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# TRACE ELEMENTS AND URBAN GARDENS

**Donald R. Hodel[1] and Andrew C. Chang[2]**
**[1]Environmental Horticulturist, University of California, Cooperative Extension**
**4800 E. Cesar E. Chavez Avenue, Los Angeles, CA 90022; email drhodel@ucdavis.edu**
**and**
**[2]Professor of Agricultural Engineering, Department of Soil and Environmental Sciences**
**University of California, Riverside, CA 92521**

Trace elements occur naturally in all areas and soils of the world. Indeed, some are essential for humans, plants, and animals. We always ingest them to some extent in food and water, and we breathe them in the air. Their concentrations are naturally low and usually not hazardous in non-urban areas with little or no environmental disturbance and past or present human activity. However, any place subjected to human activity is likely to have trace elements at elevated levels in the environment, particularly in the soil. While there is generally no cause for alarm, in some cases, these trace elements may accumulate to a level where it would be advisable to take measures that ensure they will not pose a health risk.

Potentially harmful trace elements, especially heavy metals, can accumulate in the soil and on plants, and may pose a potential health risk to people who breathe or, especially, swallow contaminated soil or eat contaminated vegetables. Although plants always absorb trace elements to some extent, in nearly all instances the quantities they take up are too insignificant to cause alarm. The potential harm is from trace elements deposited on leafy vegetables from dust, splashing water, and the air or are in the soil and cling to root crops like carrots and beets. In these instances, thorough washing of vegetables usually eliminates them. Lead is perhaps the most prevalent and problematic trace element in urban gardens but others, such as cadmium and arsenic, are often present.

Many urban community gardens also serve as family and neighborhood gathering spots where children actively play in the soil. Certain trace elements are especially hazardous to young children, particularly those under six years of age, because their tolerance levels to these contaminants are lower due to lower body weight and their still developing neurological systems are unusually sensitive to these elements. Also, the type of activity in which children engage, such as playing in the soil with frequent hand-to-mouth contact and even eating soil, allows them to ingest these trace elements directly.

So, are the elevated levels of potentially hazardous trace elements in urban gardens cause for alarm? No. Actually, the probability of harm is very low. We performed soil tests at several urban gardens in Los Angeles and in nearly all cases concentrations of trace elements were well within natural ranges. Even in the few instances where trace elements were slightly elevated, leaf and fruit tests showed that the vegetables grown in the soil had not taken up the contaminants in any significant amounts. Despite their presence, even at elevated levels, it is still possible to grow and consume vegetables safely and confidently if we understand the nature of these trace elements in urban gardens, including their origin, chemical form, and concentration in the soil, and take precautionary measures to reduce their availability to plants or eliminate them.

## Origin of Trace Elements

Relatively large quantities and numerous kinds of trace elements are inherent in the urban environment because of intense human and high industrial activity. Various types of human activity, such as soil grading, building and road construction and demolition, industrial and waste management operations, manufacturing industries, pollution, and automobile traffic, among others, are highly concentrated in urban areas and have served as sources of potentially harmful trace elements.

Knowing the history of the urban garden site can provide much information about the likelihood of having soils contaminated with trace elements. Because most urban garden sites are on vacant lots near roads with frequent automobile traffic or where illegal dumping often occurred or buildings once stood, they are unusually predisposed to having soils contaminated with trace elements. Soil may be contaminated if any of the following activities occurred at the site:

1. metal industries such as plating and smelting;
2. automobile repair shops or salvage yards;
3. waste management operations;
4. recycling businesses;
5. unauthorized local dumping where motor oil, batteries, tires, old painted wood, and other refuse and waste could have been illegally deposited;
6. buildings with old, painted surfaces;
7. heavy or congested automobile traffic.

### Lead

The soil serves as a great reservoir of lead, and a major source of lead in urban soils is fallout of engine exhaust from vehicles burning leaded gasoline. Although banned since 1986, the burning of leaded gasoline for more than 60 years has left a legacy of lead embedded in soils in urban areas, especially near roads with heavy and congested automobile traffic. Fine lead particles from exhaust are deposited directly on soil and on buildings and other structures and plants where rain then washes them into the soil.

Another source of lead in urban soils is lead-based paints. Although mostly banned since 1978, lead-based paints still remain on walls and other fixtures of old houses, buildings, and equipment. Also some specialty paints may still contain lead. Unsafe removal of lead-based paint, such as scraping, sanding, and especially sandblasting, can easily release lead particles and dust that is then deposited on nearby soils or other surfaces. Old wood protected with lead-based paint that is used or deposited in the garden also adds lead to the soil when the paint chips, flakes, and wears off. Its long natural life and history of use has ensured that lead is and will remain a common contaminant in urban areas for years to come.

Illegally or improperly discarded or dumped batteries of automobiles, trucks, boats, and motorcycles can also be sources of lead in the soil.

Children are especially exposed to lead in old homes where leaded paints were commonly and frequently used on walls, floors, and trim. Children directly ingest lead when they eat paint chips and flakes, chew on windowsills, or even crawl on the floor.

### Cadmium

Cadmium is a contaminant of many manufactured products containing zinc. Any zinc plating or galvanizing operations and galvanized metal containers sometimes used in horticulture and gardening operations are potential sources of cadmium. Zinc is also used in the vulcanization process in tire manufacturing. As tires wear, they give off minute, dust-like rubber particles containing cadmium that easily disperse and accumulate in soils and on plants.

**Arsenic**

Like lead and cadmium, arsenic occurs naturally in soils but there are no identifiable sources to account for its higher concentrations in urban settings. Fortunately, it is not too prevalent and problematic although it is highly toxic. Arsenic has proven to be a problem, however, in suburban areas where subdivisions have crept out onto former agricultural land, especially those that were used for tree fruit production where pesticides containing lead arsenate were applied. Other possible sources include manufactured wood products, like particleboard and treated lumber, where arsenic-containing compounds were used to prevent rot and provide weather resistance.

There are other potentially hazardous trace elements and compounds in urban soils. Sources of these include lumber treated with compounds to prevent rot and increase longevity, such as penta-chloro-phenols, and by-products of combustion processes, such as poly-aromatic hydrocarbons.

Even fertilizers can be a source of potentially hazardous trace elements. Prior to the more recent development of cleaner manufacturing processes, the inert materials used as blenders or fillers in phosphate fertilizers often-contained elevated levels of contaminants.

Organic fertilizers may also have potentially hazardous trace elements. Poultry manure often contains arsenic that was in drugs administered to chickens for disease management. Similarly, pig manure usually has elevated levels of copper. Fertilizers or soil amendments containing sewage sludge or “bio-solids” were once potential sources of potentially hazardous trace elements, including lead, cadmium, and zinc. Due to government regulations contaminants in sewage sludge have been greatly reduced and pose virtually no threat when the product is used properly.

Likewise, municipal green-waste composting programs are probably not a source of potentially hazardous trace elements because they usually do not use grossly contaminated street sweepings. Even if street sweepings were used, the resulting compost is probably still safe because street sweepings make up such a very small portion of the municipal and public green-waste stream that contaminants would be highly diluted.

## *Nature and Concentrations of Trace Elements*

Most trace elements, especially the heavy metals, remain in the soil nearly indefinitely. Soils have “long memories”, and most contaminants are relics of the past. The primary trace elements are relatively stable and immobile in the soil, and are mainly found to a depth in the soil that corresponds to the depth of cultivation, tilling, or disturbance.

In most cases potentially hazardous trace elements found in urban garden soils and on plants must be directly ingested to cause harm; usually only small amounts enter the body by inhalation. Plants absorb only minute amounts of lead and then mostly in the roots. However, plants, especially leafy vegetables like lettuce, cabbage, and spinach, can absorb cadmium in roots, leaves, and to some extent in fruits. There are a few cases of severe contamination with cadmium that resulted in harm. In these few instances in Japan, rice was contaminated with cadmium from industrial sources. Even then the people were only affected because they ingested unusually large quantities of contaminated rice over a long period of time. Soil pH, organic matter content, cation exchange capacity, and temperature can affect uptake of heavy metals by plants.

Under natural conditions, lead occurs in the soil at 5 to 20 ppm, cadmium at 0.05 to 0.5 ppm, and arsenic at 1 to 5 ppm. In highly urbanized areas, lead occurs in the soil at 100 to 200 ppm, cadmium at 1 to 5 ppm, and arsenic at 10 to 20 ppm. Threshold levels where these elements could be harmful by direct ingestion are generally higher than levels commonly found in urban soils. For example, U.S. government threshold levels for lead in the soil are greater than 500 ppm for lead and greater than 20 ppm of cadmium. Even at threshold levels, however, there still may not be cause for alarm because it is chronic, long-term exposure rather than acute exposure that is the primary concern.

## Testing Urban Soils

Testing soils in urban gardens is always a good idea. Not only will it reveal which trace elements are present and their concentrations but also where they are located in the garden. An added benefit of testing the soil is the opportunity to gather information about basic nutrient levels at the site. Many companies offer soil-testing services. Sometimes university cooperative extension services can provide you with a list of soil testing companies.

When collecting soil samples it is important to follow the instructions the soil testing company provides. It is a good idea to collect samples form several places at the garden site. For example, if individual gardening beds are 20 by 20 feet it would be appropriate to keep soil from each bed as a separate individual sample. However, several collections from different points in one bed could be mixed together to form a composite sample for that bed.

## How to Eliminate or Reduce Exposure to Trace Elements

There is no cause for alarm if tests show that there are concentrations of trace elements above those levels that one would expect in urban soils. There are several procedures that can reduce or eliminate these elements or exposure to them so that they are not harmful.

1. Thoroughly remove and properly dispose of refuse from urban garden sites before planting. Be especially vigilant for old painted wood, tires, galvanized metal, and batteries.
2. Always wash hands thoroughly after working or playing in urban soils. Thorough hand washing is especially important for children who are more susceptible to trace elements. Consider using gloves, especially for children.
3. Thoroughly wash all vegetables and fruits and peel root crops like beets, radishes, and carrots before eating. Discard older, outer leaves of leafy vegetables.
4. Dilute pockets of higher than normal concentrations of trace elements by digging and spreading the soil over a large area in the garden or by adding additional, clean soil and thoroughly mixing it with the contaminated soil. It is generally not feasible to dig contaminated soil from the garden and dispose of it off site. Such soil would be considered toxic waste and strict rules and regulations govern its disposal.
5. Since most potentially hazardous trace elements are found in the upper one to two inches of uncultivated or undisturbed soil, it is always a good idea to cultivate soil deeply, to at least eight inches deep if possible, before planting to dilute the contaminated soil with clean soil below.
6. Locate plantings, especially leafy crops, as far away as practical from streets. As much as 75 feet would be good. Utilize barriers, such as walls, fences, and hedges, to help to block automobile exhaust and dust from coming into the site from streets and roads.
7. Maintain soil pH near 7, or neutral, and ensure phosphate levels are adequate.
8. Use large amounts of organic matter, like composts and humus, to amend the soil.
9. Mulch with leaves, woodchips, hay, newspaper, or other material to reduce dust.
10. Consider planting in raised beds or containers using uncontaminated soil.
11. Consider having separate gardening shoes and clothes with long sleeves and pants, especially for children, which are not brought into the house.
12. Locate child play sites in uncontaminated areas and/or cover the ground around play areas with an impermeable, artificial play surface, sand, or wood chips.