EFFECT OF ORGANIC AND INORGANIC AMENDMENTS ON THE ARSENIC AND CADMIUM BIOAVAILABILITY IN SOILS

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Introduction

Generally, most heavy metal(loid)s occur in low concentrations in soils but elements such as arsenic (As) and cadmium (Cd) are common in agricultural soils, where fertilisers and organic amendments are among the sources of these contaminants. Bioavailability of heavy metal(loid)s is an important characteristic for their transfer through various systems, affecting environmental and human health. With greater public awareness of the implication of contaminated soils on human and animal health and also their potential implication to national and international trade, there has been increasing interest to develop technologies towards the remediation of contaminated sites (Megharaj *et al.*, 2011). Phytoremediation is a natural process which relies on soil higher plants to alter metal(loid) bioavailability and can be enhanced by addition of organic amendments to soils (Park *et al.*, 2011). Remediation of metal(loid)s contaminated soils can be managed by manipulating the bioavailability of metal(loid)s (Bolan *et al.*, 2014).

In agriculture, inorganic and organic amendments, are frequently used to improve the soil properties. Many of them may modify significantly the mobility of metals (and also nutrients) in the soil environment. Recently, organic wastes is being used as materials for remediation of contaminated sites and animal manure, in particular poultry manure, is one of the major source of organic amendments (Burton *et al.*, 2003; Park *et al.*, 2011). Thus, the soil amendments were tested for their capacity to improve the process of plant nutrition, and also to affect the fractionation of heavy metal(loid)s in contaminated soils and subsequently their availability to phytoextraction (Janoš *et al.*, 2010).

Bioavailability of heavy metal(loid)s is an important characteristic for better understanding of their transfer through various systems and the real risk for environmental and human health (Adamo and Zampela, 2008; Bolan *et al.*, 2014). Hence, the aim of this work was to assess the influence of different amendments (both organic and inorganic) on As and Cd mobility in soils with different texture and their bioavailability in maize plant using plant growth study.

Methods

Two soils were used in this study and the soils were spiked with 200 mg/kg As and 20 mg/kg Cd and incubated for four weeks. The soils used for the study were clay loam (MGB) from Mount Gambier,

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Australia and loamy sand (KPD) collected from Kapunda, Australia. The spiked soils were further incubated with organic and inorganic amendments such as poultry manure (PM), poultry manure biochar (PMBC) and coal fly-ash (CFA), for four weeks. The incubated samples were analysed for pH and bioavailability of As and Cd. Bioavailability was examined using 1M NH_4NO_3 extractable Cd and As, pore water concentrations of these two elements using rhizon-samplers, and phytoavailability using maize (*Zea mays*) as a test crop.

Results

The results showed that the bioavailability of Cd increased slightly in MGB for PM and CFA amendments. The highest Cd bioavailability in PM amended MGB soil compared to all other amendments can be attributed to the decrease of pH induced by PM addition. In KPD soil, Cd bioavailability decreased in all treatments significantly, respect to the control. In the case of As, an increase in bioavailability was observed after amendments addition for both soils, except for CFA amended KPD. The pore water results showed a decrease in Cd concentration for PMBC and CFA whereas an increase in PM amended soils. However, the pore water concentration of As significantly decreased in PM and CFA amended MGB soil and increased in PM amended KPD soil. After plant growth, the amounts of Cd and As extracted from both soils by 1M NH_4NO_3 followed the same behaviour in amended samples as observed before plants.

Conclusion

The addition of amendments effectively decreased the solubility of As and Cd in both the soils, thereby affecting the bioavailability of the heavy metals. The immobilization of As and Cd were pH dependent and hence CFA and PMBC were very effective compared to PM, which was low in pH. However, the bioavailability of As increased significantly on amendment addition compared slight increase in Cd.

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