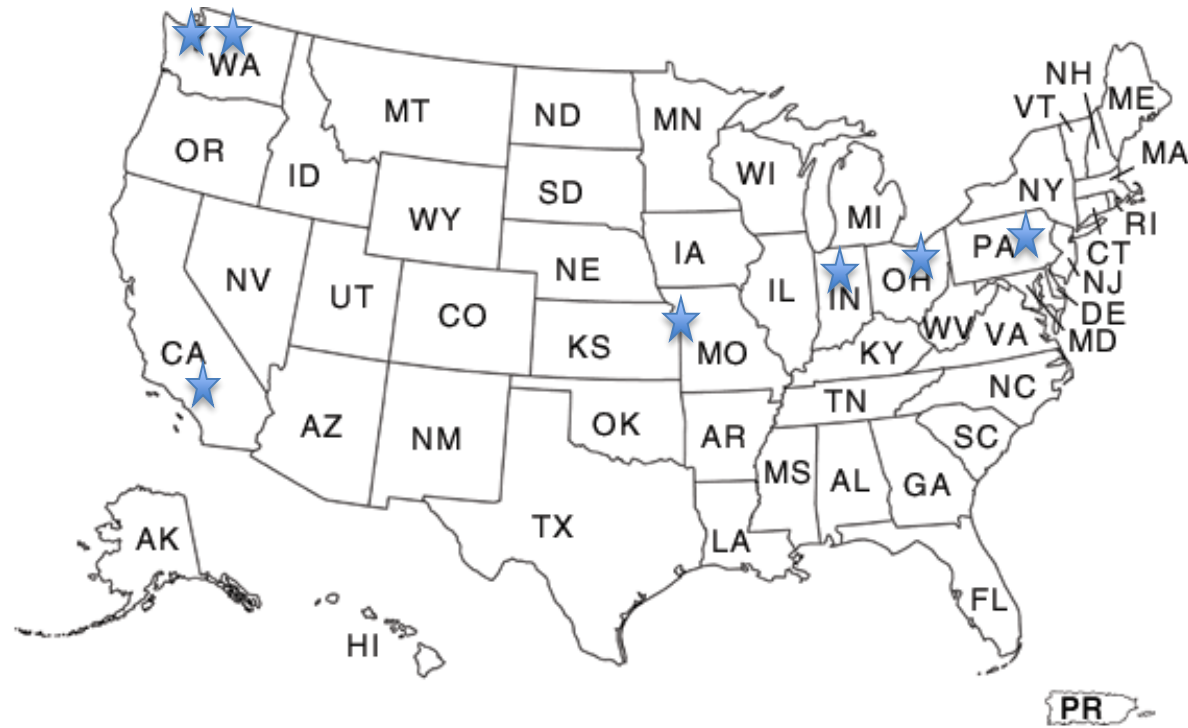


K-State Project: Gardening Initiatives at Brownfields Sites

7 test sites across the USA: Kansas City, MO; Tacoma, WA, Seattle, WA; Indianapolis, IN; Pomona, CA; Philadelphia, PA; Toledo, OH

Site Selection Criteria

- Brownfields site
- About 2,000ft²
- Intended for community gardening activities

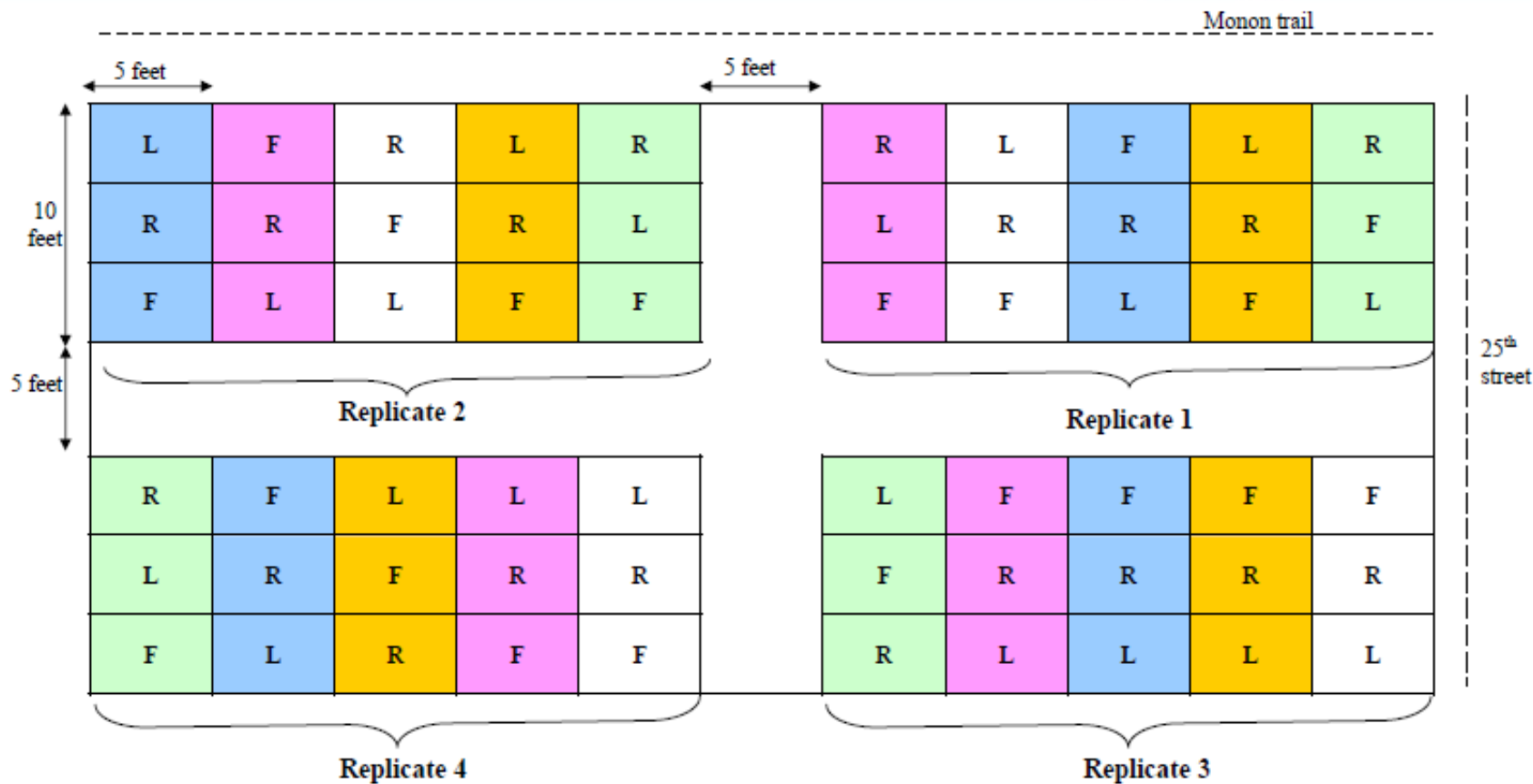


Process

- Establish site history
- Collect soil samples
- Establish test plot
- Continuous monitoring for 2 growing seasons, soil and produce sampling
- Best management practices (adding soil amendments, raised beds)
- Training and technical assistance to participating organizations (sample collection, site eval., etc.) throughout



Typical Test Plot Design



Compost type	Control	Carmel biosolids	Composted biosolids	Mushroom compost	Leaf compost
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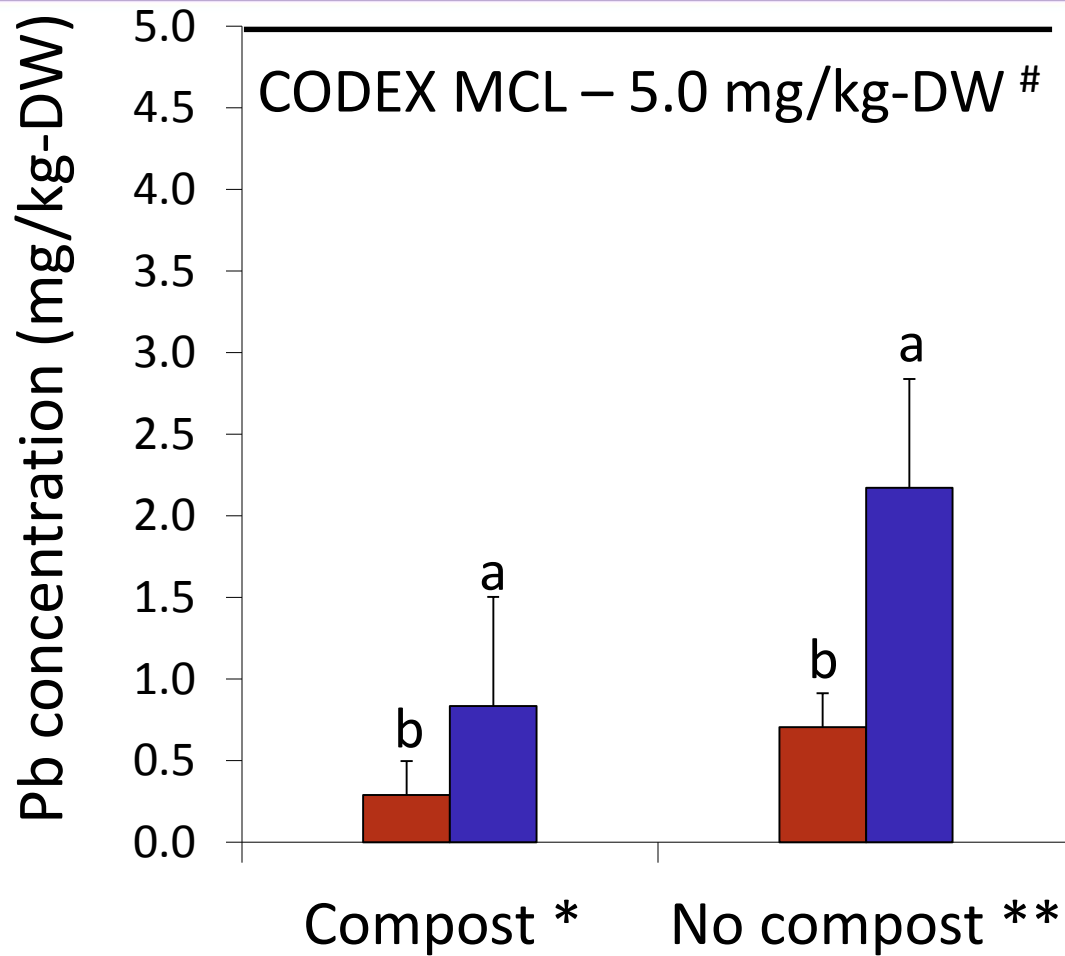
Crop Type	L- Leafy vegetable Collard green	R- Root/Tuber crop Carrot	F- Fruiting vegetable Tomato
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Contaminant Dilution through Compost Addition

Kansas City, MO

Plot #	Total Soil Pb (mg/kg)	
	Prior to Compost Addition	After Compost Addition
1	289	203
2	255	120
5	253	146
8	186	114
Average	246	146

Lead Concentration in Swiss Chard



■ Lab cleaned
■ Kitchen cleaned

Compost – ↓ 59 %

Lab cleaning- ↓ ~ 67 %

Treatment	Soil Pb (mg/kg)
No compost	128-348
Compost	101-256

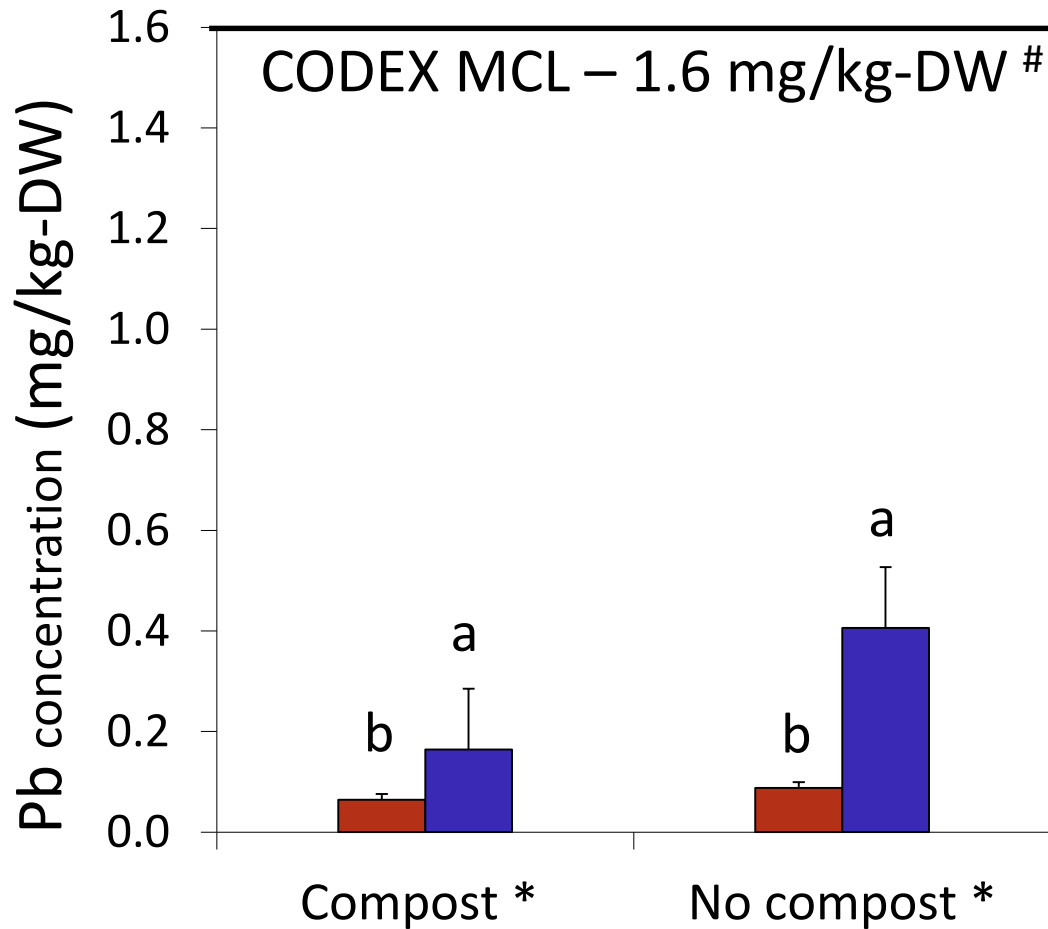
$p < 0.05$ (split plot design, 4 blocks)

*, ** between two categories

a, b- within a category

CODEX MCL (FAO/WHO) - 0.3 mg/kg fresh wt. basis (94% moisture)

Lead Concentration in Tomato



■ Lab cleaned
■ kitchen cleaned

Lab cleaning- ↓ ~ 61-78%

Treatment	Soil Pb (mg/kg)
No compost	143-271
Compost	122-193

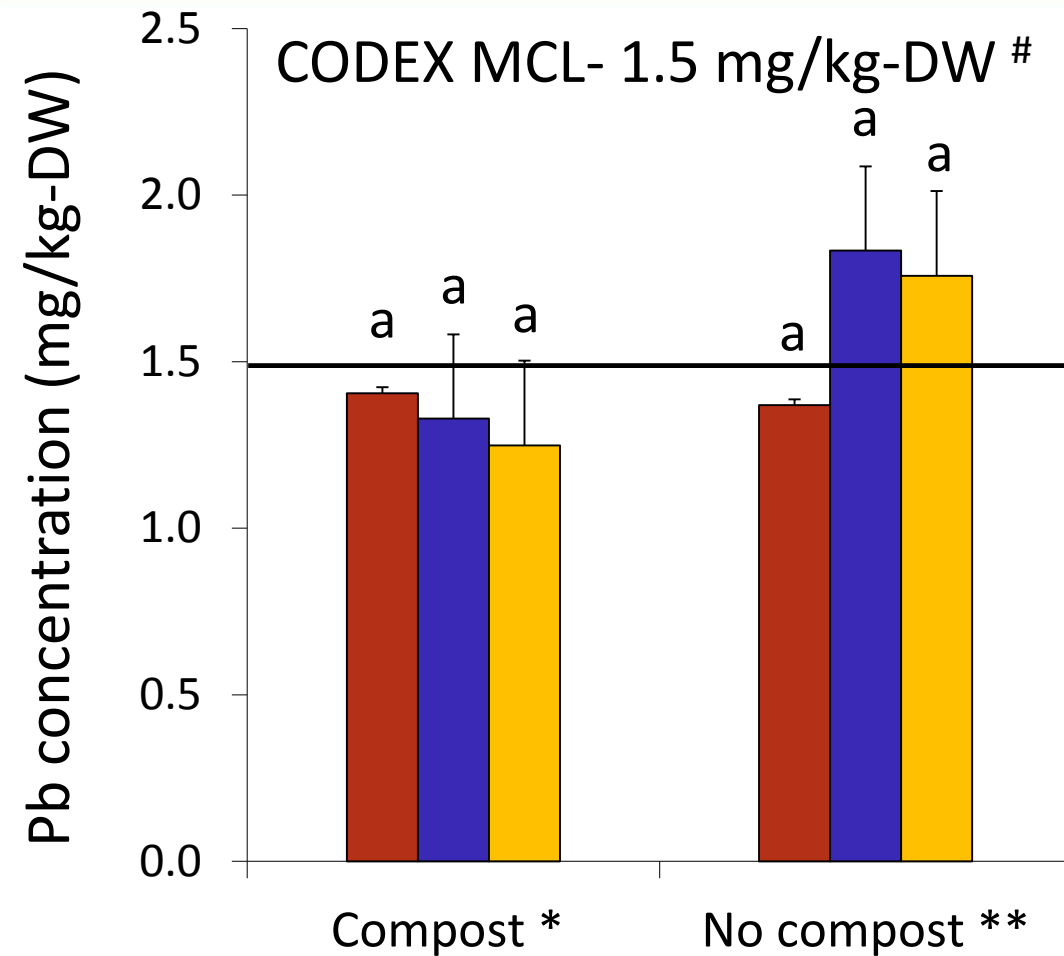
$p < 0.05$ (split plot design, 4 blocks)

*, ** between two categories

a, b- within a category

CODEX (FAO, WHO) - 0.1 mg/kg fresh wt. (94% moisture)

Lead Concentration in Carrots



- Lab cleaned
- Kitchen cleaned
- Peeled

Compost- ↓ ~ 20 %

Treatment	Soil Pb (mg/kg)
No compost	154-388
Compost	119-161

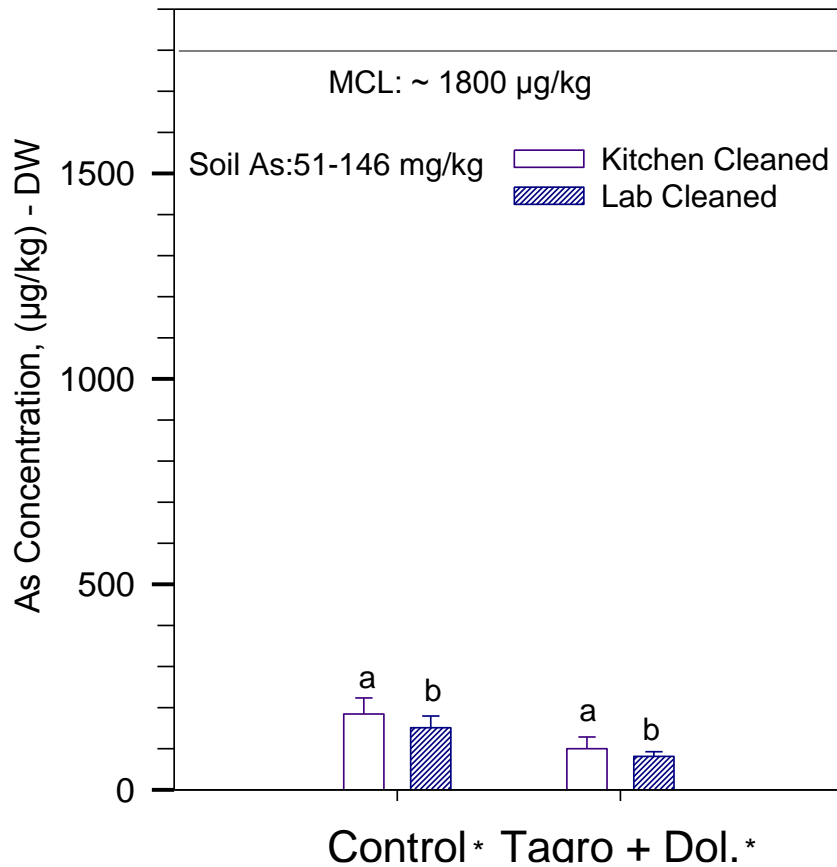
p<0.05 (split plot design, 4 blocks)

*, ** between two categories

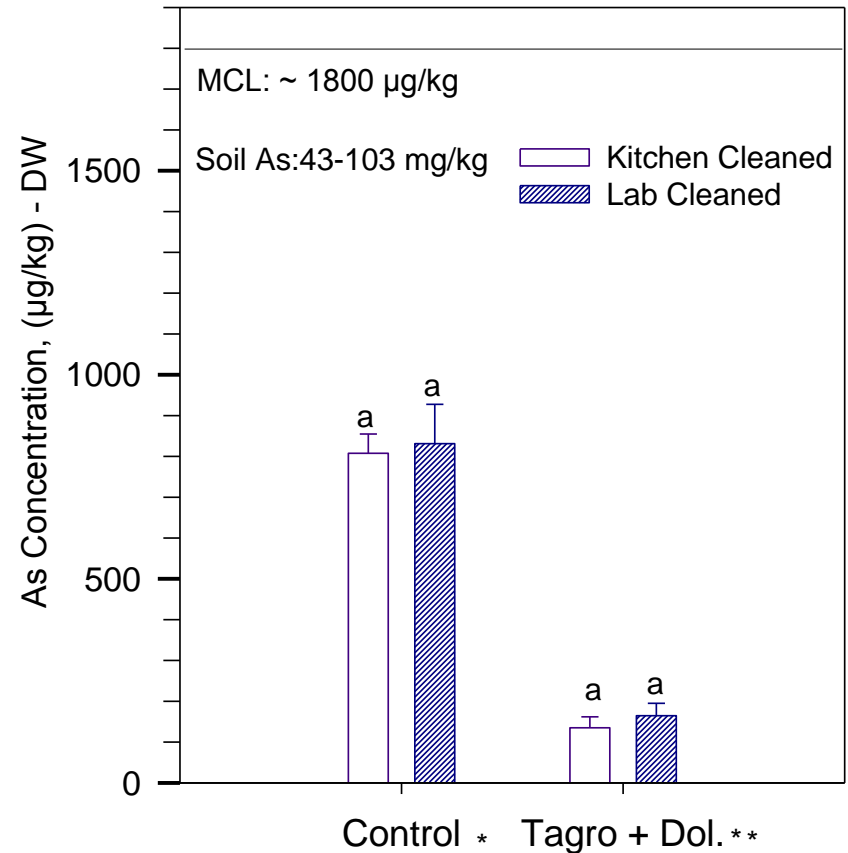
a, b- within a category

CODEX (FAO, WHO) - 0.1 mg/kg fresh wt. (93% moisture)

Arsenic in Lettuce

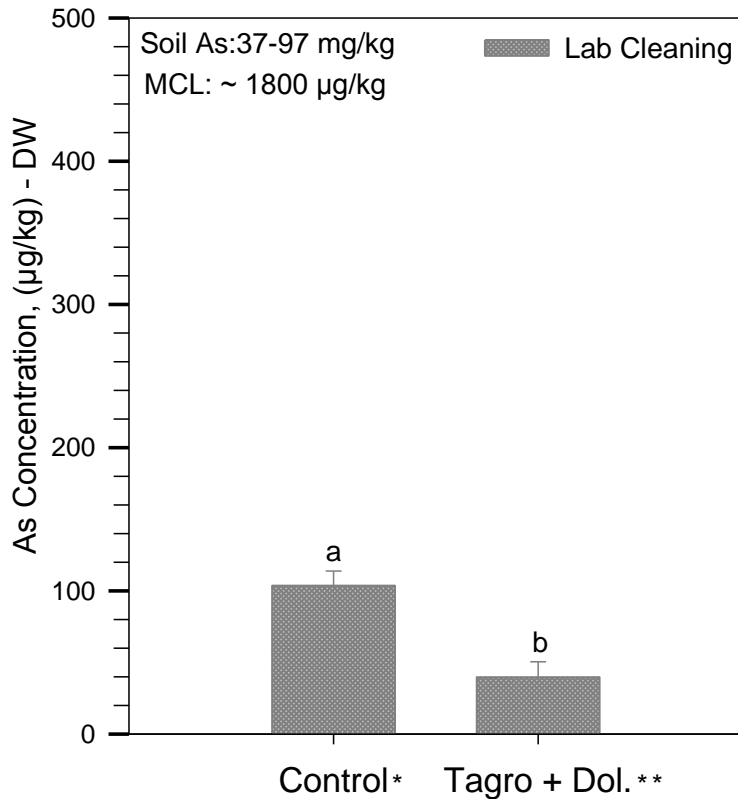


2010

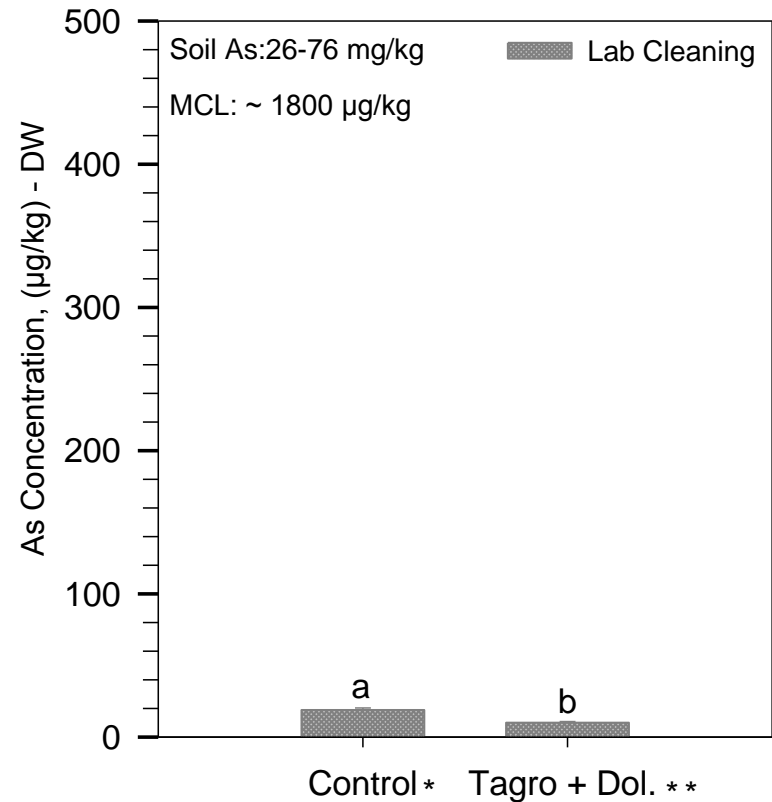


2011

Arsenic in Tomatoes

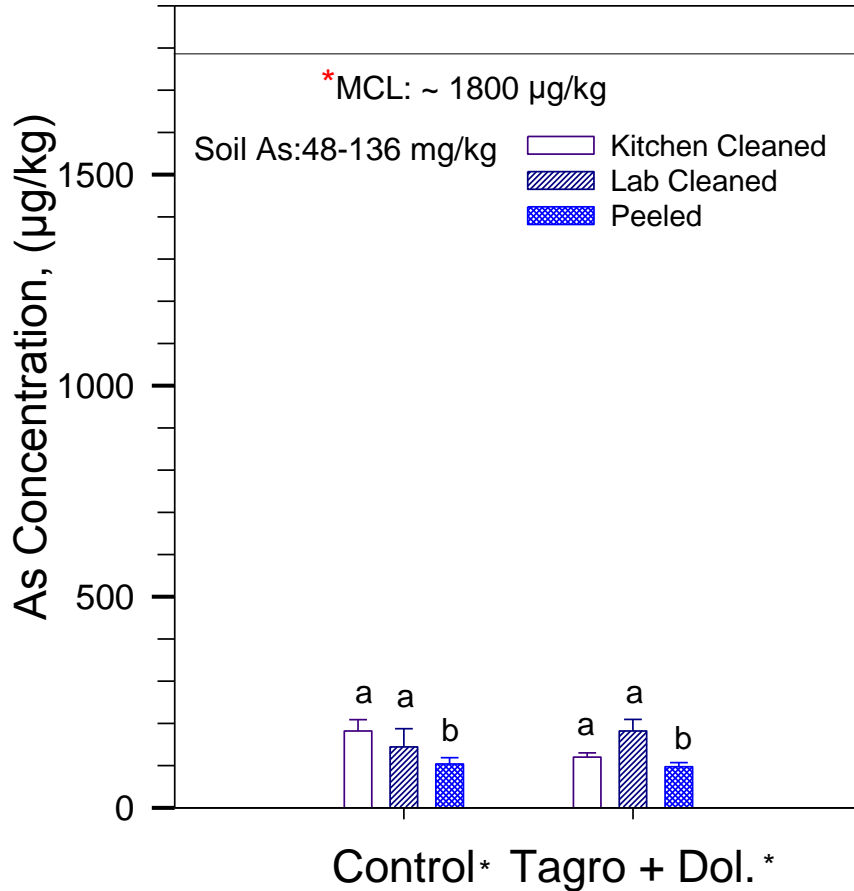


2010

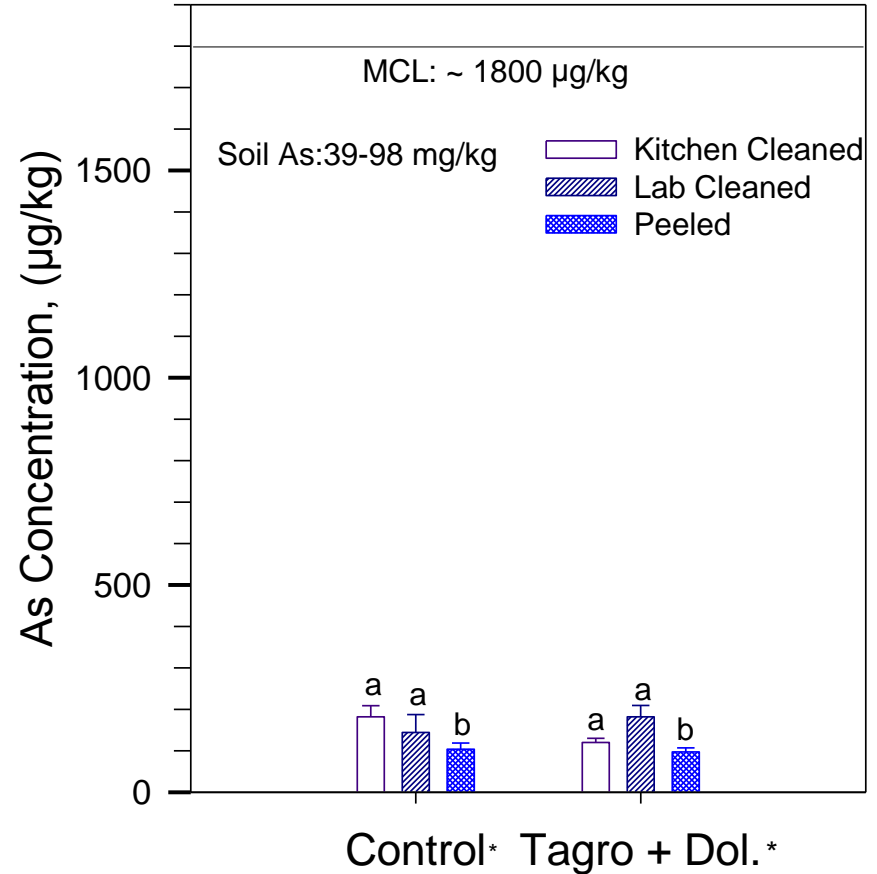


2011

Arsenic in Carrots



2010



2011

Research Findings

- Potential exposure pathway of concern = direct soil exposure: Soil → Human
- Soil → plant → Human “Non-significant”
- Contaminants were consistently diluted by compost addition
- In general, concentrations of Pb, As, Cd and PAHs in vegetables from test sites were low
- Thorough cleaning of vegetables further reduced the potential of transferring soil contaminants to humans via vegetable consumption
- Soil lead on test sites ranged from 100mg/kg to 2,000mg/kg
- Root crops will be affected by elevated levels of Pb in soils

Research Findings, cont.

- Soil lead conc. in sandy, moderately acidic soils >200-250mg/kg - lead conc. in root crops above WHO/FAO MCL (1 -1.5 mg/kg dry weight)
- Soil lead in non-sandy soils, +/- neutral pH, Pb ranging from about 250mg/kg to 400 mg/kg - roots crops ok
- Bioaccessible lead and arsenic in soils tested were low
- Arsenic uptake was always low and below WHO/FAO MCLs (As conc. in soils ranged from 50-130mg/kg)
- PAH uptake by vegetables was low or non-detect with PAH conc. in soils up to 107 mg/kg
- Cadmium conc. in soils >20mg/kg: Cd in leafy vegetables above WHO/FAO MCL (4mg/kg dry weight basis)

BMPs

- Till and add compost to mitigate compaction
- Add compost/biosolids to improve soil structure, mitigate compaction, to provide nutrients and **to reduce bioavailability of metals**
- Add lime or acidulating materials to adjust pH to **reduce bioavailability of metals**
- Maintain optimum nutrient levels - provide P to **reduce bioavailability of metals**
- Select suitable crop types



Contributors

- Co-PI Dr. Ganga Hettiarachchi (and other investigators)
- Graduate students: Chammi Attanayake, Phillip Defoe

Collaborators

- Jake Wagner (UMKC); Chris Benedict (WSU); Kristen McIvor (UW); Ginny Roberts (Purdue Extension); Monica Palomo (Cal Poly); Mary Seaton Corboy (Greens Grow- Philly); Michael Szuberla & Karen Wolkins (Toledo Botanical Gardens)
- Regional brownfields offices, EPA Regions III, V, and VII

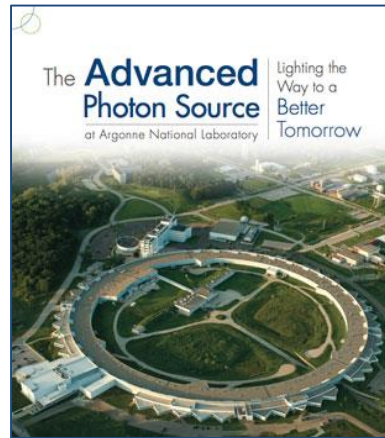
Acknowledgments

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