Analysis of Arsenic Uptake by Plant Species Selected for Growth in Northwest Ohio by Inductively Coupled Plasma - Optical Emission Spectroscopy

Arsenic (As) is a natural component of numerous minerals and enters the environment as a component of pesticides, fertilizers, industrial wastes, and through the combustion of fossil fuels. The inhalation and ingestion of As can lead to severe health problems, driving the Occupational Safety and Health Administration to regulate atmospheric exposure to 10 μgm^{-3} (for a 40 hour work week) and the U.S. Environmental Protection Agency to regulate the content of As in drinking water (10 μgL^{-1}). The manufacturing industry has had a strong presence in northwest Ohio, leading to a widespread occurrence of As in the environment. Most traditional site clean-up methods are expensive, so a less expensive alternative method of cleaning a site is needed. Plants, that absorb arsenic at levels greater than those in the soil, can be used as part of a phytoremediation system (using plants to clean a site) to reduce the amount of arsenic in the environment.

Some plants have been identified that accumulate As in significant concentration. However, they are not native to this region and could pose additional, unforeseen ecological risks. Twenty two species of plants native to northwest Ohio were examined for As accumulation. These plants were treated with a 10, 25, 100, or 250 mg As L^{-1} solution. Plants were then harvested and examined for their As content using inductively coupled plasma – optical emission spectroscopy (Table 1). These species could be separated into three different groups, based on maximum tissue concentration: plants with relatively (a) low (< 60 mg As kg^{-1}), (b) elevated (60 to 200 mg As kg^{-1}), and (c) high concentrations (>200 mg As kg^{-1}). Some plants were not able to grow well in elevated As while others showed no obvious stress symptoms when exposed to As in the fertilizer water (Figure 1A and B).

Figure 1.Some plant species exhibited discoloration or stunted growth with increasing amounts of As. Others exhibited no noticeable difference from the control group.

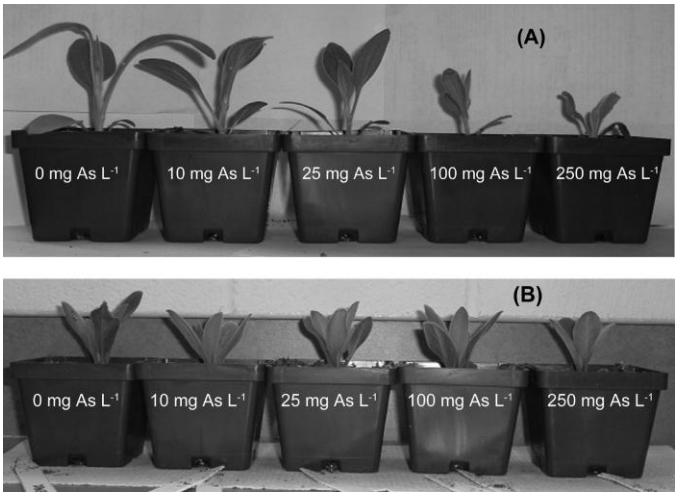

Table 1 Mean As concentration (mg kg^{-1} dw) in plant tissue. (BLD; <5 mg As kg^{-1} dw)

	Concentration of As in irrigation water	
Common Name	**10mg As L^{-1}**	**250 mg As L^{-1}**
Large Bullwort	20.5	178
Big Bluestem	BLD	78.8
Little Bluestem	7.8	43.1
Butterfly Milkweed	11.3	98.0
Common Milkweed	BLD	102
Lanced-Leaved Coreopsis	23.2	258
Prairie Clover	BLD	BLD
Virginia Wild Rye	14.5	70.0
Purple Coneflower	7.6	298
Dame's Rocket	BLD	105
Rosemallow	BLD	161
Virginia Pepperweed	BLD	214
Flax	BLD	214
Wild Lupine	6.3	333
Evening Promrose	BLD	67.9
Switchgrass	11.3	64.6
Black-Eyed Susan	34.6	661
Swamp Verbena	BLD	65.6

An important aspect of this study was to use plant species that would be suitable for growth in northwestern Ohio. *R. hirta, H. autumnale, L. perennis, E. purpurea, C. lanceolata, L. vriginicum,* and *L. lewisii* had the highest tissue As concentrations. These seven species are ecologically diverse, suggesting they may be used for phytoremediation in both wetlands and brownfields. Of all the plants tested, only the grasses did not take up As in significant amounts.

Phytoremediation offers a potentially cheaper method to remove As from contaminated water and soil. One of the ultimate goals of this research is to develop a phytoremediation system. This development is an ongoing process with the first step reported here. The next step is to take the seven species with the greatest remediation potential and determine optimum environmental conditions and rates of As accumulation. Finally the most appropriate plants and environmental conditions would then be incorporated into a phytoremediation system that would be tested at a contaminated site.

For more information, contact: Daryl Dwyer, ddwyer@utnet.utoledo.edu Department of Environmental Sciences, University of Toledo, Mail Stop 604, 2801 W. Bancroft, Toledo, OH 43606

-or-

For more information, contact: Jonathan Frantz, jonathanfrantz319@gmail.com. Dr. Frantz now works for Dupont Pioneer.

Rofkar, J. D. Dwyer, J.M. Frantz. 2007. Analysis of arsenic uptake by plant species selected for growth in northwest Ohio by ICP-OES. Comm. Soil Sci. Plant Analysis. 38:2505-2517.