PhD Dissertation Defense

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Title: "Fixing" The Urban Soil Lead Predicament: The Applicaton Of In Situ Fixation Technology As An Ecologically Sustainable Method Of Lead Abatement In Urban Soils

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ABSTRACT

Urban soils have been shown to contain high concentrations of lead (Pb) due accumulation from a variety of origins including lead based paint, regular vehicular traffic and industrial sources. The aerosol form Pb can be re-suspended and easily inhaled on fine dust particles and/or inadvertently consumed in crops grown in lead contaminated soils. At low levels Pb will impair psychological and neurobehavioral functions particularly in young children. Remediation of lead contaminated soils by conventional methods is expensive. The use of low cost environmentally safe amendments for the in situ fixation of lead contaminated soil is a promising remediation approach. In situ lead fixation does not reduce the total concentration of soil lead but changes its speciation, thus rendering the changed lead species less toxic and even non-bioavailable in the eco-system. The objectives of this research were: (1) to determine if various agricultural, municipal and industrial by-products treatments can reduce levels of bioaccessible lead in contaminated urban soils, (2) to determine if by-product treatments can reduce or prevent bioavailable lead absorption into the tissues of crops grown in contaminated soils, (3) to determine if by-product treatments will affect crop yields, and (4) to determine if by-product treatments can reduce soil and crop tissue bioavailable lead levels to within Environmental Protection Agency (EPA) or joint World Health Organization and Food and Agriculture Organization (WHO/FAO) standards. The by-products selected for study were poultry litter ash (PLA) as a phosphate source, drinking water treatment residual (WTR) as an aluminum, sulfate and iron oxide source, steel slag (SS) as an alumina, iron, and magnesium oxide source, and leaf compost (LC) as a source of organic matter. These by-products were selected because they contain chemical compounds that will absorb and fix lead. Soils were collected from three urban locations: Ft. DuPont National Park Washington DC, a residential area of Washington, DC, and a residential area in Baltimore, City MD. The average total lead concentrations were 38, 1099 and 1088 mg kg-1 respectively. By-product treatments (except WTR) resulted in decreasing Mehlich III extractable Pb in the residential DC and Baltimore soils, compared to the un-amended soil. PLA, LC, and SS treatments reduced bioavailable Pb in the residential DC and Baltimore soils to within EPA permissible limits for garden soil. In comparison, high rate treatments of WTR significantly increased Mehlich III lead levels in both residential DC and Baltimore soils. No treatments met the WHO/FAO standard. The most effective treatments at reducing Mehlich III lead in the crop tissue grown in residential DC and Baltimore soils were PLA, LC, & SS. Low and high rate treatments of WTR resulted in non-significant lead increases in crop tissues. LC and PLA treatments were found to stress crops and reduce crop yields when compared to controls. WTR increased yields with most crops. The most consistent by-product to reduced or prevent bioavailable Pb uptake into crop tissues to within EPA and/or WHO/FAO permissible limits for the Pb in leafy and roots vegetables was LC. However, due to the high levels of trace elements and salts in some of these by-products, caution is suggested when using these materials to grow crops.