Citric Acid Enhanced Metal Removal in Stormwater Basins

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Goals

Quantify the increase in metal uptake after adding citric acid to the soil of a stormwater bioretention basin for the mid-season and end-of -season harvest.

Determine differences in citric acid and metal concentrations in the pore-water at two depths (3in and 6in below ground level).

Analyze the soil and pore-water for any reduction of metals.

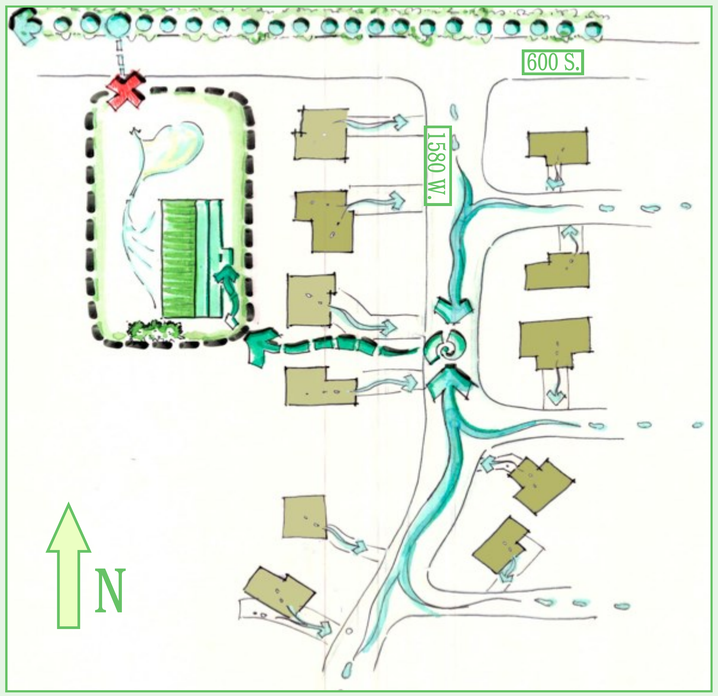

Figure 1: Schematic of Stormwater Runoff Convergence and Collection at the Green Meadows Field Site

Figure 2: Edging Installation

Figure 3: Lysimeter Field Test

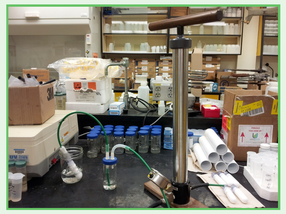

Figure 4: Lysimeter Lab Test

Methodology

Field Preparation:

Separate the 12 test bays into 3 sections by installing 6in depth edging

Test and install lysimeters (porous cup soil water samplers)

Sampling Methods:

Compile initial soil, irrigation water, and pore-water samples

Collect pore-water samples after citric acid application

After application of citric acid, collect soil and plant shoot sub-samples

Analysis Methods (Table 1):

Plant shoot biomass measurements and digestions

Soil digestions and extractions

Pore-water digestions

Table 1: Analysis Methods for Field Study Samples

Sample Type	Biomass	TP	TMetals	TN	pH	EC	Citrate	TDN/TDP	AvMetals	%Water	BioAv. Metal	BioAvN	BioAvP
Plant Shoots	X	X	X	X									
Plant Roots		X	X	X									
Suction Cup													
Pore Water 3in					X	X	X	X					
Pore Water 6in					X	X	X	X					
Auger													
Pore Water 3in									X				
Pore Water 6in									X				
Soil 1.5in		X	X	X						X	X	X	X
Soil 3in		X	X	X						X	X	X	X
Soil 6in		X	X	X						X	X	X	X

Initial Results (Table 2)

Pore-water (PW) extracted from soil samples (Figure 5) or lysimeters.

Water samples were collected from the irrigation system.

Table 2: Initial Pore-water and Water Results

	Pb (µg/L)	As (µg/L)	Zn (µg/L)	Cu (µg/L)	Ba (µg/L)	pH	EC
PW Top 2.66in	0.83	32.75	64.56	179.09	248.33		
PW Middle 2.66in	0.62	11.12	46.45	15.17	256.32		
PW Bottom 2.66in	0.41 (bdl)	10.33	46.43	11.93	248.50		
PW at 3in Depth						7.66	924.0
PW at 6in Depth						7.63	897.5
Irrigation Water						7.80	594.7

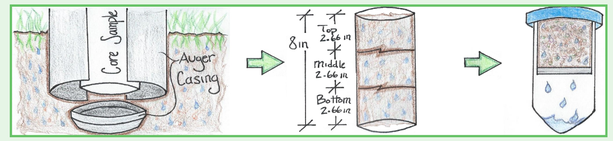

Figure 5: Retrieval of Pore-water from Soil

Impact

Bioretention basins are used to reduce stormwater flow and increase water quality.

These basins accumulate metals in the soil. Plants uptake dissolved metals into the above-ground biomass, which can be harvested and removed offsite.

This study quantifies citric acid's ability to enhance phytoextraction and reduce metal buildup in the soil.

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