POTENTIAL OF *PINUS TAEDA* AND *EUCALYPTUS UROGRANDIS* TO PHYTOREMEDIATE BENZENE-BASED COMPOUNDS: PRELIMINARY RESULTS

Diego Barcellos[1], Lawrence A. Morris[2] Tiago Moura[3], Aaron Thompson[1]

University of Georgia, [1]Department of Crop & Soil Sciences [2]Warnell School of Forestry.
[3]NewFields Company, Atlanta, GA. E-mail: barcello@uga.edu

Introduction

Benzene-based contamination of soil is common in industrial sites throughout the world. Remediation often involves persulfate oxidation of the compounds, yet this rarely removes all of the pollutants. We are exploring the phytoremediation potential of tree plantations as a hydraulic barrier down-gradient from persulfate-treated chlorobenzene plume at an industrial site in southern Brazil (Fig. 1 and 2). *Salix sp.* and *Populus sp.* are capable of phytoremediating benzene compounds from soil and groundwater [1,2], but it is unknown if this is true for *Eucalyptus* species, which are widely planted in Brazil. The objective of this preliminary study is to determine under controlled conditions: (a) if trees can survive exposure to benzene-based contaminants and (b) to assess the degree of phytoremediation of these compounds.

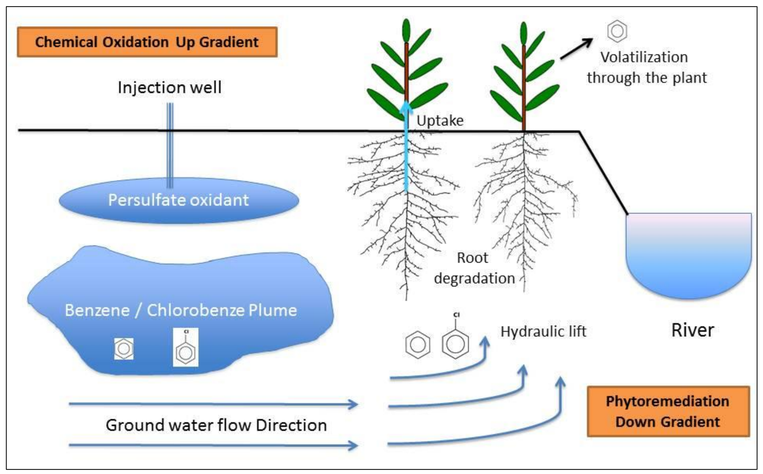

Fig. 1. The remediation plan to use Persulfate Oxidation and Phytoremediation to clean up benzene compounds in a former pesticide plant in Southern Brazil.

Fig. 2. Recently planted *Eucalyptus urograndis* at the site contaminated by benzene-based compounds.

Plant Survival Experiment

A range of concentrations around the current groundwater concentration in the field (abbreviated as "CC") was used for the survivorship study (Table 1). Seedlings of *Pinus taeda* grown in PVC plugs (20cm x 4.5cm) were irrigated daily until field capacity was reached.

Table 1. Treatment solution concentration and solubility of the three pollutants used in preliminary study of tree survival.

Compound	**Concentrations in mg L^{-1} of the 3 contaminants (CC*)**					**Solubility in water (at 20°C), in mg L^{-1}**
	Control (0)	*0.1xCC*	*1xCC*	*10xCC*	*50xCC*	
Chlorobenzene	0	10	100	1,000	10,000	500
Benzene	0	5	50	500	5,000	1,800
1.2-Dichlorobenzene	0	0.03	0.3	3	30	8,700

*CC = Current Concentration in the Field Experiment in Brazil

After 25 days, no plant mortality was observed, even in the highest concentration treatment (50xCC), in which both chlorobenzene and benzene exceeded their aqueous solubility. In fact, plant growth was observed in all treatments (p=0.92) at rate of 2.0±0.8 cm/month (Fig. 3).

Fig. 3. Seedlings exposed to benzene compounds at different concentrations after 25 days exposure (NO MORTALITY). Seedlings not exposed to benzene compound (far left) and highest concentration (far right).

References

[1] Nzengung, V. (2005). Case studies of phytoremediation of petrochemicals and chlorinated solvents in soil and groundwater. *Proceedings of the 2005 Georgia Water Resources Conference (UGA).*

[2] Burken, J. G., and Schnoor, J. L. (1998). Predictive relationships for uptake of organic contaminants by hybrid poplar trees. *Environmental Science & Technology* 32, 3379-3385.

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Phytoremediation (in progress)

Two species widely planted in Southern Brazil were used in the study: *Pinus taeda* and *Eucalyptus urograndis*. A replicated greenhouse experiment (Fig. 4) is being conducted to quantify phytodegradation of benzene-based compounds. There are 3 treatments: 0, 0.1xCC and 1xCC (4 reps), for *Eucalyptus*, *Pinus* and No-Plant pots (Fig. 5). To match groundwater conditions of the field, near constant water and contaminant levels are maintained in the soil columns (Fig. 6). Water leach will be regularly collected to determine contaminant concentration via GC/MS.

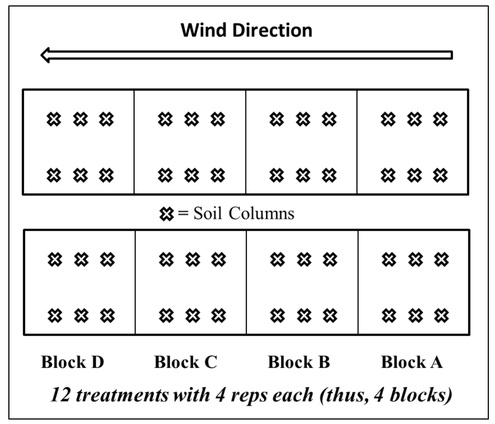

Fig. 4. Greenhouse study to assess phytoremediation in randomized block design.

Fig. 5. Pots with Eucalyptus , Pinus, and No-Plant in the greenhouse.

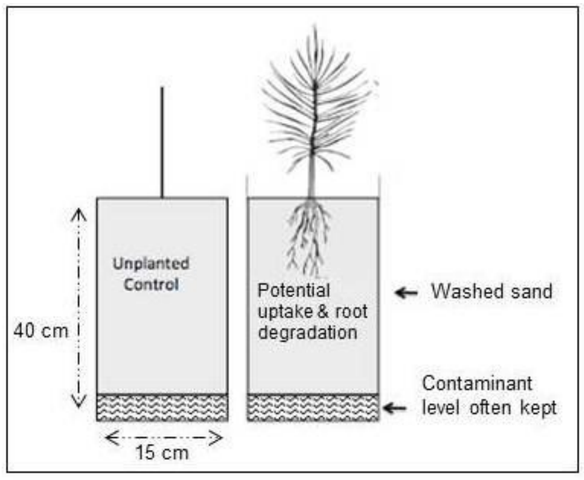

Figure 6. Pots in the greenhouse experiment with plant and unplanted control. Washed sand is used to reduce sorption.

Conclusion

Initial results suggest trees can survive at levels of contamination greater than we expect in the field. Uptake and degradation experiments are underway.