Trace Element Contaminants in Urban Soil Environments

Trace elements are defined as having indigenous concentrations (either in the solid or liquid phase) less than 100 parts per million (ppm).

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Some Baby Food May Contain Toxic Metals, U.S. Reports

Testing found high levels of arsenic, lead and cadmium in some ingredients, congressional investigators said.

New York Times February 4, 2021

- **Carrots**
- **Sweet potatoes**

- Lead (Pb) and Arsenic (As), EPA's two priority trace element pollutants
- Why & When to be concerned
- Soil Test
- Gardening in Contaminated Soil

Health Concerns

Lead (Pb)

- most ubiquitous toxic metal in the environment
- It adversely impairs cognitive development
- according to the U.S. Center of Disease Control and Prevention (CDC), Pb poisoning is the most universal and serious disease to impact young children – the the most frequent mode of poisoning arising from ingestion of Pb laden paint chips and soil.
- The population as a whole receives almost 70% of its total Pb exposure from food, aside from the risk associated with occupational exposure (Biddle, 1982; Klaassen, 1996).

Arsenic (As)

Acute

- The immediate symptoms of acute arsenic poisoning include vomiting, and gastrointestinal distress.
- Followed by numbness and tingling of the extremities, muscle cramping and death, in extreme cases.

Long-term exposure

- can cause cancer and skin lesions
- It has also been associated with cardiovascular disease and diabetes.
- In utero and early childhood exposure has been linked to negative impacts on cognitive development and increased deaths in young adults.

Lead (Pb)

- Uncontaminated surface soils: 20 to 27 mg/kg mean background concentration
- Urban soil about 150 mg/kg or higher
- EPA: 400 mg/kg

Arsenic (As)

- Typical natural background levels in soils: <0.1 to 40 mg/kg
- Regional screening levels (RSL) range from 0.039 to 40 mg/kg
- USU: 20 mg/kg

Urban Sources of Pb and As contamination

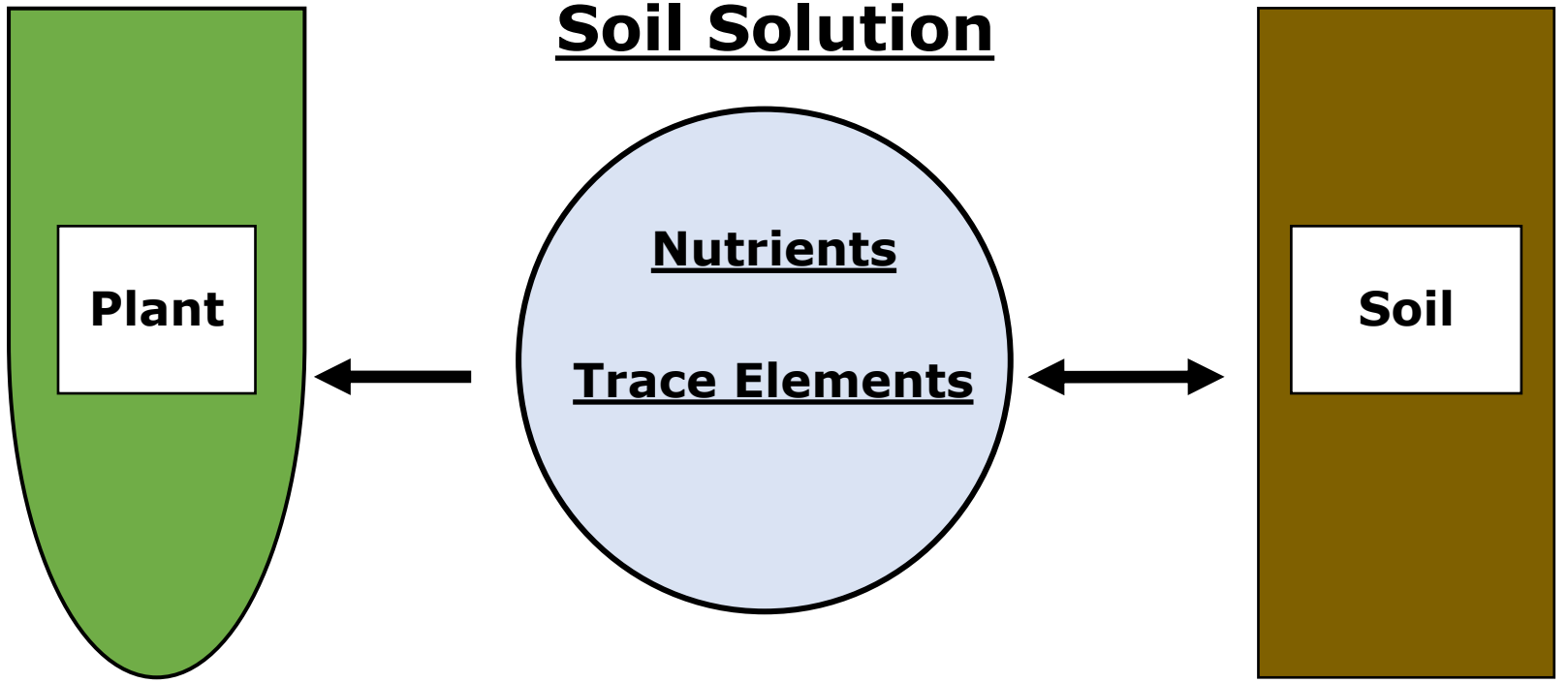
- Pb from auto emissions
- Lead in paint
- Lead arsenate pesticide
- Industry and smelters
- Mining activities
- biosolids

Suspect Soils

- within 20 feet of older buildings
  - Leaded paint (1978 residual use banned)
- Within 100 feet of roadways, parking areas, and higher traffic areas
  - Leaded gasoline (Phase out began in mid 1970s. Banned January 1, 1996)
- Within 1 mile of smelters, fossil fuel powered plants and cement facilities
- Pre-1950 orchard sites (Lead arsenate pesticides)
- Near tailings from current and former metal ore mines
- Biosolids

BIOAVAILABILITY

Bioavailable = soluble = mobile



Soil-Plant Barrier

Lead and arsenic are strongly sorbed to soil and very little is translocated to edible portions of plants despite the the amount present in soil, therefore, their potential food chain toxicity is low.

Soil Test

Total Element Composition (EPA 3050) = bioavailable + sorbed

From Brown, Sally L. et al. 2015. Lead in urban soils: A real or perceived concern for Urban Agriculture. *Journal of Environmental Quality.*

“Recent studies have shown that Pb in contaminated urban garden soils (concentrations ranging from <300 to 2586 mg kg^{-1} Pb) mainly existed in the carbonate fraction complexed with organic matter or adsorbed to iron oxides (Attanayake et al., 2014; Attanayake et al., 2015; Cheng et al., 2011). Lead entering soils from Pb-based paints or gasoline will generally have high bioavailability.”

Best Mangement Practices (BMP) to reduce Pb and As exposure in Vegetable Gardens

Vegetables

- Avoid suspect areas

- Avoid root vegetables and leafy greens

Pb uptake: Root crops > leafy crops > fruiting, legume, and grain crops

- Wash or peel any soil off of vegetables before eating

Best Management Practices

Soil

Keep soil covered – Minimize exposure to bare soil.

- Turf
- Ornamentals
- Mulch

Dilute with contaminant free material

- Compost
- Quality topsoil

Raised Beds

Best Management Practices

Always

- Thoroughly wash hands after working in garden soil and before eating
- Remove or rinse off ”garden” shoes before entering house

Examples

- Typical backyard vegetable garden in SLC. Home built in 1903.

- Garden area contaminated with lead containing paint chips.
  - Fruit trees (peach and fig)
  - Rhubarb patch

Recommendation:

- **Soil is fine**
- **No restrictions on what to grow**

Front East Corner surrounding house (w/in 20’)

Pb – 200 ppm
As – 21 ppm

Recommendation:

- No edible food crops
- Keep soil covered

Garden area contaminated with lead containing paint chips.

Soil: Pb = 580 ppm and As = 19 ppm

Both Pb and As below detection (< 0.05 ppm) in tree fruits.

Only Pb - no As - detected in rhubarb stalks at 2.5 ppm. If you ate a cup of this rhubarb a day you would still be 1000x lower than the FDA Provisional Tolerable Total Intake level (PTTIL) for adults of 75 micrograms Pb per day. ***The FDA has set the PTTIL of Pb from all sources at 25 micrograms (ug)/day for pregnant women and 6ug/day for infants and children up to 6 years of age.***

Summary

- Get soil tested if suspect for Pb and As contamination
- Soil Test EPA 3050 – Total Elemental Composition
- Pb 400 ppm, As 20 ppm
- Avoid growing root crops and leafy greens in contaminated soil
- Follow best management practices: cover soil, dilute, raised beds
- Wash hands and vegetables
- Rinse soil from shoes before entering house
- If still concerned, have vegetables analyzed for trace metals