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The role of dissolved organic carbon in the mobility of Cd, Ni and Zn in sewage sludge-amended soils

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"Capsule": *Applications of natural dissolved organic carbon significantly increased metal (Cd, Ni, Zn) extractability from soils and their uptake by ryegrass.*

Abstract

A pot experiment was conducted to investigate the effect of application of naturally derived dissolved organic compounds (DOC) on the uptake of Cd, Ni and Zn by *Lolium perenne* L. from mixtures of soil and sewage sludge and on their extractability with $CaCl_2$. DOC was applied at concentrations of 0, 285 and 470 mg l^{-1} to a loamy sand (LS) and a sandy clay loam (SCL) soil mixed with sewage sludge at rates equivalent to 0, 10 and 50 t ha^{-1}. DOC applications significantly increased the extractability of metals and also their uptake by ryegrass, but the increase was greater where sludge was applied at 50 t ha^{-1}. It is suggested that DOC in soils significantly increased the availability of the metals to plants. This was especially the case in the LS soil, where DOC had less competition with surface sorption than in the SCL soil.

Keywords: DOC; Heavy metals; Availability

1. Introduction

Dissolved organic carbon (DOC) consists of several types of low molecular weight organic compounds, such as polyphenols, simple aliphatic acids, amino acids and sugar acids (Fox and Comerfield, 1990). DOC stays dissolved in the soil solution under natural conditions and it has been found that it may be responsible for the dissolution equilibria of metals in the soil solution especially at neutral pH values (Harter and Naidu, 1995). DOC also has a unique role in the chemistry of heavy metals in soils; it reduces metal adsorption onto soil surfaces by either competing more effectively for the free metal ion and forming soluble organo-metallic complexes or being preferentially adsorbed onto the surfaces instead of the metals it is competing with (Guisquiani et al., 1998). DOC can also be taken up by plant roots, along with the metals it has bound (Hamon et al., 1995) and this can increase metal availbility to plants. Krishnamurti et al. (1997) maintained that this could establish a diffusion gradient to transport more chelated metals towards the root surface.

The effects of DOC on the chemistry of heavy metals in sludge-treated soils is of great environmental importance for two main reasons. The first is that the pH conditions in which DOC is more effective in competing with heavy metals are the same as those found in agricultural soils (pH 5–7) and this implies risks for increased heavy metal accumulation in crops and possible movement of heavy metals down the soil profile. (Lamy et al., 1993). The second implication is that DOC can be more effective over time after the application of sewage sludge has ended. This is because the decomposition of the sludge organic matter can increase the DOC concentration in the soil (Lineham, 1985). Neil and Sposito (1986) suggested that sewage sludge can provide amounts of DOC which are sufficient to reduce the adsorption of Cd onto soil surfaces. This was also recognised by Singh and Pandeya (1998), who found that the complexes of Cd with fulvic acids were positively correlated with the soil organic matter content and the CEC value of the soil. Moreover, Baziramakenga and Simard (1998) suggested that it is not only the quantity of DOC that changes over time, but the quality as well.

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