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Chiang Mai, Thailand 2023

Application of Vetiver Grass in the Treatment of Lead-Contaminated Community Garden Soil

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Pb Contamination in Urban Soils

Pb-containing paint

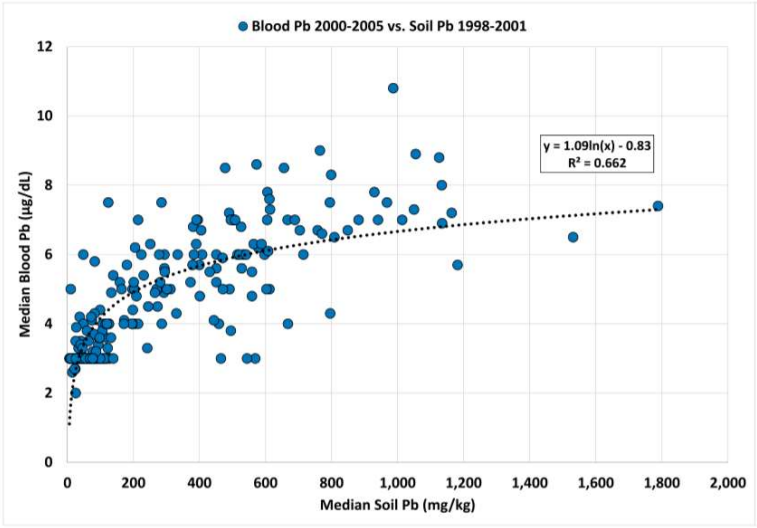
Banned in 1978 in U.S.

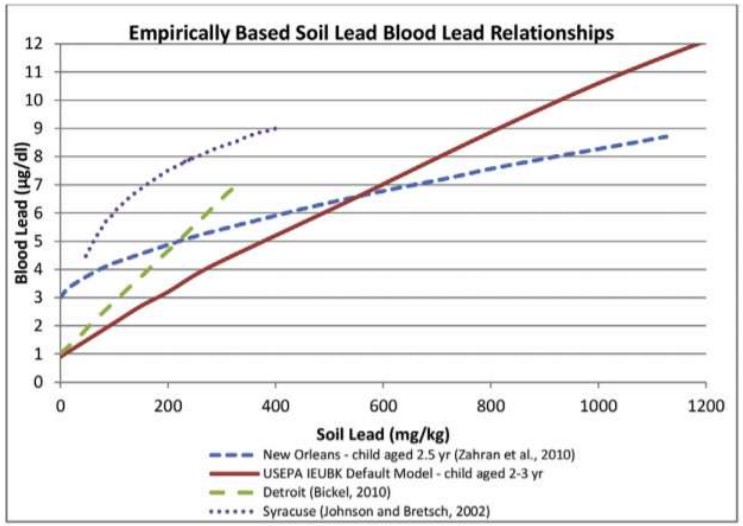
Pb dosage in urban soils (Residential; Community Garden)

Leaded gasoline

Banned in 1996 in U.S.

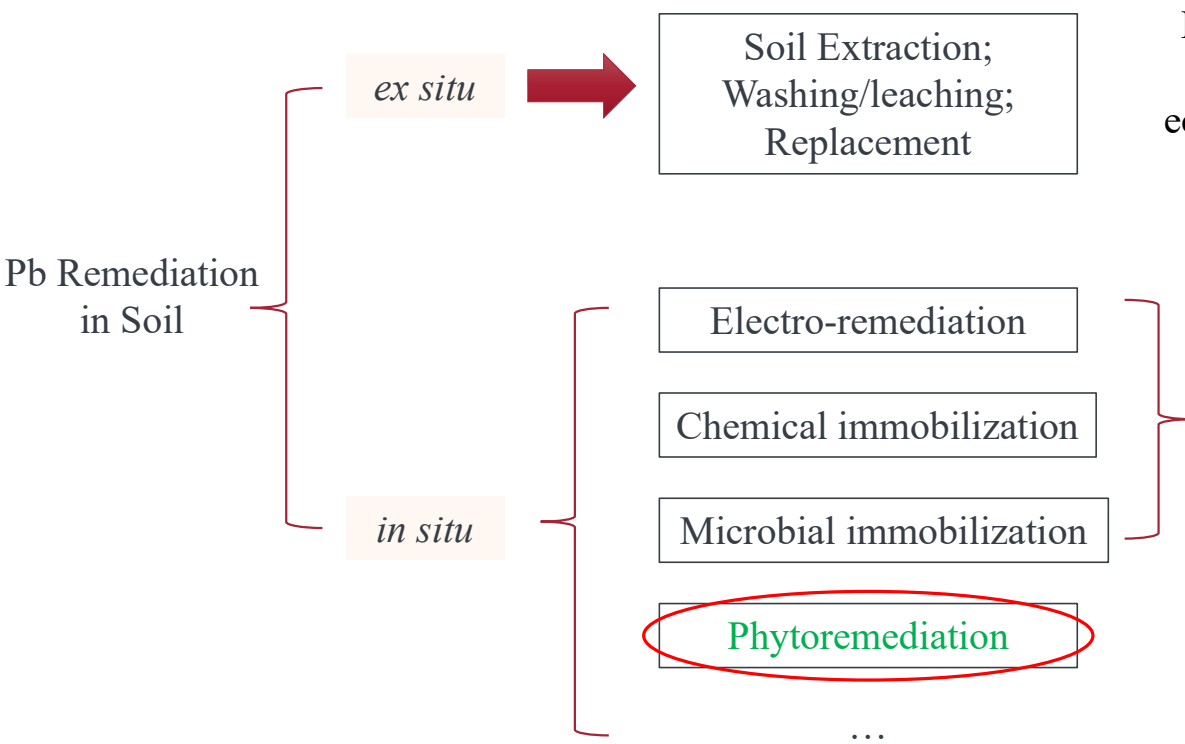
Pb Contamination: Human Health Implications





Bickel, M. J. (2010). Spatial and temporal relationships between blood lead and soil lead concentrations in Detroit, Michigan. Wayne State University.
Farr D. (2015). Issues of The Environment: The Dangers of Lead in Washtenaw County. http://www.wemu.org/post/issues-environment-dangers-lead-washtenaw-county
Johnson & Bretsch. (2002). Soil lead and children's blood lead levels in Syracuse, NY, USA. Environmental Geochemistry and Health. 24, 375-385. https://doi.org/10.1023/A:1020650904367
Laidlaw et al. (2017). Case studies and evidence-based approaches to addressing urban soil lead contamination. Applied Geochemistry, 83, 14-30. https://doi.org/10.1016/j.apgeochem.2017.02.015
Mielke et al. (2007). Nonlinear association between soil lead and blood lead of children in metropolitan New Orleans, Louisiana: 2000–2005. Science of the Total Environment, 388(1-3), 43-53. https://doi.org/10.1016/j.scitotenv.2007.08.032
Zahran et al. (2011). Nonlinear associations between blood lead in children, age of child, and quantity of soil lead in metropolitan New Orleans. Science of the Total Environment, 409(7), 1211-1218. https://doi.org/10.1016/j.scitotenv.2010.11.036

Soil Pb Remediation

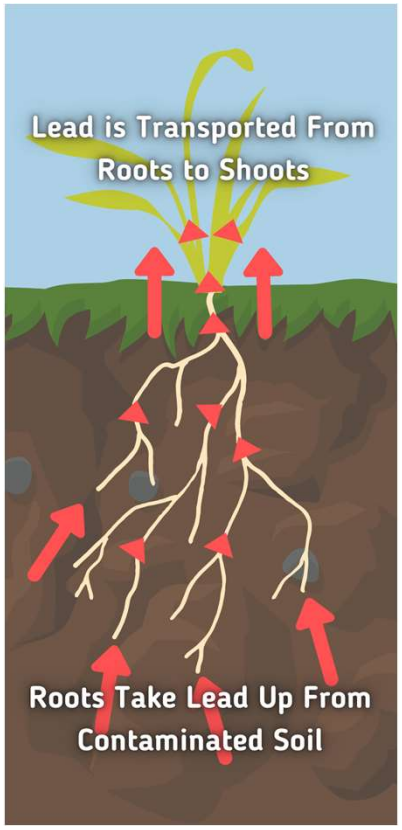


Large expense (~$1.6 million per acre feet in New Jersey), ecological disruption, and other regulatory issues

Dependent on many environmental factors such as pH, redox, water content, chemical availability, etc.

Use of plants to absorb and translocate lead to above ground tissues which are harvested and removed

Phytoremediation of Pb using Vetiver Grass (*Chrysopogon zizanioides*)



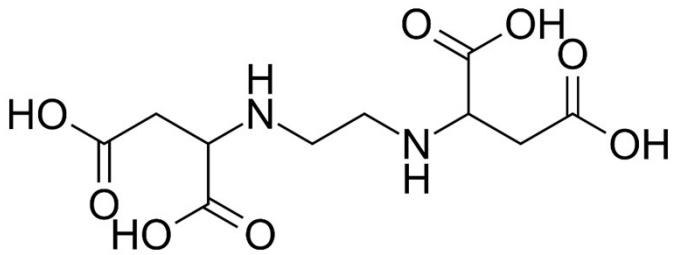
Phytoextraction

6-mo old Vetiver

Mature Vetiver Root

- ✓High tolerance for metals
- ✓Fast growing
- ✓High biomass
- ✓Non-Invasive. Sterile, doesn't produce seeds.
- ✓Perennial grass
- ✓Massive complex root system
- ✓Tall and dense shoot system
- ✓Reduces soil erosion
- ✓Survives in different types of soils (pH 3 -10; EC up to 8 dS/m)
- ✓Survives in a wide range of climates (55°C to -10°C)
- ✓Easy to maintain once established

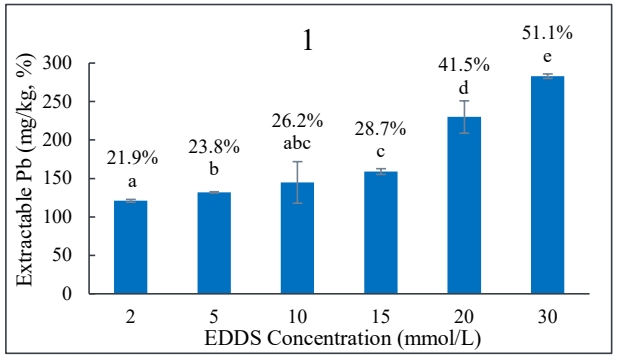
Chemically Catalyzed Phytoremediation for Soil-Pb Removal

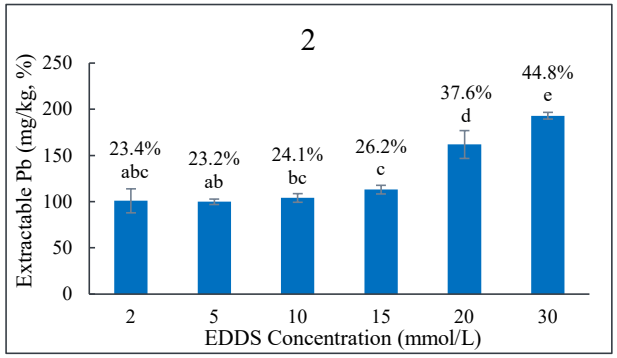


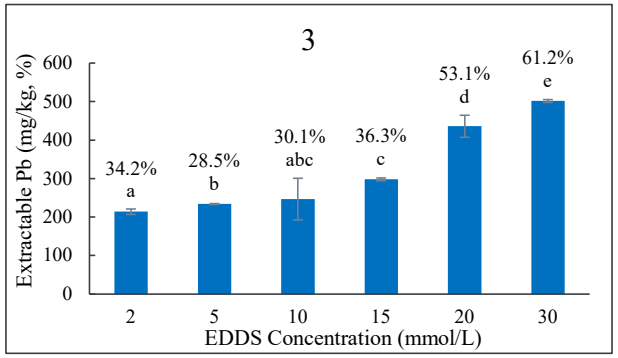
EDDS

Pb Mobilization by EDDS

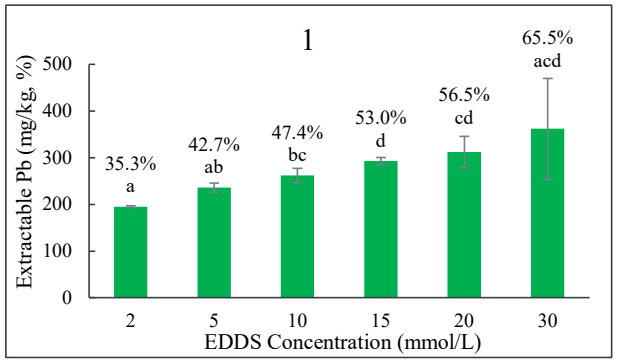
Jersey City, NJ

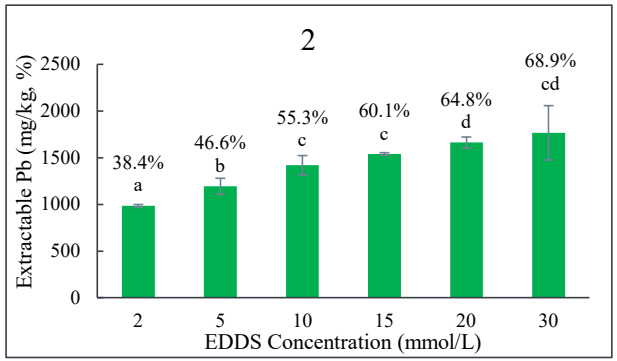


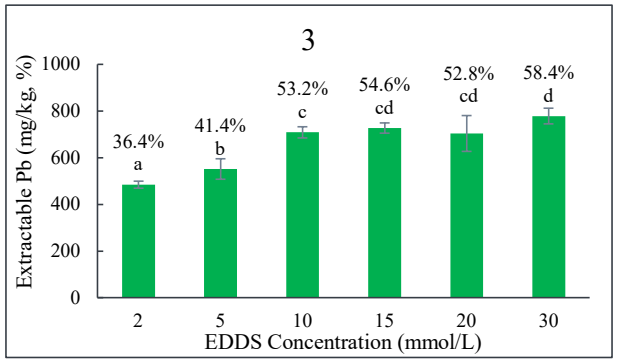




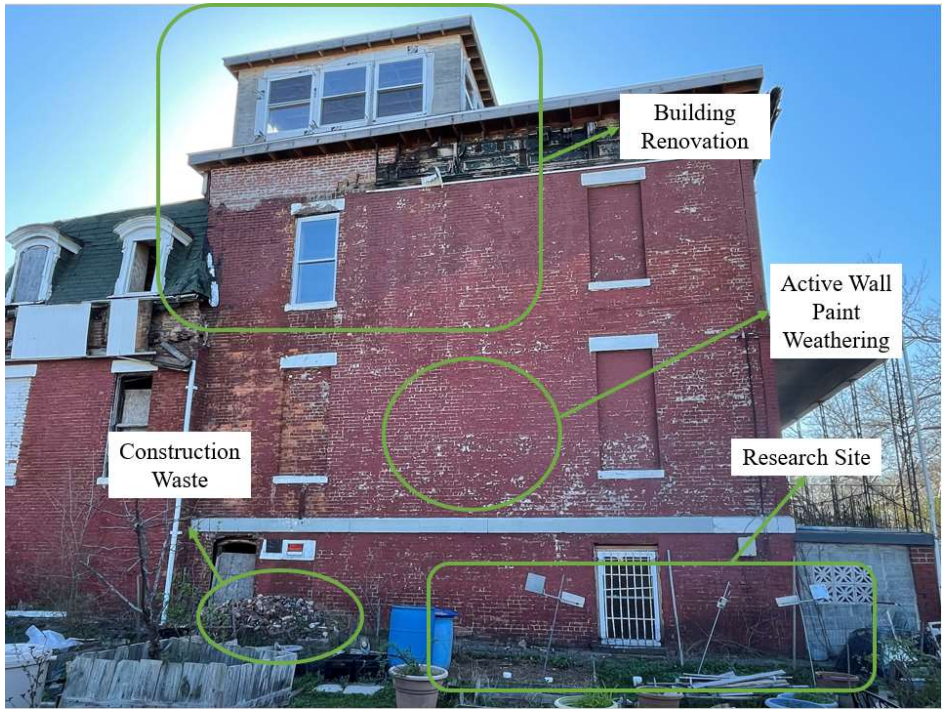
San Antonio, TX



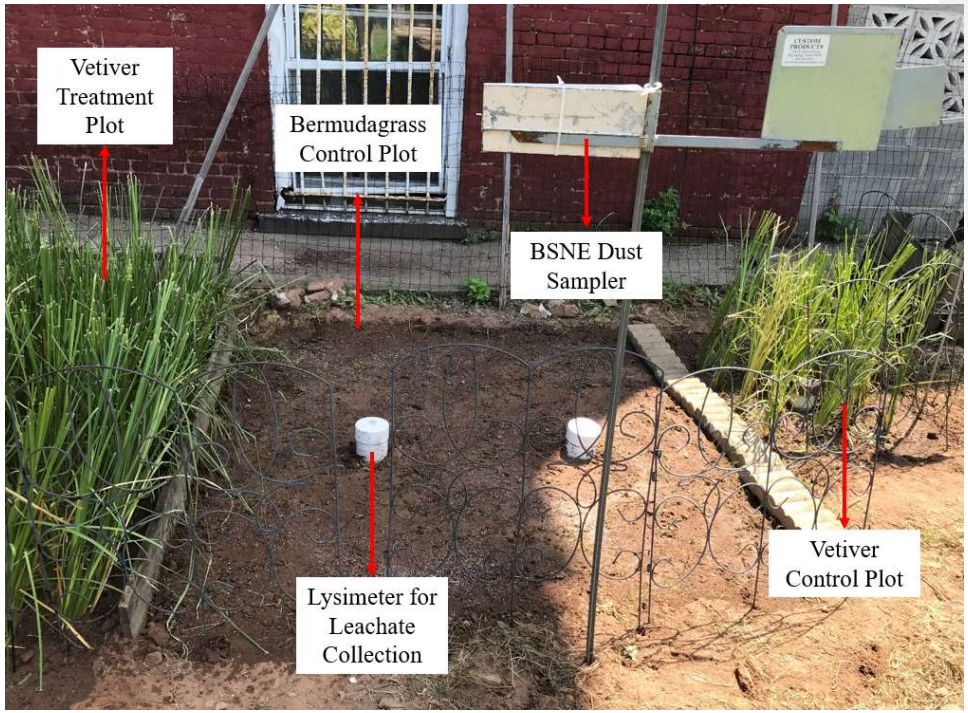




Pb Phytoremediation in Community Garden



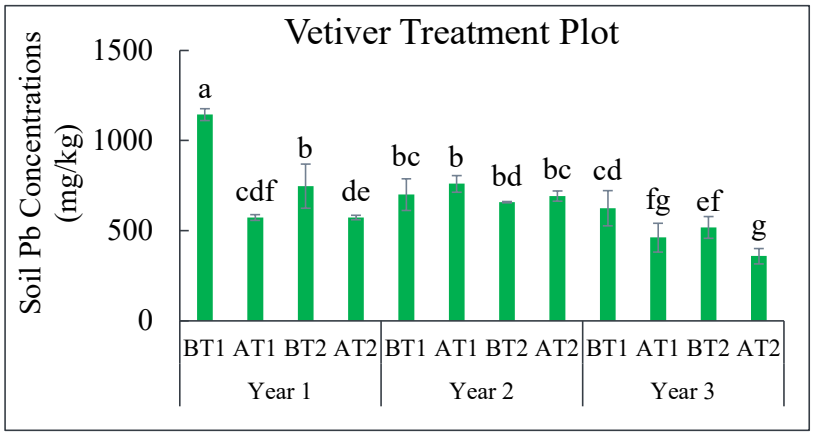
Community garden with active Pb input

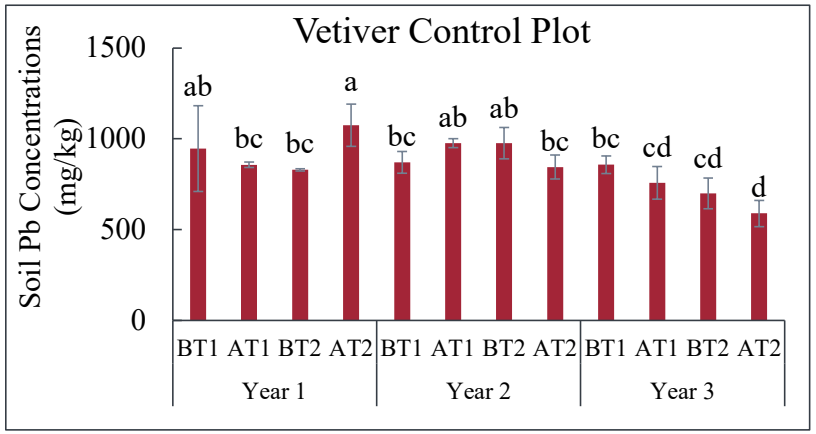


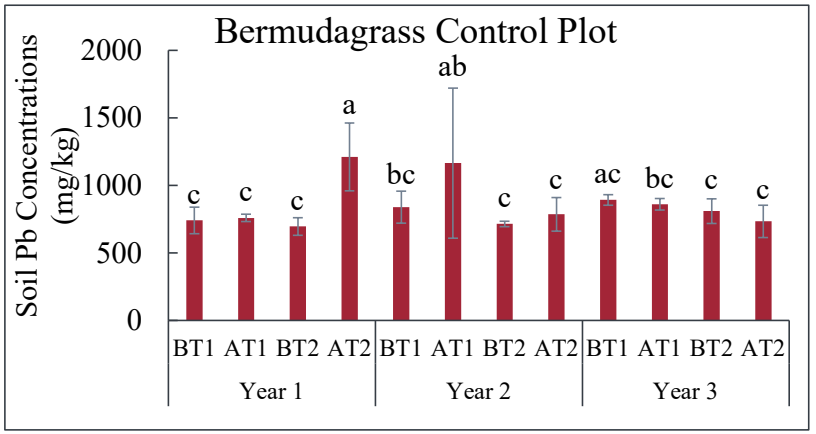
Vetiver Treatment Plot: Vetiver + EDDS
Vetiver Control Plot: Vetiver + No EDDS
Bermudagrass Control Plot: Bermudagrass + No EDDS

Zhang et al. (2023). Chemically Catalyzed Phytoextraction for Sustainable Cleanup of Soil Lead Contamination in a Community Garden in Jersey City, New Jersey. Sustainability, 15(9), 7492. https://doi.org/10.3390/su15097492

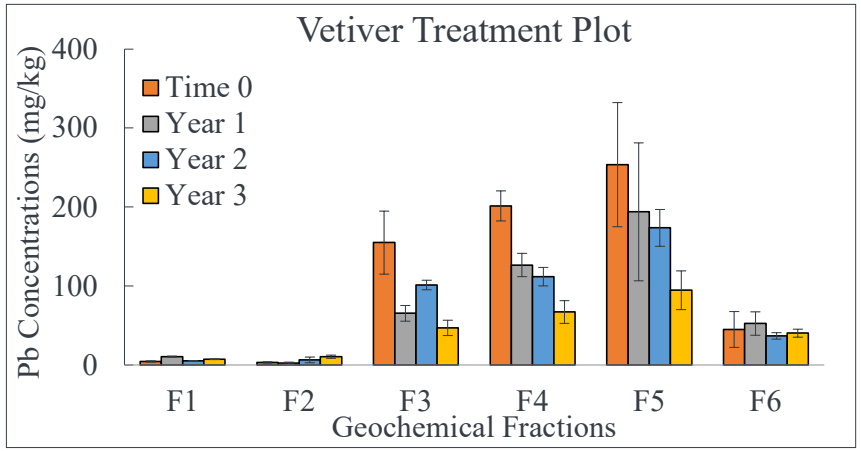
Changes in Pb Concentration



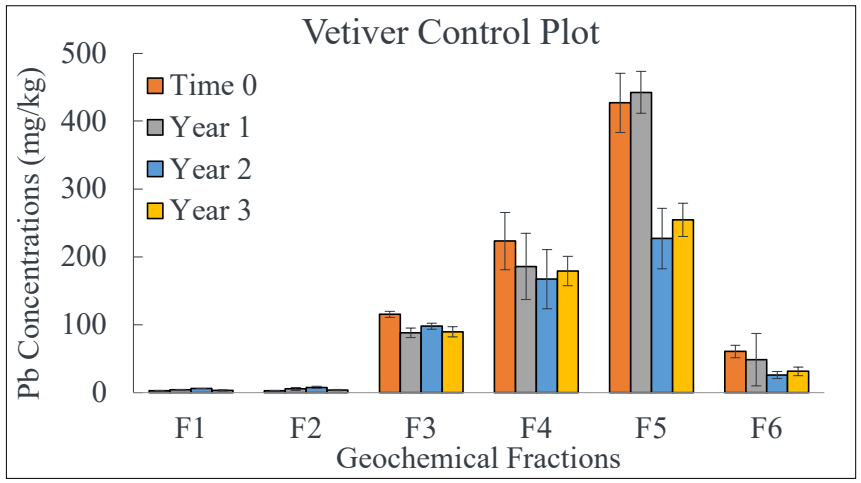


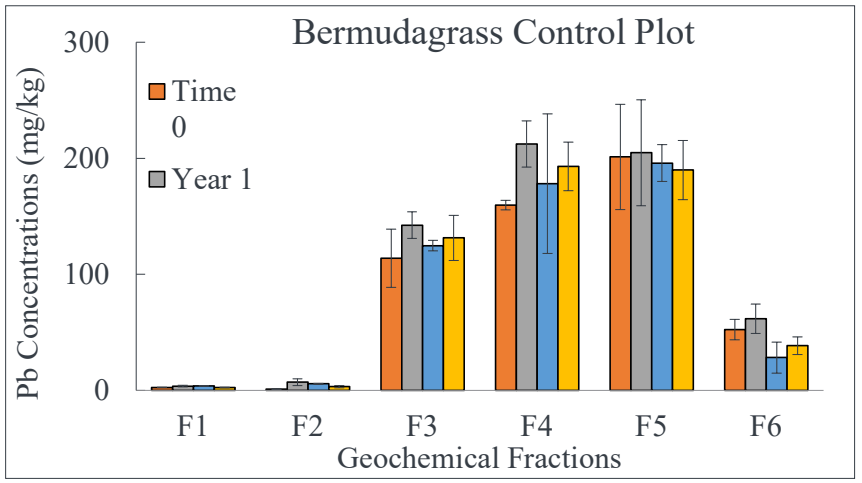


Changes in Pb Existing Forms

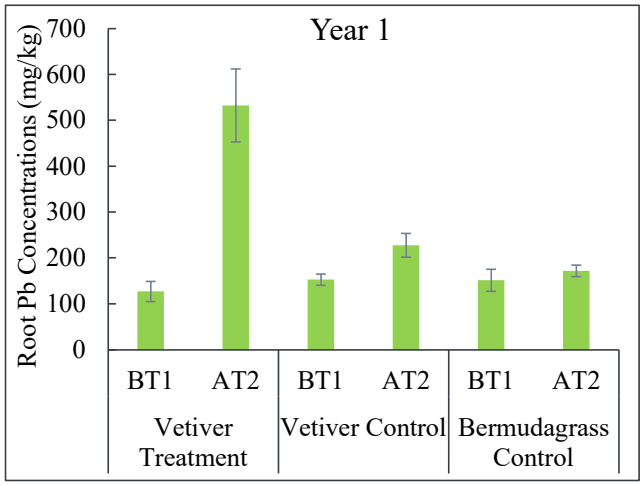


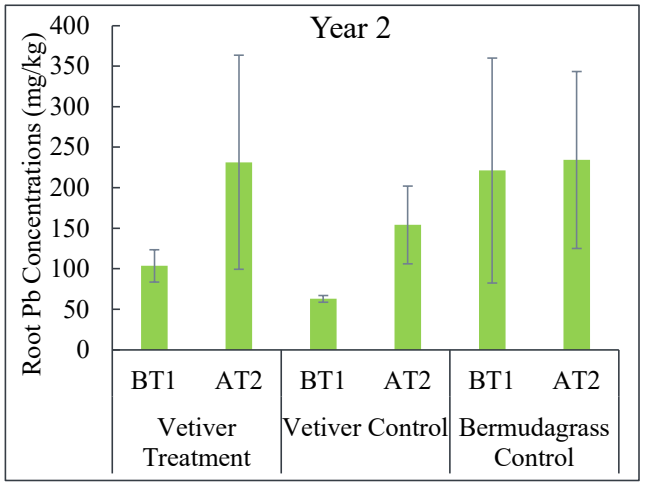
F1: water-soluble Pb
F2: exchangeable Pb
F3: carbonate-bound Pb
F4: oxide-bound Pb
F5: organic-bound Pb
F6: residual silicate-bound Pb

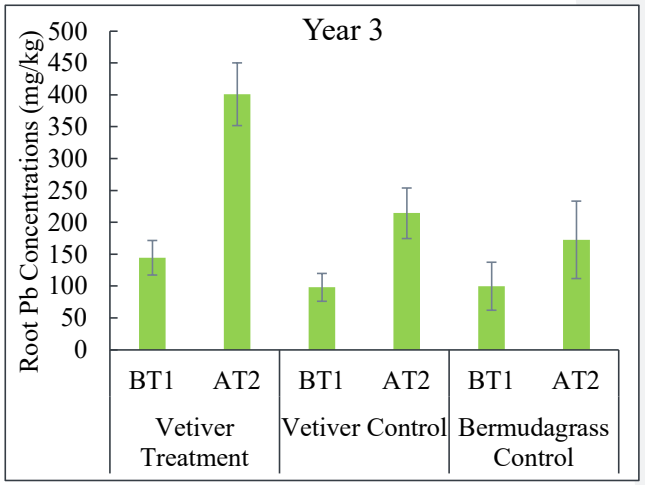


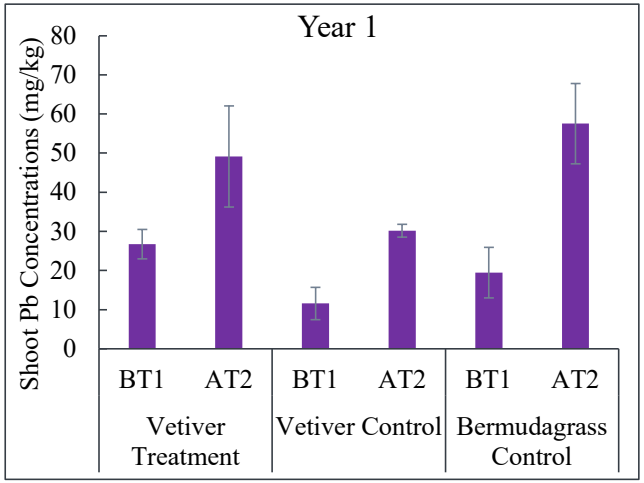


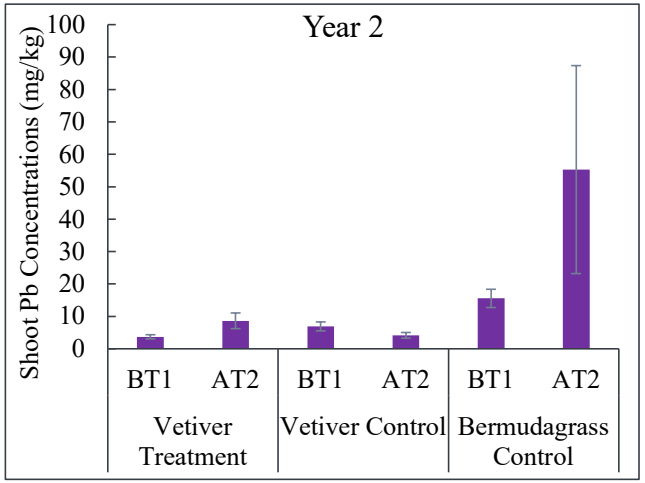
Pb Accumulation in Plant Root and Shoot

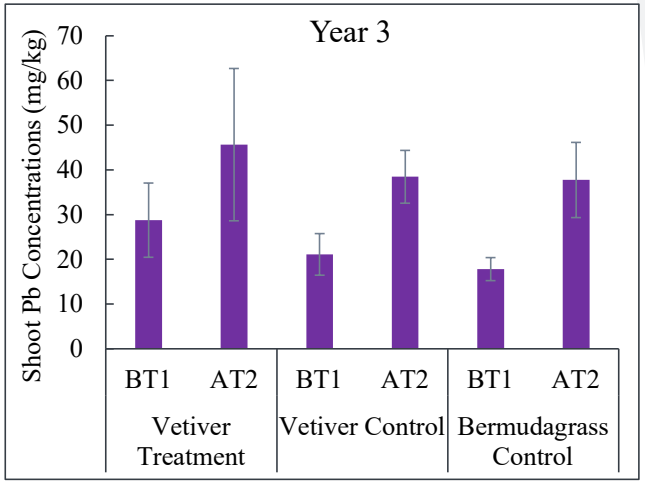






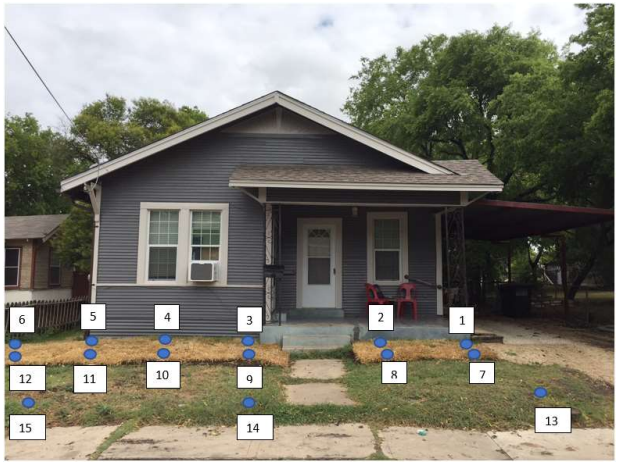






Examples of Pb Phytoremediation in Residential Properties

San Antonio, TX



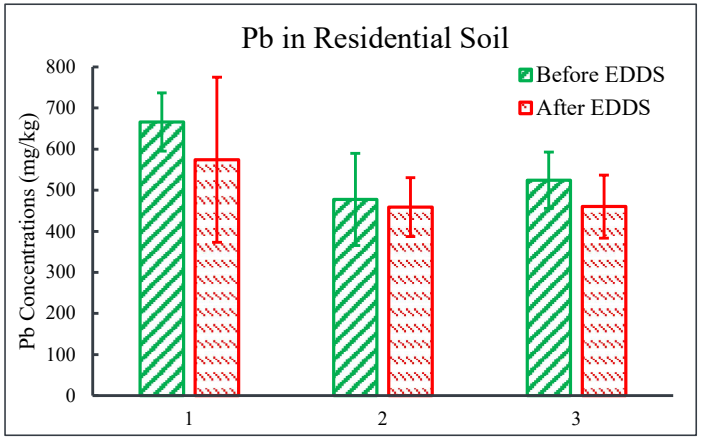
Jersey City, NJ

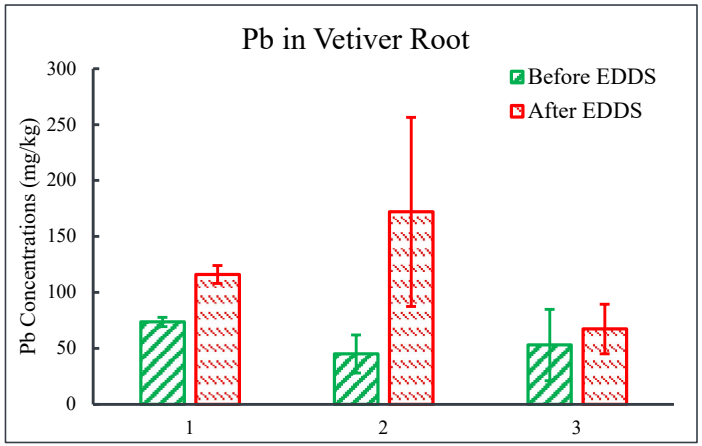
Sample ID		Range of Pb Concentration (mg/kg)
San Antonio	1	236 - 2413
	2	391 - 14721
	3	452 - 8432
Jersey City	1	377 - 636
	2	156 - 745
	3	283 - 2696

Field Study Design

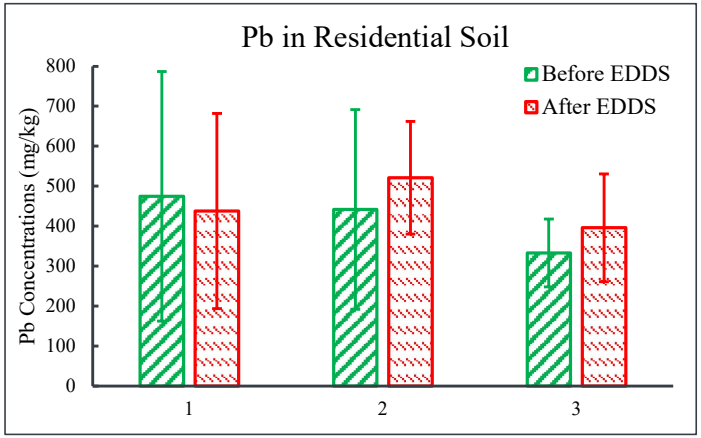
Field Test Results after First Round of EDDS Application

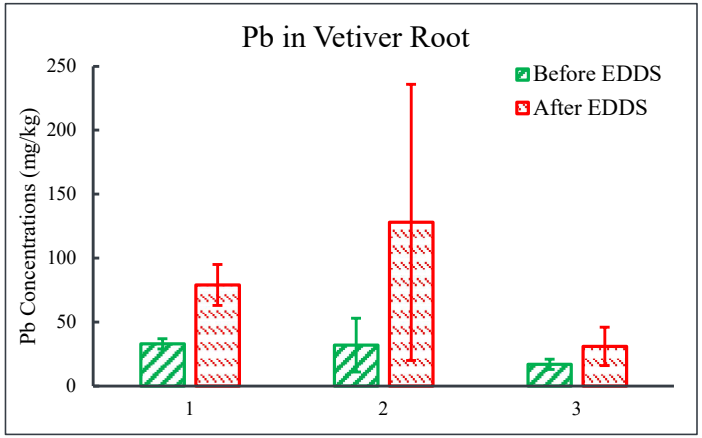
Jersey City, NJ





San Antonio, TX





Summary

Chemically catalyzed phytoremediation enhanced the removal of Pb from urban soils.

The biodegradable chelating agent, EDDS, promoted Pb conversion from non-plant-extractable forms to plant-extractable forms.

Thank You!

Acknowledgement:

This work was supported by a Lead Technical Studies grant (#MILTS0007-17) from the U.S. Department of Housing and Urban Development.

We are grateful to Maria Rozier for providing the study site and for maintaining plant growth in the community garden. Frances Levy is acknowledged for helping with field study and laboratory sample analysis. We thank Roley Nöffke for presenting our research in ICV-7.