Trace Metal Distribution in Colloid Size Fractions from Biosolids Amended Soils – using a Modified Multistage Tangential Flow Ultrafiltration System

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INTRODUCTION

The application of biosolids to agricultural land is becoming an increasingly popular disposal option for wastewater treatment residues. However, in addition to being a rich source of nutrients, biosolids can also contain high concentrations of trace metals, which may pose a hazard to both humans and the surrounding environment. Biosolids are a major source of dissolved organic matter (DOM), and it has been found that colloidal organic carbon, particularly low molecular weight molecules, have a high affinity for trace metals (Besnard *et al.* 2001). Dissolved organic mater has been found to be mobile in soils and has the ability to migrate over long distances and thus may play an important role in the transport of associated trace metals in the environment.

In this study we used a modified multistage tangential flow ultrafiltration system to examine the relationship between trace metals and colloid size fractions in soil solutions to improve the understanding of their mobility, transport, and lability in the environment.

METHODS

Soil solutions were collected using a centrifugal extraction procedure from amended soils with different biosolid treatments. The amended soil treatments were selected to gain an understanding of the effect of pH, ageing, and application rate on trace metal (i.e. copper, nickel, zinc, lead, iron, and manganese) distribution in different colloidal size fractions. The colloidal fractions in soil solutions were fractionated using a modified tangential flow multistage ultrafiltration system (TF-MUF). The soil solutions were separated into the following colloidal size fractions: 0.2 µm – 100 KDa, 100 - 50 KDa, 50 - 10 KDa, 10 - 5 KDa, 5 - 1 KDa, and < 1 KDa. The different colloidal size fractions were analysed for trace metals (i.e. copper, nickel, zinc, lead, iron, and manganese) by inductively coupled plasma - mass spectrometry following nitric acid digestion and total organic carbon.

RESULTS AND DISCUSSION

The major findings of this study are summarised below:

a) In all the treatment types the distribution of DOM was predominantly in the lowest colloid size fraction (<1 KDa);

b) The distribution of DOM in the higher size fractions (>1 KDa) was dependent on treatment type with amended soil age found to have the greatest influence on colloidal size distribution;

c) The majority of trace metals in all treatments was found associated with the < 1 KDa size fractions (Figure 1); and

d) Copper distribution in different size fractions was found to be similar to DOM.

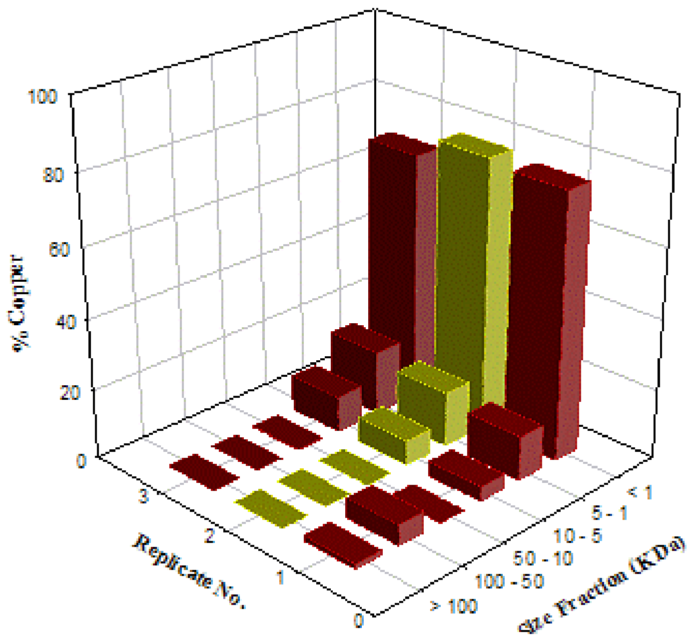

Fig 1. Copper colloidal size distribution in soil solution from a biosolid amended soil aged for 8 years (500 t ha^{-1})

CONCLUSIONS

A significantly high proportion of the DOM found in the soil solution of the biosolids amended soils was found to be in the smallest and most mobile colloidal size fraction. In addition it was found the distribution of trace metals in pore waters were strongly correlated with the presence of dissolved organic matter. These results highlight the potential mobility and transport of trace metals in the environment from the addition of biosolids to soils.

In addition it was found using a modified isotope dilution technique described by Lombi *et al* (2003) that nickel in the freshly amended soils was associated with colloidal fractions in a non-labile form. Non-labile metals have the potential to be transported over longer distances compared with labile metals, and as such have the potential to be transported and may contribute to the

REFERENCES

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