*Short communication*

# Increase in metal extractability after liming of sacrificial sewage sludge disposal soils

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## Abstract

A sandy and a sandy clay-loam soil from two dedicated (sacrificial) sewage sludge disposal sites were incubated with a total lime equivalent of 45 $Mg \cdot ha^{-1}$. Both these soils were acidified (pH 4.0 to 4.2) and had a significant accumulation of organic material (organic C of 2.9 to 3.7 %) compared to non-polluted soils (organic C of 0.6 to 1.0 %). The limed soils did not attain the desired pH of 6.5 after 6 months' incubation due to a high buffer capacity. After incubation, soil samples were taken from the incubated pots and the levels of Al, Fe, Mn, Cu, Zn, Pb and Cd were determined by atomic absorption spectrophotometry (AAS) after extraction with $NH_4$-EDTA and $BaCl_2$. Most of the metals extracted with $BaCl_2$ (except Mn in the sandy soil and Cd in both soils) decreased after liming. The EDTA-extractable Mn, Fe, and Cd in both soils and Cu and Pb in the sandy clay-loam soil increased after liming, whereas Al and Zn, decreased in extractability (Statistically significant differences could not be determined for the trial due to the trial not having been designed for the results that were obtained). Similar results were reported in the literature for EDTA metal extraction but the phenomenon was not elaborated upon, except for Cr. The increased extractability of some of the metals after liming could negatively influence the use of EDTA as an extracting agent in proposed heavy-metal guidelines for similar sacrificial soils. Should liming be considered as a strategy to decrease metal mobility in sacrificial soils, the observed increase in extractability becomes a cause for concern and should receive attention in further research.

**Keywords**: sewage sludge, liming, metal extractability, $BaCl_2$, $NH_4$-EDTA

## Introduction

In recent years, the trend has been to express heavy-metal levels in soils as plant- or potentially plant-available metal levels (Beckett, 1989; McLaughlin, et al., 2000) rather than "total" concentrations. This implies that "weaker" extractants or chelating agents be used in heavy-metal studies. Ethylenediaminetetraaceticacid (EDTA), in either the di-sodium or di-ammonium salt form, has been used extensively in a host of studies as an extractant of potentially plant-available heavy metals.

In some trials, EDTA was found to give a very good indication of the pollution hazard of heavy metals in soils as well as being a reliable test for predicting plant-available metals (Hooda et al., 1997; Cajuste and Laird, 2000). Earlier, Bruemmer and Van der Merwe (1989) stated that the $NH_4$-EDTA-extractable heavy metal concentration gives a good estimate of those potentially plant-available, and therefore suggested it to be used in the establishment of preliminary threshold values for heavy metals in South African soils. Currently, however, there are no guidelines stipulating the maximum EDTA-extractable metal levels in South African soils.

Neutral salt extractants are generally weaker extractants than EDTA and give an indication of the immediately exchangeable (therefore immediately plant-available) metals (Beckett, 1989; McLaughlin et al., 2000). Examples of such extractants are $BaCl_2$, $NH_4NO_3$, $NH_4$-Acetate buffered at pH 7, and more. The $BaCl_2$ method (Hendershot and Duquette, 1986) gives an indication of the effective cation exchange capacity (ECEC) of the soil at un-buffered pH levels. This is particularly relevant in studies where the pH dependence of metal extractability is one of the parameters of investigation.

In a preliminary study it was found that soils from some sacrificial sewage sludge disposal sites can be acidified (pH 4.0 to 4.2) and also have very high pH-buffering capacities due to relatively high organic carbon levels (organic C % of 2.9 to 3.7%). Coupled to this is a significant increase in total heavy metal content of the soil. The aim of this study was to determine the $BaCl_2$ and $NH_4$-EDTA extractability of a range of metals in two acid soils after liming to near-neutral pH levels and incubation in pots.

## Materials and methods

The buffer capacity of the two acid soils (here referred to as Soils 1 and 2) was determined with a $Ca(OH)_2$ buffer (Van der Waals and Claassens, 2002). The required amount of a commercial dolomitic lime (according to the buffer determination) for a pH of 6.5 was added to each soil in 7.5 kg pots (with 4 repetitions) and the soil incubated for 3 months with regular watering and mixing. After sampling the soil and finding only a slight change in pH it was decided to add an equal amount of lime and incubate the soil again for the same period of time. The total amount of lime added amounted to the equivalent of 45 $Mg \cdot ha^{-1}$.

After the second incubation period, a representative sample was taken from each pot and the pH determined according to the method described by the The Non-Affiliated Soil Analysis

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