# Evaluating improvement techniques for phytosuction separation method to remove heavy metals from contaminated soils

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Soil contamination by heavy metals has been a critical issue because heavy metals are bonded with soil particles tightly and are difficult to remove. Phytoextraction is one of the soil decontamination methods that plants growing at contaminated sites extract contaminants with soil moisture. Although the phytoextraction is environmentally friendly and low in cost, removal rates of contaminants are limited because plants growth is inhibited due to the toxicity of contaminants. Katoh et al. (2016) proposed a new method for heavy metal decontamination, phytosuction separation (PSS), which utilizes plant water uptake and an immobilization material (they used hydroxyapatite). In PSS, a immobilization material for heavy metals was placed on a contaminated soil, and plants grow in non-contaminated soil mounded on the immobilization material. Plant water uptake induces heavy metal transfer from contaminated soil toward the immobilization materials. Since plants are protected from the toxicity of heavy metals in this method, the removal rates of heavy metals are much higher than that with phytoextraction. In this study, we aimed to improve the PSS method by i) using new immobilization materials, ii) inducing soil water cycle between the contaminated and non-contaminated soils, and iii) applying organic fertilizer to enhance plant growth and to increase mobility of heavy metals.

We performed pot experiments to evaluate each improvement techniques with lead contaminated soil collected from a shooting range. As a new immobilization material, we examined iron slag and commercialized adsorption sheet. Water cycle between contaminated and non-contaminated soils are induced by changing position of water supply. Katoh et al. (2016) supplied water from contaminated soil, but we supplied from non-contaminated soils. The water supplied to non-contaminated soil move downward by gravity and reach contaminated soil, and then go back to the non-contaminated soil by plant water uptake. Plant roots produce organic acid and it will be transferred to the contaminated soil with water. Since organic acid increase mobility of lead, the water cycle possibly improve the efficiency of PSS method.

The results showed poor plant growth when slag and commercialized sheet are used as a immobilization material compared with when hydroxyapatite was used. Obviously the plants growth was inhibited by the toxicity of lead. The slag did not have enough ability to immobilize the lead, possibly due to the small soil moisture content in PSS method. The commercialized sheet allowed plant roots penetrate itself and the roots reached contaminated soil. The water cycle increased soluble lead content in contaminated. It means that organic acid produced by roots reached the contaminated soil. Applying organic fertilizer did not increase soluble lead content in the contaminated soil, but it improved plant growth. Therefore, water cycle and organic fertilizer improves the PSS method, but immobilization materials still need to be investigated.

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