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The use of a biodegradable chelator for enhanced phytoextraction of heavy metals by *Festuca arundinacea* from municipal solid waste compost and associated heavy metal leaching

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HIGHLIGHTS

- Using NTA and permeable barrier to assess metal phytoextraction by turfgrass and leaching.
- NTA increased Cu, Pb, and Zn uptakes in two crops of *F. arundinacea*.
- Barriers positioned between MSW compost and soil effectively reduced metal leaching.
- With regard to total metal amounts in the compost, slight metal leaching occurred in all treatments.
- NTA-assisted phytoextraction by turfgrass with barriers should be environmentally safe.

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ABSTRACT

In a column experiment with horizontal permeable barriers, the effects of a biodegradable chelator-nitrilotriacetic acid (NTA) on the uptake of heavy metals from municipal solid waste (MSW) compost by *Festuca arundinacea* and metal leaching were investigated. The use of NTA was effective in increasing Cu, Pb, and Zn uptakes in shoots of two crops of *F. arundinacea*. In columns with barriers and treated with 20 mmol NTA per kg MSW compost, metal uptakes by the first and second crop of *F. arundinacea* were, respectively, 3.8 and 4.0 times for Pb, and 1.8 and 1.7 times for Zn greater with the added NTA than without it. Though NTA application mobilized metals, it caused only slight leaching of metals from MSW compost. Permeable barriers positioned between compost and soil effectively reduced metal leaching. NTA-assisted phytoextraction by turfgrass with permeable barriers to cleanup heavy metal contaminated MSW compost should be environmentally safe.

1. Introduction

The amount of municipal solid waste (MSW) generated is increasing rapidly as a result of population growth. As the most populous country, China faces the urgent problem of municipal solid waste disposal (Zhang et al., 2010). Composting has proved to be a safe and effective way to reduce large quantities of MSW and accelerate the decomposition and stabilization of the biodegradable components of biowaste from MSW, for sustainable complete recycling, thereby producing compost that can be used as soil amendment and/or organic fertilizer (Moldes et al., 2007). Composted municipal waste may be applied to cropland as a source of nutrients and to improve the physical properties of the soil, leading to improved crop yield and quality (Cherif et al., 2009; Fagnano et al., 2011). However, despite the possible usefulness of MSW compost, some concerns have been expressed regarding its potential risk to agricultural soils because it could be a source of heavy metal pollution, especially in developing countries (Jordão et al., 2006; Achiba et al., 2009). Long-term application of MSW compost may result in accumulation of heavy metals in amended soil and in crops, posing a direct threat or potential hazard to human health through food chain.

Phytoremediation, especially phytoextraction, which uses plants to remove inorganic contaminants, primarily heavy metals, has emerged as a cost-effective, environmentally friendly *in situ* remediation technology for soils contaminated with heavy metals (Salt et al., 1998; Garbisu and Alkorta, 2001). Phytoextraction can be broadly classified as either natural or chemically assisted (Saifullah et al., 2010; Lombi et al., 2001). The natural phytoextraction technique utilizes metal hyperaccumulating plant species with exceptionally high metal-accumulating capacities (Kumar

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