Oregon State University Extension Service

How to Detect and Control Heavy Metals on Your Farm or in Your Garden

Farmers and gardeners who suspect their soil may contain heavy metals have several options for improving their soil or using cultivation techniques that lessen the risk to human consumers. This article will explain how to test your soils and what to do if the results show contamination.

The most common way humans are exposed to heavy metals is through ingestion, and the most common path for that ingestion is through the consumption of plants.

What is a heavy metal?

A heavy metal is a chemical element with a specific gravity at least five times that of water, whose specific gravity is 1 at 39°F. Specific gravity measures the density of a given amount of a solid substance when compared to an equal amount of water. Heavy metals that fall into this category include arsenic, cadmium, iron, lead, chromium, copper, zinc, nickel and mercury.

Not all heavy metals are toxic to humans. In small quantities, metals such as iron, copper, manganese and zinc are essential for good health. Heavy metals such as lead, which is used in car batteries, are also good industrial ingredients.

However, these heavy metals become toxic when they are not metabolized and end up in the body's soft tissues.

Heavy metals and plants

In plants, uptake of heavy metals depends on the plant species and bioavailability of the metal in the soil. Since most of the ingestion of heavy metals in humans occurs from the consumption of plants, addressing how plants acquire heavy metals can aid in controlling heavy metal toxicity.

The ingestion of heavy metals is not enough to cause toxicity. In laboratory animals, absorption of toxic metals may occur as a result of chronic deficiencies of calcium and magnesium in the body. In other cases, excess levels of aluminum mobilizes calcium and heavy metals to move from bones to the central neural tissue.

Lead and arsenic levels are higher than federally set levels in most soils studied, including those near former smelters and tailings from metal ore mines and those close to fuel-fired electrical plants. Heavy metals exist naturally in soil in complex forms with other minerals (see Table 1showing the average abundance of total heavy metals in the earth's crust and in typical soils).

Table 1. Average abundance (mg/kg = ppm) of total heavy metals in the earth's crust and in typical soils (Source; Plant and Raiswell. 1993).

Element	Earth's crust	Soil range
Arsenic	1.5-1.8	0.1-40.0
Cadmium	0.11-0.20	0.01-2.00
Chromium	100	5-1000
Lead	12.5-14.0	2-300
Nickel	75	5-500

Sources of heavy metals

Arsenic is a common cause of acute heavy metal poisoning in adults — although the source is not from soils but from the process of smelting copper, zinc, and lead in from the manufacture of chemicals and glass.

Lead, the leading cause of heavy metals poisoning, primarily comes from soils. Excess levels of lead in soils greater than 400 ppm result from prior use of lead paint around houses, lead-arsenate sprays for pest control during 1910–1950s, use of leaded gasoline (up to 1996 in Oregon), locations close to former smelters and tailings from metal ore mines, and proximity to fossil fuel-fired electrical plants.

A 2001 study of lead-contaminated soils in Multnomah County around homes built before 1930 found that in bare-soil play areas, lead concentrations were often above the EPA limit of 400 ppm. Lead accumulates in the top 1–2 inches of fine-clay soil unless disturbed by excavation and tillage.

Testing your soil

If you think you might have lead contamination in your farm or home, the best procedure is to collect soil samples and have them analyzed for lead content. OSU publications *Analytical Laboratories Serving Oregon* (https://catalog.extension.oregonstate.edu/em8677) (EM 8677) and *A Guide to Collecting Soil Samples for Farms and Gardens* (https://catalog.extension.oregonstate.edu/ec628) (EC 628) list laboratories that can do heavy metal soil testing. They also explain

how to sample soil for home gardens and small acreages. If you are testing for farming purposes, always take soil samples to tillable depth.

Once you receive your soil test back, use Table 2 to interpret what you need to do for your soil.

Soils with less than 50 ppm lead are considered free of lead contamination while those showing greater than 1,200 ppm lead are not recommend for any gardening practices. Instead, they should be mulched heavily and planted with perennial plants that are not harvested for food. Another option for soils high in lead is to use container or raised-bed gardening with clean soils and installing a barrier (such as a geotextile fiber) between good soils and the contaminated soil below.

Table 2. Recommended farming practices based on results of soil test for lead. Source OSU publication EC 1616-E

Soil lead test (ppm)	Recommendations
Less than 50	Little or no lead contamination in soil. No special precautions needed.
50 to 400	Some lead present from human activities. Grow any vegetable crops. Choose gardening practices that limit dust or soil consumption by children.
400 to 1,200	Do not grow leafy vegetables or root crops. These crops carry the highest risk of lead contamination. Choose gardening practices that limit dust or soil consumption by children.
Greater than 1,200	Not recommended for vegetable gardening. Mulch and plant perennial shrubs, groundcover or grass. Use clean soil in raised beds or containers for vegetable gardening.

Plants do not absorb or accumulate substantial amounts of lead. Lead does not readily accumulate in the fruiting part of vegetables and fruit crops (such as corn, beans, squash, tomatoes, strawberries and apples). Since lead is tightly bound to clay particles, higher concentrations of lead will therefore be on surfaces of leafy vegetables from lead-laden dust, and on surfaces of root crops such as carrots and potatoes if soils are contaminated.

Taking preventive steps

Lead contamination is more likely to come from external lead on unwashed produce than from actual uptake by plants. Consumers should always wash their produce before eating or cooking, and growers should always wash their leafy vegetables before marketing them, since lead-laden dust can blow in from distant places. Soil contaminated with lead looks and smells like normal soil. Lead has a half-life of 53,000 years and does not biodegrade.

If your soil tests for lead higher than 50 ppm, you might need to use some soil amendments to reduce lead toxicity. These include:

- Maintaining a neutral soil pH above 6.5. Lead uptake by plants is reduced when pH is above 6.5.

- Add phosphorus when soil tests indicate a need. Phosphorus reacts with lead to form insoluble compounds, therefore reducing toxicity.
- Add organic matter, which in turn binds lead and makes it less soluble in soil water. When adding organic material, soil pH soil should be maintained above 6.5 to reduce uptake by plants.
- What about lead in water? If you still have leaded water pipes, you should test your water for lead content. It is recommended to replace these pipes or keep water off edible plants.

What about lead in fertilizers? Most fertilizer and soil amendment products do not significantly increase health risks. Fertilizer manufacturers are required to test products for lead and tell Oregon Department of Agriculture or Washington Department of Agriculture. Check online for Oregon (http://oregon.gov/ODA/PEST/fertilizer.shtml) and online for Washington (http://agr.wa.gov/PestFert/Fertilizers/Metals.htm). Compost makers and distributors are not considered fertilizers and therefore are not required to provide lead analysis data to regulatory agencies. However, many composters determine lead levels in their products and will supply the analytical information to consumers upon request.

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