RHIZOREMEDIATION OF CO-CONTAMINANTS USING AUSTRALIAN NATIVE VEGETATION

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Introduction

Rhizosphere influences the dynamics of nutrients and contaminants through increased microbial activity, release of root exudates, and alteration of pH (Hinsinger et al., 2009). Chromate [Cr(VI)] and trichloroethylene (TCE) occur together in many contaminated sites (Lo et al., 2005). The bioavailability and ecotoxicity of Cr(VI) and TCE can be mitigated by enhancing their reduction reactions (Bolan et al., 2013a; Lo et al., 2005). The objective of this study was to evaluate the rhizosphere-induced reduction (i.e., rhizoreduction) and redistribution of Cr(VI) and TCE in Australian native vegetation in relation to their bioavailability.

Methods

The reduction of Cr(VI) and microbial activity by basal respiration were examined using rhizosphere and bulk soil samples from a number of Australian native vegetation (*Acacia pubescens, Eucalyptus camaldulensis, Enchylaena tomentosa*, *Templetonia retusa, Dichantheum sericeum,* and *Austrodanthonia richardsonii*). Naturally Cr(VI) contaminated and TCE spiked soils were used to examine the effect of *D. sericeum* on the redistribution and bioavailability of these contaminants following the modified plant growth experiment of Stanford and Dement (1957) .

Results and Discussion

The rhizosphere soil contained higher levels of microbial activity, dissolved organic carbon (DOC), and organic acid content than the non-rhizosphere soil (Table 1). The batch experiment indicated that the rhizosphere soil caused up to 5.1 fold increases in the reduction rate of Cr(VI) (Table 1). There was a significant relationship between rhizosphere-induced increases in microbial activity and Cr(VI) reduction, indicating the role of increased microbial activity in rhizosphere soil on Cr(VI) reduction. In the plant growth experiment, *D. sericeum* decreased the concentrations of Cr(VI) and TCE in soil (Table 2). The decrease in Cr(VI) concentration was attributed mainly to the reduction of Cr(VI) to Cr(III) , thereby reducing its bioavailability and mobility (Bolan et al., 2013b). The decrease in TCE concentrations may be

attributed to a number of processes including plant uptake, volatilization, and reduction (Graber et al., 2007). Reduction of TCE to ethylene has been shown to reduce its ecotoxicity.

Table 1. Chemical and biological properties of rhizosphere and non-rhizosphere soils, and rhizosphere effect of Cr reduction

Plant species	Rhizosphere/non-rhizosphere	DOC (mg/kg)	Basal respiration (mg CO_2/kg)	Organic acid (mmol/kg)*	Rhizosphere effect of Cr reduction**
Acacia pubescens	Rhizosphere	2280	78.5	79.3	2.45
	Non-rhizosphere	674	22.2	15.3	
Eucalyptus camaldulensis	Rhizosphere	1154	39.2	45.1	2.56
	Non-rhizosphere	587	23.7	9.24	
Enchylaena tomentosa	Rhizosphere	1212	44.3	34.5	3.89
	Non-rhizosphere	347	18.7	7.12	
Templetonia retusa	Rhizosphere	1624	78.5	65.4	3.80
	Non-rhizosphere	456	23.3	3.45	
Dichantheum sericeum	Rhizosphere	1897	95.3	54.1	5.07
	Non-rhizosphere	345	25.2	3.45	
Austrodanthonia richardsonii	Rhizosphere	1434	36.5	31.3	2.66
	Non-rhizosphere	768	24.3	6.45	

**mainly acetic and lactic acids in the non-rhizosphere soils; a range of acids including citric, malic, oxalic, malonic, fumaric, pyruvic, and trans-aconitic in the rhizosphere soil*

***Rhizosphere effect = Ratio of rate of Cr reduction between rhizosphere and non-rhizosphere soils*

Table 2. Cr(VI) and TCE distribution in soil in plant growth experiment

Contaminants*	Soil concentration (mg/kg)	
	With plants	Without plants
Cr(VI)	43.7±7.25	124±18.2
TCE	37.5±19.2	89.3±36.7

**Original soil concentration (mg/kg): Cr(VI) = 257; TCE = 100*

Conclusion

Depending on the nature of contaminants present in soil, the rhizosphere-induced reduction by plant species such as *D. sericeum* has implications to both their bioavailability to higher plants and microorganisms, and remediation of contaminated soils. Further research is required to examine the plant-induced decrease in TCE concentration in rhizosphere soil.

References

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