Urban gardens and soil contaminants: Alum-based drinking water treatment residues to attenuate metal uptake by vegetables

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OBJECTIVES:

1. Derive optimum soil amendment rates for alum-based DWTRs to maximize metal immobilization & minimize fertilizer P sorption
2. Assess whether banded application of P fertilizer can effectively minimize P sorption by DWTRs & increase plant P use efficiency

INTRODUCTION

- Urban soils frequently contain elevated concentrations of metals which can be taken up by plants grown in these soils
- Immobilization of metals in contaminated soils via adsorption & co-precipitation reactions with alum-based drinking water treatment residues (DWTRs) limits metal absorption by plants
- Strong, specific P sorption by alum-based DWTRs limits their use in cultivated soils due to P immobilization
- It is necessary to find a balance between beneficial metal immobilization by DWTRs & their disadvantageous sorption of P to capitalize on the widespread availability of this by-product for productive re-use in vegetable production systems

KEY FINDINGS

- Soil amendment with alum-based DWTRs reduced tissue Cd & As concentrations by 30-52% & 75%, respectively, relative to untreated controls (Figures 1 & 4)
- Tissue P concentrations in treatments with banded P fertilizer were 30-47% greater than in analogous treatments with broadcast-applied P fertilizer (Figure 2)
- 2% (w/w) DWTR amendment with banded P fertilizer yielded the greatest quantity of *B. pekinensis* biomass (Figure 3)
- *B. pekinensis* tissue P & Cd or As concentrations in soils amended with 2% w/w alum-based DWTRs were comparable to treatments with 4-6% w/w DWTRs (Figures 1, 2, & 4)

RESULTS

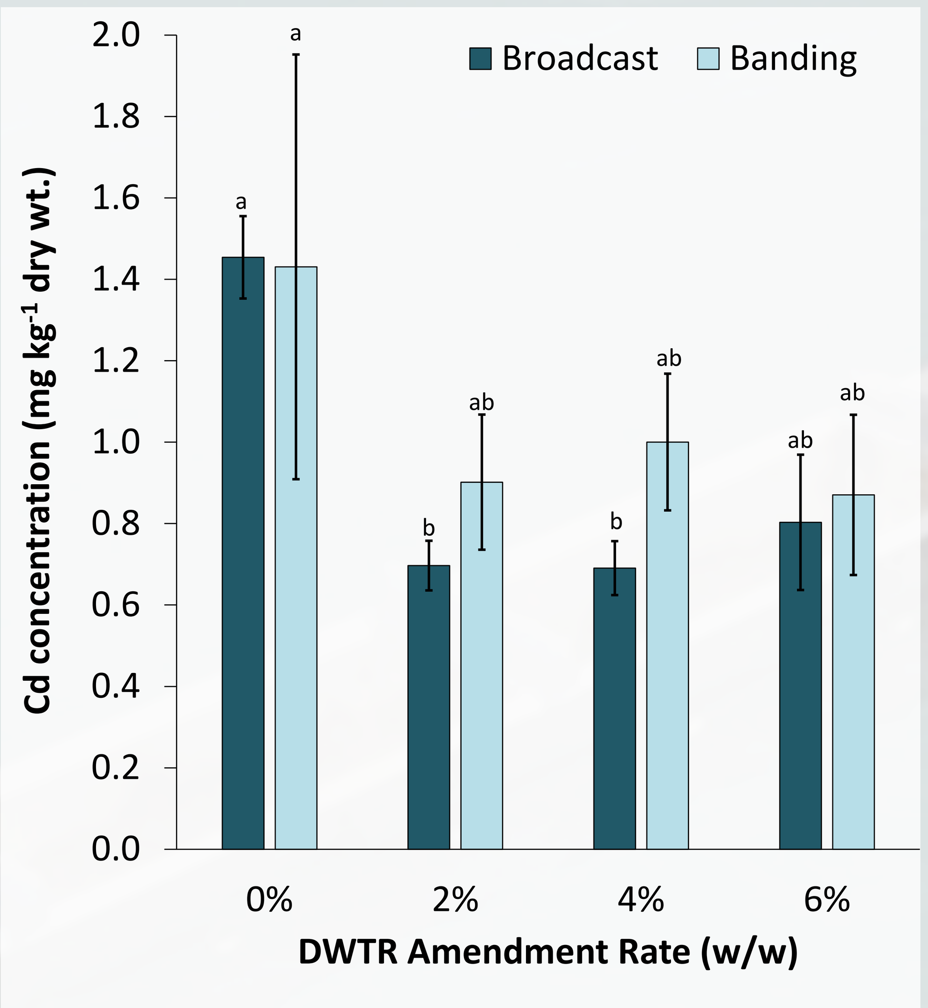


Figure 1. Mean Cd concentration of *B. pekinensis* aboveground tissues grown in sandy loam soil with broadcast- or band-applied P fertilizer as a function of alum-based DWTR amendment rate (0-6% w/w)

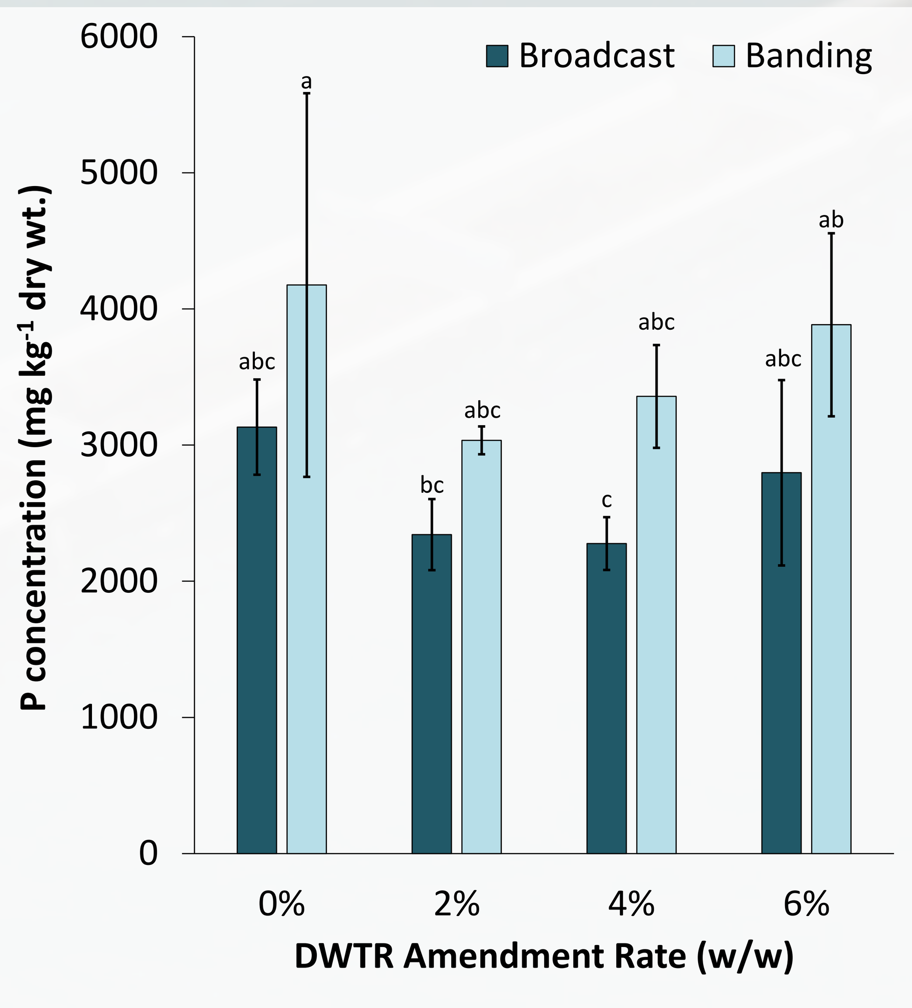


Figure 2. Mean P concentration of *B. pekinensis* aboveground tissues grown in sandy loam soil with broadcast- or band-applied P fertilizer as a function of alum-based DWTR amendment rate (0-6% w/w)

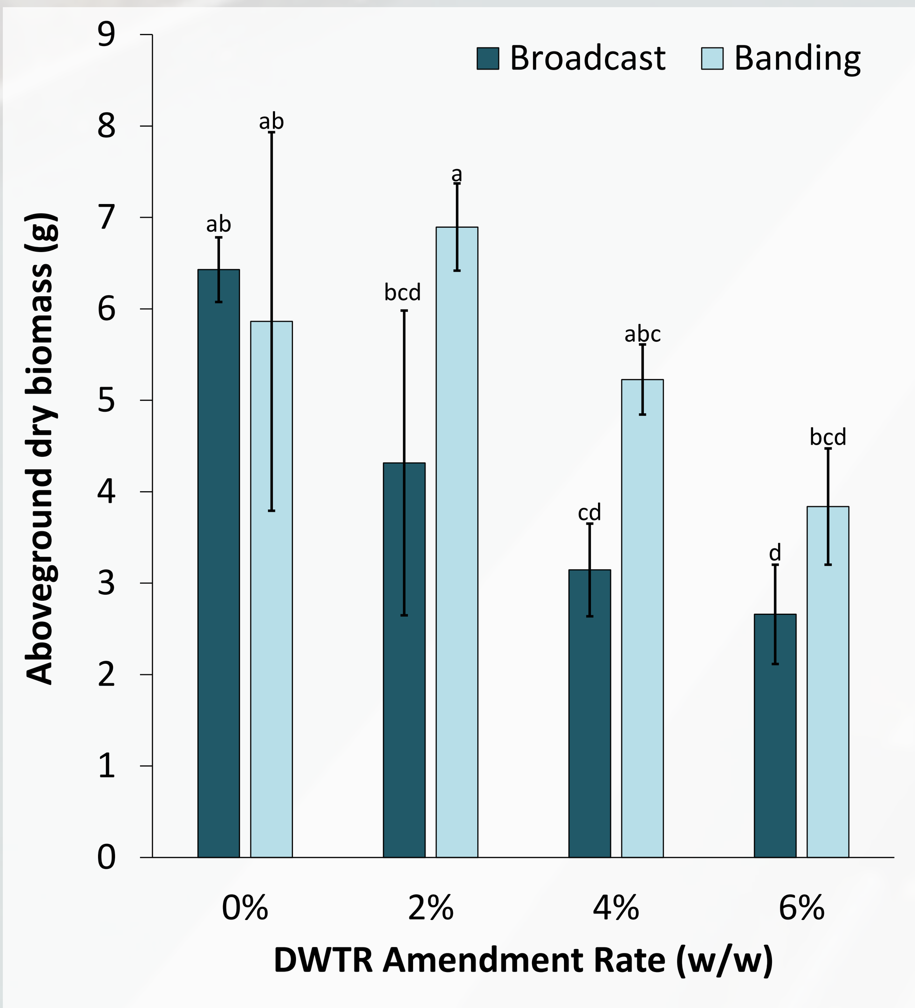


Figure 3. Mean aboveground dry biomass of *B. pekinensis* grown in sandy loam soil with broadcast- or band- applied P fertilizer as a function of alum-based DWTR amendment rate (0-6% w/w)

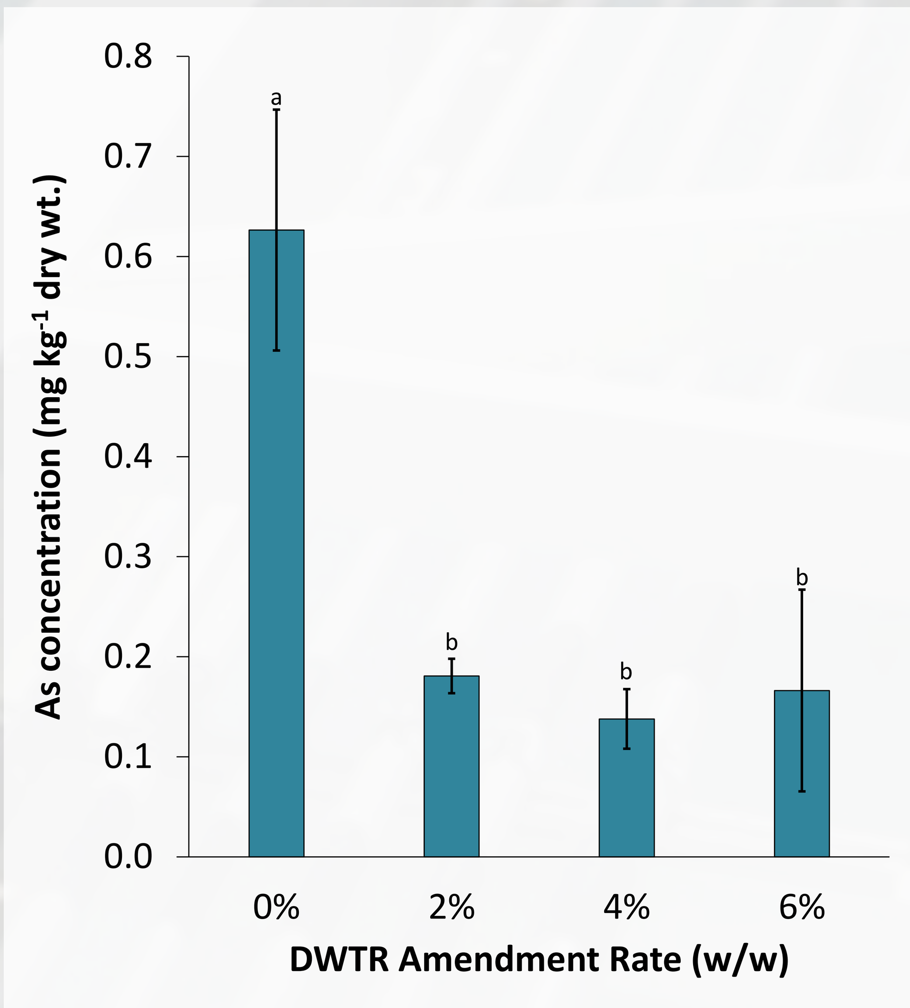


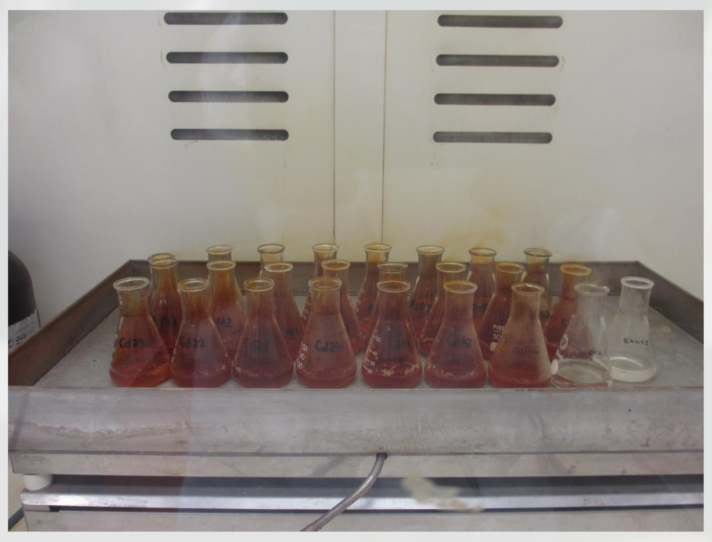
Figure 4. Mean As concentration of *B. pekinensis* aboveground tissues grown in sandy soil with band-applied P fertilizer as a function of alum-based DWTR amendment rate (0-6% w/w)

METHODS

Alum DWTR slurry was dewatered & oven-dried at 105°C prior to amending soil

P fertilizer was applied either as a dense band or broadcast & mixed with top 5 cm soil before planting

Chinese cabbage (*Brassica pekinensis*) was grown under controlled conditions for 50 days before harvest & oven-drying of aboveground tissue



Dried plant tissues were finely ground & digested with a 5:1 nitric-perchloric acid mixture; major & trace elements in digest solutions were analyzed by ICP-MS