Heavy metal extractability and plant bioavailability from two sacrificial biosolids soils as influenced by intensive liming

by

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Submitted in partial fulfilment of the requirements for the degree of

Doctor of Philosophy

In the Faculty of Natural and Agricultural Sciences
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University of Pretoria

Pretoria

June 2005

DECLARATION

I, the undersigned, declare that the thesis, which I hereby submit for the degree of Doctor of Philosophy at the University of Pretoria, is my own work, except where acknowledged in the text, and has not previously been submitted for a degree in any form at this or any other tertiary institution.

Johan Hilgard van der Waals

June 2005

Dedicated to Jacquie.

You complete me!

ACKNOWLEDGEMENTS

The **Water Research Commission (WRC)** and **ERWAT** for the funding of the project,

Professor Andries Claassens for guidance, support and a lot of patience,

Dr Heidi Snyman for support, motivation and funding for the project,

Personnel (**Willem Kirsten**, **Charl Steyn** and **Elise Herselman**) from the ISCW for information on heavy metal testing and aspects related to heavy metals in South African soils,

Personnel from the **Department of Plant Production and Soil Science's** soil testing laboratory for help in conducting numerous tests,

Colleagues in the **Department of Plant Production and Soil Science** for lending their ears and giving advice and moral support,

My parents for supporting me through major career changes that led to this study,

My parents in-law for supporting me as their "new son" in this endeavour,

My wife Jacquie for believing in me and a lot of support through the tough times and early mornings,

My son Andrew for being his wonderful (and energetic) self and for his hug in the mornings after a late night's work and little sleep,

My Lord and **Saviour Jesus Christ** for life, the ability and the opportunity to discover His creation.

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Abstract

The influence of pH on metal extractability from two sacrificial soils that received large amounts of biosolids was studied in four separate trials. The soils (Soil 1: gravelly sandy loam; Soil 2: sandy clay loam) were collected from different water treatment plants in Gauteng. Both soils had undergone significant changes in physical (organic carbon content) and chemical characteristics (pH, metal and nutrient content) due to the prolonged disposal of biosolids.

A preliminary pot trial was conducted where large quantities of lime were added to the soils. Results indicated that the soils had high pH buffer capacities due to low pH and high organic matter content. An unexpected increase in the metals extracted with NH_4EDTA after intensive liming lead to the performing of three further trials to shed light on the phenomenon.

In the second trial lime was added to the soils at four rates (0, 12, 24, 36 tons ha^{-1}). An increase in most NH_4EDTA extractable metals was found and this was correlated with increasing absorbance values (at 465 nm) of the extracting solutions (indicating increased extractability of organic matter). In the third trial limed (27 ton ha^{-1}) and unlimed samples were incubated over a period of 20 weeks with regular sampling intervals. The NH_4NO_3 extractable metals decreased significantly in the lime treated soils but the NH_4EDTA extractable metals generally increased.

A fourth trial was conducted due to concern regarding the increased EDTA extractable metals after liming and a possible correlation with plant metal bioavailability. The soils were incubated in pots with four lime rates (0, 12, 24, and 36 ton ha^{-1}) and wheat and spinach grown for two months. Although similar trends as for

the previous trials were obtained in terms of metal extractability, plant metal content was best correlated with NH_4NO_3 extraction levels.

The results indicate that liming is a safe option for sacrificial soils and that NH_4NO_3 extractable and plant metal levels decrease with liming. The use of EDTA in metal guidelines or in soil metal content studies is discouraged due to its increased metal extractability with liming and poor correlation with plant metal content.

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