

Large Area Phytoremediation Experiment to Study the Uptake of Metals by Twelve Plant Species Growing in the Contaminated Site of Central Taiwan

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Abstract

A 1.3 ha of Cr-, Cu-, Ni-, and Zn-contaminated site in the central Taiwan was used to study the feasibility of phytoextraction. Based on the result of pre-experiment in the site, 12 plant species were selected from 33 plant species and further used for large area phytoremediation experiment in the site. Comparing with the initial plants before planting, most plant species significantly accumulated higher Cr, Cu, Ni, and Zn in their shoots after growing in this contaminated site for 33 d. Among the 12 plant species, those plants that accumulated higher concentration of metals in their shoot were Garden canna and Garden verbena (in the levels of 45-60 mg Cr kg⁻¹), Chinese ixora and Kalanchoe (30 mg Cu kg⁻¹), rainbow pink and sunflower (30 mg Ni kg⁻¹), and French marigold and sunflower (in the levels of 300-470 mg Zn kg⁻¹), respectively. Result of two times of large area phytoremediation experimental demonstrates that phytoextraction is a feasible method to re-use those...

Key words: Heavy metals, large area experiment, phytoextraction, phytoremediation...

Introduction

About 300 ha of cropped lands in Central Taiwan were contaminated with metals resulted from the use of effluent from surrounding chemical plants. The most often techniques to be used in Taiwan to treat these metal-contaminated soils included soil turnover and dilution method and acidic washing soil method. However, the disadvantages after treating with these two methods include the decrease of soil fertility, soil pH value, and soil nutrient content. The treated soils even can not be used for further crop production. In-situ growing suitable plant is practicable to beautify and to reuse the metal-contaminated sites. Chen and Lee (1997) reported that when rainbow pink was grown in a Cd-contaminated site in northern Taiwan for five weeks, the Cd concentration in the plant shoots significantly increased from 1.56 (control treatment) to 115 mg kg⁻¹ (74-fold). Lai and Chen (2004 and 2005) reported that applying EDTA can significantly increase the metal concentration in the soil solution and in the...

Materials and Methods

The studied site was located in the Central Taiwan and the total experiment area of this site was 1.3 ha. Soils were contaminated with combined metals and the total concentration in the topsoil (0-15 cm) was 46-463 (Cr), 23-152 (Cu), 103-523 (Ni), and 202-958 (Zn) mg kg⁻¹, respectively. We selected 12 plant species from 33 plant species based on the result of small area-experiment before the beginning of this large area study. The selected 12 species are Rainbow pink (*Dianthus chinensis*), Serissa (*Serissa japonica*), French marigold (*Tagetes patula*), Chinese ixora (*Ixora chinensis* Lam), Sunflower (*Helianthus annuus*), Croton (*Codialum variegatum*), Kalanchoe (*Kalanchoe blossfeldiana*), Garden canna (*Canna generalis* spp.), Garden verbena (*Verbena hybrida*), Purslane (*Portulaca oleracea* Linn), Scandent Scheffera umbrella tree (*Schefflera arboricola* Hayata), and Bojers spurge (*Euphorbia splendens*), respectively. Total area of 1.3ha was divided into 12 blocks and one plant species is planted in one block (0.1ha). At the 1st stage of large area-experiment, total amounts of 12,000 seedlings were...

Results and Discussion

The result indicated that the soil texture of the contaminated site was silty clay. The CEC and pH value of the topsoil was $13.2 \text{ cmol}(+) \text{ kg}^{-1}$ and in the levels of 5.6-7.2, respectively. After planting in this combined metals-contaminated site for 33 d, these 12 plant species have no any toxic symptoms of metals. Figure 1 shows the initial and final concentration of Cr, Cu, Ni, and Zn in the shoots of 12 plant species. Except for Cu concentration of Chinese ixora and Purslane in shoot, the other 10 plant species have low metal concentration before planting (initial in Fig. 1). The initial metal concentration in their shoots was <20 (Cr), <10 (Cu), <5 (Ni), and <50 (Zn) mg kg^{-1} , respectively. The final metal concentrations were increased after two stages of large area-planting for 33 d in relative to initial

status. The plant species that accumulated higher metal concentration in shoot were Garden canna and Garden verbena (in the levels of 45-60 mg Cr kg^{-1}), Chinese ixora and Kalanchoe (30 mg Cu kg^{-1}), rainbow pink and sunflower (30 mg Ni kg^{-1}), and French marigold and sunflower (in the levels of 300-470 mg Zn kg^{-1}), respectively. Based on the experimental results and conditions of this study (10,000 plants/ha/species), we can probably calculate the total phytoextraction capacity of different metals.

The plant that can remove the maximum amounts of Cu are Chinese ixora and French marigold (in the levels of 2.2-3.1 kg ha^{-1}). Rainbow pink and French marigold have the maximum total removal of Cr (in the levels of 1.8-3.7 kg ha^{-1}), Ni (in the levels of 1.2-2.5 kg ha^{-1}), and Zn (in the levels of 9.7-16.8 kg ha^{-1}) among these 12 plant species...

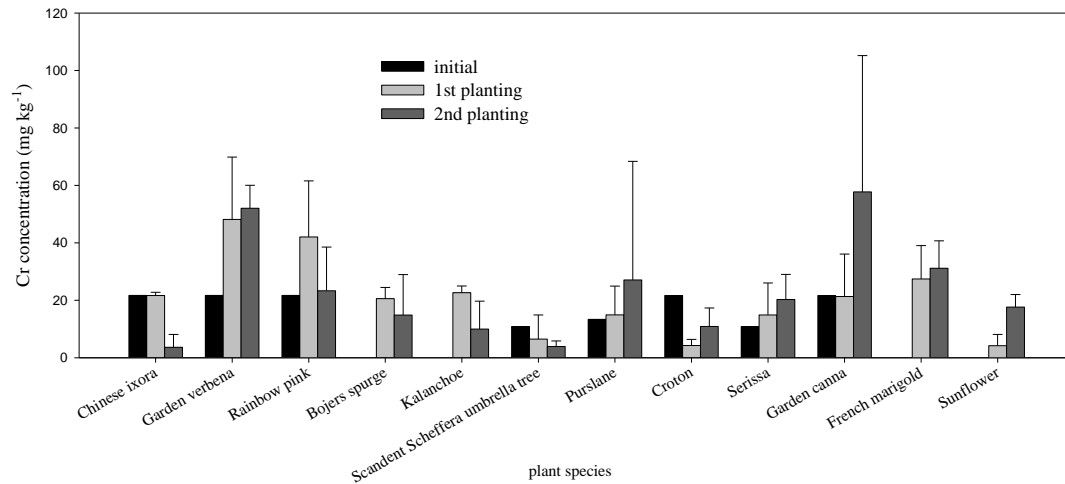


Fig. 1. The initial and final concentration of Cr in the shoot of 12 plants which were large area-planting in the metals-contaminated site for 33 d.

Conclusion

Large area of phytoremediation experiment results shows that the selected 12 plant species were grown well and there are no any toxic symptoms after planting in this combined metals-contaminated site in Central Taiwan for 33 d. For most of plant species, the final Cr, Cu, Ni, and Zn concentration in...

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