Optimizing arsenic uptake by a hyperaccumulating fern through fertilizer use

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Arsenic (As) contamination is a widespread issue, as a result of mining activities, coal combustion, pesticide use, and irrigated agriculture. Cost-effective, broadly applicable, low-waste remediation methods are needed to limit human exposure to this carcinogen. Phytoremediation with the As-hyperaccumulating fern *Pteris vittata* [1] has emerged as a technology to remediate soils with shallow contamination. While the mechanisms of As uptake and accumulation in the fern have received attention in numerous greenhouse and hydroponic experiments, only a few studies have investigated the fern's performance under field conditions, which is crucial to developing successful remediation methods. The objective of this study is to understand the role of fertilization in enhancing arsenic phytoremediation efficiency.

A field study was initiated in January 2013 to determine the effects of organic and inorganic fertilization on *P. vittata* frond biomass, As uptake rate by *P. vittata,* and on cumulative As removal from soil. The field site is an abandoned railroad right-of-way (sandy loam) mildly contaminated with As (20-100 ppm), located in Berkeley (CA) and characterized by a Mediterranean climate. The soil was tilled and limed before 1,600 *P. vittata* ferns were planted. One of five treatments was applied to fern beds: 1) compost; 2) organic nitrogen as blood meal (5 g N m^{-2}); 3) inorganic nitrogen as $(NH_4)_2SO_4$ (5 g N m^{-2}); 4) organic phosphorus as bone meal (20 g PO_4^{3-} m^{-2}); 5) inorganic phosphorus as phosphate rock (20 g PO_4^{3-} m^{-2}). Two controls were established: 1) ferns, no treatment; and 2) soil, no ferns and no treatment. After 8 months of growth, all mature and senescing fronds were harvested. Soil from two depth intervals (0-15 and 15-30 cm) was sampled using a multi-increment method. Frond and soil samples were analyzed for total As and extractable nutrients. In addition, soil physical and chemical characteristics (pH, exchangeable acidity, aggregate stability, density, cation exchange capacity, percent base saturation, and soil organic matter) were determined. Our results showed that both frond biomass and arsenic uptake are correlated to soil treatment. These results will contribute to an understanding of arsenate and phosphate competitive uptake by *P. vittata* and will inform remediation optimization.

[1] Ma *et al* (2001) *Nature* **409**, 579