Optimizing arsenic phytoextraction from an urban brownfield: A two year field study

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Elevated arsenic concentrations are commonly found in urban soils due to historical use of arsenical pesticides, use of treated wood, mining activities, and glass manufacturing. Sustainable remediation methods are needed to reduce levels of this carcinogen, enabling safe reuse of brownfields for purposes such as urban agriculture. Among *in situ* methods, phytoextraction is an emerging technology to remediate soils with shallow arsenic contamination; the hyperaccumulating fern *Pteris vittata* removes arsenic from soil with very little disturbance to the sites. Estimates of remediation rates using *P. vittata*, based mainly on greenhouse experiments, are on the order of decades. More research is needed to optimize arsenic phytoextraction in the heterogeneous field conditions typical of urban soils.

The objective of this study is to quantify fertilizer impact on *P. vittata* biomass production and arsenic uptake, in order to develop faster and more efficient methods for *in situ* arsenic phytoremediation. The study, begun in February 2013, was performed in an urban soil moderately contaminated with arsenic (20-100 mg kg^{-1}). The field study site is an abandoned railroad right-of-way (sandy loam to clay loam) located in Berkeley (CA) characterized by a Mediterranean climate. The soil was tilled and limed before *P. vittata* ferns (200-400 per treatment) were planted, 30 cm apart (11 ferns m^{-2}). Five slow-release agricultural amendments, including organic N and inorganic N (50 kg N ha^{-1}), organic P and inorganic P (85 kg P ha^{-1}), and compost (151 kg N ha^{-1}, 34 kg P ha^{-1}), were applied semiannually to separate fern plots to determine effects of fertilizer on aboveground biomass, arsenic uptake per gram of fern, overall arsenic removal per plant, and estimated remediation time. Two controls were established: 1) ferns, no treatment; and 2) soil, no ferns and no treatment. Fern arsenic accumulation and biomass data 9 months post-planting suggest control ferns are most effective at removing arsenic (7.8 kg As ha^{-1} yr^{-1}), followed by compost-amended ferns (6.9 kg As ha^{-1} yr^{-1}); all other treatments decreased arsenic accumulation by a factor of 2 to 3, compared to the control. New biomass and arsenic accumulation results from fronds harvested 21 months post-planting will be presented; preliminary data suggest that compared to the first harvest, arsenic uptake in N-amended ferns increased by a factor of 2.