Role of Plants in Migration of Antimicrobials from Land-Applied Biosolids

Dawn Reinhold and Alison Cupples

Project Abstract
Antimicrobials, like triclosan (TCS) and triclocarban (TCC), are introduced into terrestrial and aquatic ecosystems via land-application of biosolids, a common waste management practice for municipal wastewater treatment facilities. However, the fate of TCS and TCC in fields to which biosolids have been applied is largely unknown, especially with regards to the role of plants. Studies have demonstrated that plants can remediate soils contaminated with hydrophobic chlorinated aromatics that are similarly structured to TCS and TCC, justifying research into the role that plants play in reducing migration of TCS and TCC from land-applied biosolids. Proposed research tests the hypothesis that plants, through uptake, hyperaccumulation, and other processes, can reduce the concentration of TCS and TCC in land-applied biosolids, thus reducing migration of TCS and TCC from fields into water resources. Research objectives are (i) to evaluate multiple plant varieties for their capabilities to reduce migration of TCS and TCC from land-applied biosolids and (ii) to assess plant uptake and hyperaccumulation of TCS and TCC by multiple plant varieties. Research will compare migration of TCS and TCC from greenhouse scale experimental reactors containing a biosolid-soil mixture that are either planted (e.g., zucchini, pumpkin, switch grass) or barren (i.e., control reactor). Over three to four months, migration of TCS and TCC from the biosolid-soil mixture will be assessed by collecting and analyzing leachate produced from simulated rainfall events. At the conclusion of the migration experiments, soil concentrations of TCS and TCC will be analyzed to assess the long-term impacts of vegetation on accumulation of TCS and TCC in soils. Additionally, research will examine concentration of TCS and TCC in multiple plant compartments (e.g., root, stem, leaf, fruit) to quantify the uptake, translocation, and hyperaccumulation of TCS and TCC by plants. Expected research outcomes include (i) assessment of the influence of plants on migration of TCS and TCC, (ii) identification of plant varieties that hyperaccumulate TCS and TCC, (iii) determination of TCS bioaccumulation and translocation factors in plants, and (iv) insight into impacts of hyperaccumulation on migration of TCS and TCC. Outcomes of the proposed research will ultimately lead to enhanced understanding of TCS and TCC fate and improvements in best management practices for land application of biosolids. Proposed research results are expected to form a foundation for future research on plant processes related to environmental fate and risks of TCS and TCC, including phytostimulation, phytometabolism, and hyperaccumulation. The results obtained through the CWS Venture Grant will drastically increase our competitiveness for extramural funding by demonstrating that plants contribute to fate of TCS and TCC from land-applied biosolids. Highly competitive extramural funding will be pursued for the long-term objectives related to the proposed research; we are currently planning on submitting related proposals to the USDA CRES National Research Initiative - Water and Watershed RFP (January 2009) and the NSF Chemical, Bioenergy, Environmental and Transport System - Environmental Engineering RFP (Sep 2008 or Mar 2009).