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Evaluating the use of DGT-DIFS to measure Cd, Cu, Ni and Zn plant availability in soils treated with biosolids and metal salts

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Abstract

The application of biosolids to land is increasing because of the benefits of improved soil fertility and productivity, as well as providing an alternative use of waste disposal. However, the metals present in biosolids are potential concerns for environmental and public health, arising from the possibility of metal accumulation in soils and their introduction into the food chain via plant uptake. The success of environmental risk assessments of metal contaminated soils depends on their accuracy of estimating metal bioavailability. Diffusive gradients in thin-films (DGT) combined with 2D-DIFS (DGT-induced fluxes in soils) is a relatively new technique for measuring labile metals in soils, characteristically expressed as effective solution metal concentrations (C_E).

This technique has shown to be a promising surrogate for predicting metal uptake in plants and is being extensively examined using three soil types collected from the Canterbury region. Lysimeters (containing soil monoliths) were treated with a one-off application of increasing levels of Cd (1, 5, 10 mg/kg), Cu (50, 200, 750 mg/kg), Ni (30, 150, 300 mg/kg) and Zn (70, 300, 1000 mg/kg) in the presence and absence of biosolids (400 kg nitrogen ha⁻¹yr⁻¹). Ryegrass (*Lolium perenne*) was sown on each lysimeter immediately after treatment application. Ryegrass, harvested at 6-monthly intervals is analysed for total plant metal content and soil (0-10 cm) is sampled and assessed using the DGT and 2D-DIFS method. Metal contents of plants generally increased as treatment levels increased.

Zinc and Ni contents of plants were higher in soils treated with metal salts in the presence of biosolids. Cadmium levels were higher in treatments without biosolids, and highest in the Cd-only treatment. With respect to plant uptake, Cu and Ni levels reached a plateau, whilst corresponding C_E values increased linearly. However, reasonable linear relationships were found between the C_E of Zn and Cd and corresponding plant contents.