiency went in the following order from higher to lower order:  $\text{M4} > \text{M3} > \text{M2} > \text{M1} > \text{S3} > \text{S2} > \text{S1} > \text{S0}$ . The plants that received the three-fungus mixture inoculation (M4) exhibited noticeably greater growth in all types of treatments. In comparison to the control treatment, plants treated with individual fungal inoculum, have also shown a considerable growth rate. It was demonstrated that *Helianthus annuus* L. is an effective plant for phytoextraction of multimetal-contaminated TSW. Lower percentages (5, 10, and 20%) of TSW were found to be appropriate for the phytoremediation of the majority of the studied metals when growth factors and metal accumulation in the plant were taken into consideration.