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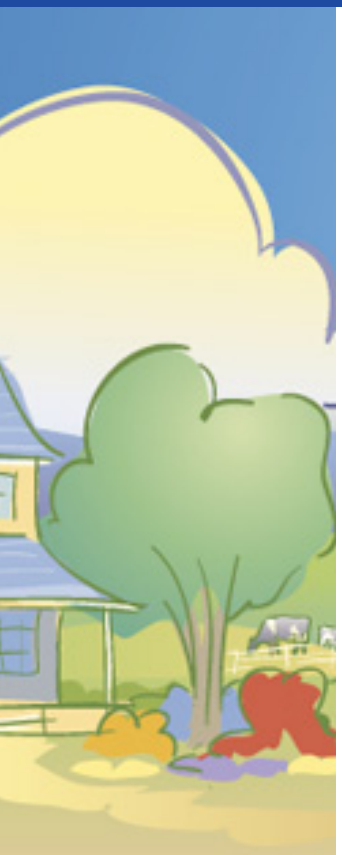

Home Gardens and Lead

What You Should Know about Growing Plants in Lead-Contaminated Soil

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How does lead get into the soil?

Lead (Pb) is a heavy metal that occurs in low levels in all soils. Natural concentrations of lead in most soils range from 10 to 30 parts per million (ppm). (Lead concentration is commonly expressed on a mass basis: a level of 1 part per million [ppm] corresponds to 1 milligram [mg] of lead in one kilogram [kg] of soil or other medium; 1 ppm = 1mg/kg.) However, some soils have higher concentrations of lead due to contamination from various pollution sources, including

- chipping, sandblasting, and peeling of exterior lead-based paint from older buildings
- automobile emissions from combustion of leaded gasoline (lead was added to gasoline as an anti-knock ingredient, but this practice was stopped by 1986 in the United States and subsequently in many countries, although leaded gasoline is still available in some parts of the world)
- disposal of scrap containing lead, such as old lead pipes, roof flashing, or lead-acid batteries

Recent studies show that the lead content of some urban soils may range from 100 ppm to over 1,000 ppm. Elevated lead concentrations in soils in urban areas are often directly related to their distance from highly travelled roads and older buildings painted with lead-based paints. Houses close to freeways and other highly used roads or located in industrial zones may have soil lead concentrations in excess of 1,000 ppm. The soil next to older buildings painted with lead-based paint that is flaking or has been scraped or blasted may have lead concentrations exceeding 3,000 ppm.

What are the hazards associated with lead?

Lead is toxic to humans, and poisoning can occur either through ingestion of lead or by breathing in lead dust. Both long-term low-dose and short-term high-dose exposure can permanently damage the nervous, renal (kidney), and hematopoietic (blood-forming) systems. Lead may also harm the reproductive, endocrine (hormonal), hepatic (liver), cardiovascular, immune, and gastrointestinal systems. Young children (ages 0 to 5) are more sensitive to the toxic effects of lead than are adults. For more information on the health effects of lead, contact this division of the California Department of Public Health:

Childhood Lead Poisoning Prevention Branch
850 Marina Bay Parkway
Building P Third Floor
Richmond, CA 94804-6403
(510) 620-5600, Web site
http://www.cdph.ca.gov/programs/CLPPB/Pages/default.aspx

Will plants grow in lead contaminated soil?

Yes. Unlike many other heavy metals such as cadmium, copper, and nickel, moderate concentrations of lead in the soil (< 500 ppm) have no noticeable harmful effect on plant growth. Therefore, ornamental plants can be grown safely in lead-contaminated soil. In fact, it is a good idea to grow a ground cover such as turfgrass, low-growing ceanothus, bearberry, or lantana over lead-contaminated soil to reduce the amount of lead-laden soil dust that can become airborne with windblown topsoil.

Is it safe to eat plants that have been grown in lead-contaminated soils?

The answer is not a simple yes or no: it depends on the soil concentration of lead and the type of crop grown. The greatest exposure to lead in soil is from soil dust, which is why the U.S. Environmental Protection Agency (EPA) set a standard for lead in bare soil in play areas of 400 ppm and 1,200 ppm for nonplay areas. The greater risk to children, and some adults, is not through ingestion of vegetables, but through direct ingestion of lead-contaminated soils, especially by children who intentionally eat soil (pica) (see Alloway 2005).

Plants do not readily absorb large amounts of lead, and the amount they do absorb depends on the species and variety of plant, the chemical composition of the soil, the amount of lead in the soil, and the soil temperature. Because so many factors influence how much lead a plant absorbs, it is difficult to predict how much lead a plant will contain based on the amount of lead in the soil. However, lead is generally slow to move within a plant (from roots to leaves), and most of the lead that does enter a plant accumulates in the fine roots and secondarily in the leaves, though there are some exceptions. Fruits such as tomatoes, peppers, melons, okra, apples, and oranges and seeds such as corn, peas, and beans generally have the lowest lead concentrations and are the safest portions of the respective plants to eat if grown in lead-contaminated soils.

What precautions should I take before eating plants grown in lead-contaminated soils?

Recent studies of leafy vegetables (collard greens) grown in urban gardens contaminated with lead estimated that ingestion of these greens would provide only 25 percent of the intake from water containing a safe level of lead (4 ppm). While this amount is small in comparison to water, it is still significant and should be minimized. It can be safe to eat plants grown in soils contaminated with lead if you follow some simple, low-cost precautions.

- Do not grow leafy vegetables or root or tuber crops (carrots, potatoes, beets, turnips) in lead-contaminated soils. Grow them in raised beds filled with clean soil, where the clean soil cannot become contaminated with paint flakes, chips, or dust.
- Fruits that are marketed as vegetables, such as tomatoes, peppers, beans, cucumbers, and squash, may be grown in lead-contaminated soils will not accumulate significant concentrations of lead.
- The primary risk of lead consumption from eating a plant grown in a lead-contaminated soil is from ingesting lead-rich soil that adheres to the surface of the plant. Therefore, washing and peeling greatly reduces the risk of ingesting lead deposited on surfaces of vegetables and fruits.
- Root and tuber vegetables, such as potatoes, beets, turnips, and carrots, may have lead-rich soil particles attached to their skin. It is essential to peel these vegetables if grown in lead-contaminated soils.
- Peeled root and tuber vegetables should also be washed with tap water after they are peeled, in order to rinse away any contaminants transferred to the outer flesh during the peeling process.
- Leaves, stems, and fruits (the aboveground portions of a plant) can become superficially contaminated by dust enriched with lead. To reduce the risk of lead consumption, remove the outer leaves and rinse produce thoroughly.

Can I do anything to reduce the amount of lead my vegetables take up from the soil?

Yes, you can! You can reduce the amount of lead uptake by plants by providing amendments that promote binding of the lead with other components of the soil, and also manage the soil acidity (pH).

- Organic matter has been proven to bind and hold lead effectively, making it less available to plants. However, organic matter eventually breaks down, so the soil should be frequently amended with organic matter (compost, decomposing leaves, or well-rotted manure).
- Composts rich in phosphorus are especially able to lower lead uptake into the edible parts of plants. Applying additional phosphorus using any garden fertilizer containing phosphate to the soil surface when adding organic matter increases the phosphorus content and does not hurt the plants even if the compost is already rich in phosphorus.
- For vegetable gardening, maintain the soil pH in a range close to neutral (pH 6.5 to 7.5). You may need to add limestone to increase the pH in acidic soil. Generally, plants take up less lead as the soil pH increases. However, the soil pH should not be raised beyond 7.5, otherwise elements necessary for healthy plant growth and development will also become unavailable to the plants. Although garden pH meters are readily available at

garden centers, it may be more accurate to have the soil tested for pH at a local commercial soil laboratory (see below for more information on soil testing).

Can I reduce or remove the lead in my soil?

Not easily. Unless the soil is removed or diluted the lead concentration in the soil does not change over time. If the soil has not been disturbed, the highest concentration of lead will be in the upper few inches. The lead concentration of many roadside soils remains elevated even though lead has not been added to gasoline in the United States for more than 30 years.

- Inhalation of lead-laden dust while gardening is generally a greater risk than consuming well-washed vegetables grown in low to moderately contaminated soil. Consider covering contaminated soil with 8 to 12 inches of uncontaminated soil, which limits lead absorption by plants and reduces the hazard presented by inhaling and ingesting soil dust containing lead.
- You can also minimize the hazard from lead dust by applying a 4- to 6-inch-thick layer of mulch around your plants. Mulching has the added benefits of maintaining moisture in the soil and reducing weed growth. Also, maintaining a dense stand of a ground cover (lawns, etc.) that covers the soil entirely reduces dust and mud problems and lowers the risk of lead inhalation significantly.

Can I have my soil tested for lead content?

Yes. Your local UC Cooperative Extension office may have a list of commercial laboratories certified to do soil analyses. Otherwise, check the telephone directory or the Web for such a list. Note that UC Cooperative Extension offices do not perform soil tests. Not all labs may be able to analyze for lead, and the cost may vary. When collecting soil for a lead test, collect samples from the top 3 inches of soil, where the lead concentration will be the highest (unless the soil has been disturbed or mixed).

If I cannot afford to have my soil tested, what can I do?

You may contact your city or county departments of health or environmental health to find out whether public programs are available to help. For example, in Boston a program called The Food Project helps urban residents build raised beds and supplies them with clean, composted soil for the beds. They recommend that people grow leafy vegetables (which may accumulate lead) in the beds and grow fruiting plants in soil that may be contaminated. This is a great way to decrease potential exposure to lead in soil!

Where Can I Get More Information?

For more information about protecting yourself and your family from lead poisoning contact

Department of Health Services Childhood Lead Poisoning Prevention Branch
1515 Clay Street, Suite 1801
Oakland, CA 94612
(510) 622-5000
Fax: (510) 622-5002
Web site http://www.dhs.ca.gov/childlead/

Other useful links include:

EPA Standards (Water and Soil), http://www.atsdr.cdc.gov/csem/lead/pb_standards2.html

Lead in House Paint and Dirt (California Department of Public Health) http://www.cdph.ca.gov/programs/CLPPB/Documents/CLPPB-PaintSoil(E).pdf

Lead in the Home Garden and Urban Soil Environment (University of Minnesota) http://www.extension.umn.edu/distribution/horticulture/DG2543.html

Trace Elements and Urban Gardens (University of California Cooperative Extension) http://celosangeles.ucdavis.edu/Environmental_Horticulture/Trace_Elements_and_Urban_Gardens.htm

The Food Project (Boston, MA) http://thefoodproject.org

References

Alloway, B. J. 2005. Bioavailability of elements in soil. In O. Selinus, ed., Essentials of medical geology. Boston: Elsevier Academic Press.

Berti, W. R., and S. D. Cunningham. 1997. In-place inactivation of Pb in Pb-contaminated soils. Environmental Science and Technology 31:1359-1364.

Chaney, R. L., S. B. Sterrett, and H. W. Mielke. 1984. The potential for heavy metal exposure from urban gardens and soils. In J. R. Preer, ed., Proceedings of the Symposium on Heavy Metals in Urban Gardens. Washington: University of the District of Columbia Extension Service.

Clark, H. F., D. J. Brabander, and R. M. Erdil. 2006. Sources, sinks, and exposure pathways of lead in urban garden soil. Journal of Environmental Quality 35:2066-2074.

Cobb, G. P., K. Sands, M. Waters, B. G. Wixson, and E. Dorward-King. 2000. Accumulation of heavy metals by vegetables grown in mine wastes. Environmental Toxicology and Chemistry 19(3): 600-607.

Dudka, S., and W. P. Miller. 1999. Accumulation of potentially toxic elements in plants and their transfer to human food chain. Journal of Environmental Science and Health B34(4): 681-708.

Farley, D. 1998. Dangers of lead still linger. FDA Consumer Magazine [U.S. Food and Drug Administration].

Hooda, P. S., D. McNulty, B. J. Alloway, and M. N. Aitken. 1997. Plant availability of heavy metals in soils previously amended with heavy applications of sewage sludge. Journal of the Science of Food and Agriculture 73:446-454.

Page, A. L., T. J. Ganje, and M. S. Joshi. 1971. Lead quantities in plants, soil, and air near some major highways in Southern California. Hilgardia 41(1): 1-31.

Sterrett, S. B., R. L. Chaney, G. H. Gifford, and H. W. Mielke. 1996. Influence of fertilizer and sewage sludge compost on yield and heavy metal accumulation by lettuce grown in urban soils. Environmental Geochemistry and Health 18:135-142.

Turpeinen, R., J. Salminen, and T. Kairesalo. 2000. Mobility and bioavailability of lead in contaminated boreal forest soil. Environmental Science and Technology 34:5152-5156.

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