The Potential of Prairie Grasses to Clean-up Hazardous Waste Sites.

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Contaminated soils pose a significant threat to human and ecosystem health. There are estimated to be 10 000 contaminated sites in Canada with 1000 of these considered high risk sites (Hrudey and Pollard, 1993). The clean up cost for these sites can be considerable. For example, as of 1992 the United States of America spent $15.2 billion remediating abandoned or uncontrolled contaminated soil sites (Hrudey and Pollard, 1993) The use of plants to clean up hazardous waste sites *i.e.* phytoremediation, may reduce clean up costs. Phytoremediation systems are estimated to cost $0.02 to $1.00 per cubic metre compared to traditional technologies that can cost from $10 to $100 per cubic metre (Cunningham et al., 1995) The use of plants has other important benefits in comparison to traditional methods. For example, plant growth improves soil quality, whereas bioremediation treatments such as soil washing or thermal treatments can sterilize soil. Furthermore, plant growth can limit the downward percolation of chemicals through the soil profile (April1 and Sims, 1990) The objective of this study was to evaluate the usefulness of prairie forage grasses in remediating contaminated sites.

Saskatchewan soils contaminated with 2-chlorobenzoic acid (2CBA), 3-chlorobenzoic acid (3CBA), 2,3-dichlorobenzoic acid (2,3-diCBA) or 2,5-dichlorobenzoic acid (2,5-diCBA) were placed in cups, watered to 60% MHC and placed in a growth chamber. Twenty seeds of different forage grasses were planted in contaminated soil and growth assessed 14 DAP. Seeds of contaminant tolerant plants were planted in contaminated soil and plant growth assessed 28 DAP. Soil was extracted with alkaline water and extract analyzed by HPLC. Roots and shoots of plants grown in 2CBA contaminated soil were harvested 42 DAP, extracted with dichloromethane and analyzed by GC/FID.

Five plant species grew *i.e.* germinated with first leaf either at or through the coleoptile, in 2CBA contaminated soil (Table 1). Two grasses grew in 3CBA contaminated soil and two grasses grew in 2,3-diCBA or 2,5-diCBA contaminated soil. We found that a wide range of plants can degrade contaminants. Furthermore, a large variety of contaminants are degraded by plants. However, a plant tolerant of a contaminant does not necessarily degrade that contaminant . Bioconcentration factors found are often below one, indicating that little, or no bioconcentration has occurred.

Table 1. Growth of forage grasses in contaminated soil 28 DAP.

Common Name	Scientific Name	Plant Growth[a]			
		Contaminant Levels (mg/kg)			
		2CBA	3CBA	23diCBA	25diCBA
Common brome	*Bromus inennis*	+++	+	+	+
Dahurian wild rye	*Elymus dauricus*	++	+++	+	+
intermediate wheatgrass	*Agropyron intermedium*	++		-	-
Meadow brome	*B. biebersteinii*	++	+++	+++	+++
Streambank wheatgrass	*A. riparium*	++	+	-	-
Tall wheat grass	*A. elongatum*	+	+	-	-
Northern wheat grass	*A. dasystachyum*	+	+	-	-
Reed Canary	*Phalaris arundinacea*	+	+	-	-
Altai wild rye	*E. angitus*	+	+	+++	+++
Crested wheat grass	*A. cristatum*		+	-	-
Perennial rye grass	*Lolium perenne*		+	+	-
Russian wild rye	*E. junceus*		+	+	-
Sheep fescue	*Festuca ovina*		+	-	-
Slender wheatgrass	*A. trachycaulum*			-	-
Orchard grass	*Dactylis glomerata*		+	-	-
Timothy	*Phleum pratense*		+	-	-

[a] Gradient of visual responses: - no seed germination; +, seed germination; + +, seed germination with leaf at coleoptile tip; + + + , seed germination with first leaf through coleoptile.

Plants offer a low cost, effective remediation strategy that reduces contaminant levels in soil. Exploring the relationship between the plant species and contaminants degraded by that species may elucidate important underlying mechanisms in phytoremediation.

References

1. Hrudey, S.E. and S.J. Pollard. 1993. The challenge of contaminated sites: remediation approaches in North America. Environ. Rev. 1:55-72.
2. Cunningham, S.D., W.R. Berti and J. W. Huang. 1995. Phytoremediation of contaminated soils. Trends in Biotechnology. 13:393-397.
3. Aprill, W. and R.C. Sims. 1990. Evaluation of the use of prairie grasses for stimulating polycyclic aromatic hydrocarbon treatment in soil. Chemosphere. 20:253-265.