Best Management Practices to **Mitigate Soil Lead (Pb) Exposure Risk**

Lead in Soils

All soils naturally have some amount of lead (natural background or geogenic), but soils in urban environments may have enrichment or increases over this natural level. At sufficiently high enrichment levels in soils, lead can pose risks to those participating in urban agriculture.

The United States Environmental Protection Agency sets a maximum soil lead threshold of 200 mg/kg (ppm) total lead for soils with exposed surfaces. This threshold was recently revised in January of 2024 to decrease by 50% from 400 ppm as EPA's Updated Screening Levels. Some states in the U.S. and other nations have lower recommendations, such as California (80 ppm) and the Netherlands (85 ppm). It should be noted that these threshold levels are set as guidelines focused on children playing in and around soil that is directly ingested or inhaled incidentally. There are yet to be guidelines developed that focus on crop uptake, and the cumulative exposure from the consumption of crops that uptake lead into edible tissue and the other direct pathways for exposure (Saikawa and Filippelli, 2021). Cumulative exposure guidelines would require information about dietary patterns, body weight, and other variables.

In general, research finds that urban agriculture can be safely practiced in the context of heavy metal exposure. However, proper guidelines and nuanced site-specific approaches need to be followed regarding risk assessment, particularly for vulnerable populations like children. Additionally, even though vegetables are often safe to eat from lead-enriched soils, management practices that generate breathable soil dust may expose farmers and gardeners to lead through the direct inhalation pathway. Long-term guidelines for heavy metal levels in urban ag systems should consider cumulative exposure to metals, local and seasonal conditions, as well as the nutritional benefits of urban-grown produce (Lupolt et al., 2021).

Chicago Soil Research

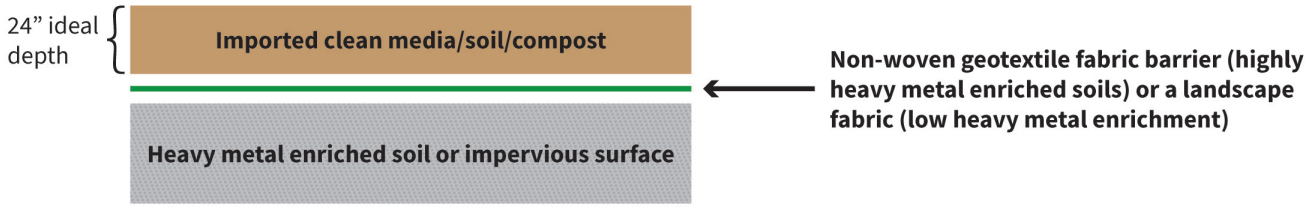
The University of Illinois Urbana-Champaign, College of ACES in the Department of Crop Sciences and Illinois Extension has also recently conducted some research into lead (Pb) in Chicago soils and implications for urban agriculture. From a data set of 1,151 collected soil samples, the median (i.e., a more careful average) lead concentration city-wide was 220 ppm, which slightly exceeds the new EPA threshold for direct exposure (Watson et al., 2022). Additionally, a two-year in-ground tomato production study as well as two greenhouse experiments using soils with slight to significant lead enrichment (77-1206 ppm) found that those levels of lead contamination led to no risk of tomatoes having elevated levels of lead and being safe to eat according to the World Health Organization guidelines (Watson and Margenot, 2022).

With this background in mind, below are some general best practices when it comes to lead exposure in food production. Most of these practices are also relevant to other heavy metals found in urban soils with high enrichment of lead. These are guidelines only.

Good Growing Practices to Reduce Lead Exposure

- To minimize the inhalation/ingestion risk of soil with lead, test the soil for total concentrations. Note: total lead concentration in soils is not a predictor of lead uptake by the crop
- Locate gardens away from older buildings built before 1980 and roads, especially those with heavy traffic
- Grow in elevated raised beds with clean imported soil or media and a landscape fabric (lower lead levels) or non-woven geotextile fabric barrier (higher lead levels) between raised beds and contaminated soil

Scenario for Remediating a Heavy Metal-Enriched Soil in Place (In Situ)



Bring at least 24" of clean growing media, soil, compost, or mulch to create a physical barrier between potential crops and the heavy metal-enriched soil. Non-woven geotextile has a lower chance of roots accessing enriched soil than woven landscape fabric.

Begin preferring fruiting crops (e.g., tomatoes, corn, apples, squash), followed by leafy greens, and consider avoiding root crops in soils above 80 ppm. As stated above, there is a lack of a quantitative correlation between soil Pb concentration and vegetable uptake even at low enrichment (e.g., 80 ppm). Additional best practices include:

- Add organic matter amendments such as compost to the soil
- Add/replace 1 to 2 inches of leaf compost each year as mulch to cover or replace soil that may become re-enriched with lead from windblown deposition.
- Add lime to increase soil pH to 6.5 to 7.5. Note: Some vegetables prefer a pH <6.5, though most will do fine in this range.
- Wash hands immediately after gardening and before eating
- Wear clean gloves for soil work and harvesting if desired
- Discard soil-flecked, dusty, or outer leaves of leafy vegetables
- For root crops, scrub and peel them before consumption
- Wash all produce thoroughly
- Protect gardens from airborne particulates using a fence or hedge
- Minimize dust by maintaining surface covers or mulches, including grass, plastic, wood chips and avoiding drying of exposed soil

Management Practices Based on Soil Lead Concentration

The following soil management practices are recommended from research findings in Surls et al., 2016.

Low (80 to 200 ppm)

Follow the best management practices listed above for extra caution.

Medium (200 to 1200 ppm)

- Consider not growing leafy green vegetables or root crops (fruiting crops only) when soils are heavy metal-enriched at this level. Once again, there is a lack of definitive correlation between soil Pb concentration and vegetable uptake, even at this level of enrichment.
- Follow the best management practices listed above
- Cover bare soil and minimize dust with barriers, mulch, or living cover

High (>1200 ppm)

- Do not grow food crops in this soil. Higher exposure risk, consider setting up food production elsewhere.
- If still considering food production near this level of enrichment, then in situ remediation is recommended by capping contaminated soil with non-woven geotextile fabrics and bringing in clean soil and media around 24 inches deep on top of the fabric. This could be a combination layer of mulches or woodchips topped off with clean soil or media. At a smaller scale, container and raised beds filled with clean soil or media are an option.
- Crop selection should be based on only those with root systems that will not risk contacting or growing into contaminated soils and remain contained in clean/soil media, like shallow-rooted crops.
- Do not allow children access to the soil.
- Keep soil covered
- Contact your local health department for advice on other lead abatement measures.

References

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