AVAILABILITY OF Cd, Ni AND Zn TO RYEGRASS IN SEWAGE SLUDGE-TREATED SOILS AT DIFFERENT TEMPERATURES

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(Received 4 November 1999; accepted 1 November 2000)

Abstract. A pot experiment to compare the availability of Cd, Ni and Zn to ryegrass (*Lolium perenne* L.) was conducted at 15 and 25 °C. For this purpose, three rates of sewage sludge (0, 10 and 50 t ha^{-1}) were applied in a loamy sand (LS) and a clay loam (CL). Heavy metal availability assessed by soil extractions with 0.05 M $CaCl_2$ and the organic matter content were monitored during a period of two years, while uptake by ryegrass was monitored over one year after addition of the sludge. The concentrations of Cd and Ni in both the ryegrass and the soil extracts increased significantly, during the first year, especially at 50 t ha^{-1}. However, in the second year metal availability reached a plateau. During the first year, in the ryegrass Zn concentrations did not show an increase, but in the soil $CaCl_2$-extracted Zn increased. During the same period, the organic matter content decreased rapidly, especially at 25 °C, in the first year and much more slowly in the second, giving a total decrease of 16%. Temperature had a marked effect on metal availability; both soil extracts and plant samples from the 25 °C treatment had greater concentrations of Cd, Ni and Zn than those at 15 °C. This may be attributed to the organic matter, which decomposed more rapidly at 25 °C. Moreover, soil-plant transfer coefficients (Tc) of the metals were significantly higher at 25 °C than at 15 °C, with Cd showing the greatest difference, followed in decreasing order by Zn and Ni.

Keywords: $CaCl_2$ extraction, heavy metals, metal bioavailability, organic matter, temperature, time

1. Introduction

Sewage sludge is the residue product of wastewater treatment and has been used in agriculture for many years as a fertiliser containing organic matter and macro-and micronutrients. However, it contains heavy metals, which may have adverse effects on crops and possibly humans (Solar-Rovira *et al*., 1996). The 'available' fraction of heavy metals is that which can be readily mobilised in the soil environment and taken up by plant roots. Organic matter exerts a major control on the availability of metals to plants (Towers and Paterson, 1997; McBride *et al*., 1997) and it is especially responsible for reducing the availability of Cd and Zn to plants. It has been reported that organic matter diminishes metal toxicity symptoms, because it adsorbs heavy metals and removes them from the soil solution (Alloway and Jackson, 1991; Bell *et al*., 1991; El-Hassanin *et al*., 1993). However, low molecular weight fulvic acids (forming part of the dissolved organic carbon, DOC) may increase metal mobility, as they can complex metals previously bound onto soil

Water, Air, and Soil Pollution **132:** 201–214, 2001.