University of Minnesota Extension
www.extension.umn.edu
612-624-1222

Garden

Lead in the home garden and urban soil environment

Carl J. Rosen

Sources of lead in the environment

At high concentrations, lead is a potentially toxic element to humans and most other forms of life. For this reason, there is a need to be concerned about elevated lead levels in the environment, particularly in metropolitan areas. Background concentrations of lead that occur naturally in surface agricultural soils in the United States average 10 parts per million (ppm) with a range of 7 to 20 ppm[1]. Soils with lead levels above this range are primarily the result of lead contamination.

There are two major sources of lead contamination: 1) lead-based paint where contamination may occur when paint chips from old buildings mix with the soil; and, 2) lead from auto emissions. Studies conducted in urban areas, have shown that soil lead levels are highest around building foundations and within a few feet of busy streets[2,3]. Although lead in paint and gasoline is not presently used to any great extent, once lead has been deposited, it moves very little through the soil and can persist for a long time. Therefore, lead contamination of soils from these sources continues to be a concern.

In addition to lead contaminated soils, elevated lead in water, air, food, and some folk medicines can also affect human health. Exposure to lead can come from one or more of the pathways depicted in Figure 1. The focus of this fact sheet is to outline the risks to human health from lead contaminated soils and how to minimize these risks.

Lead in garden soils and plants

The most serious source of exposure to soil lead is through direct ingestion (eating) of contaminated soil or dust. In general, plants do not absorb or accumulate lead. However, in soils testing high in lead, it is possible for some lead to be taken up. Studies have shown that lead does not readily accumulate in the fruiting parts of vegetable and fruit crops (e.g., corn, beans, squash, tomatoes, strawberries, apples). Higher concentrations are more likely to be found in leafy vegetables (e.g., lettuce) and on the surface

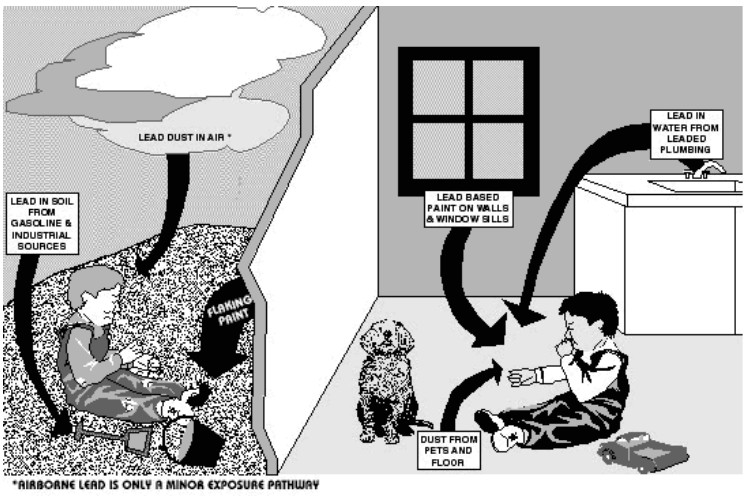

Figure 1. Pathways of lead exposure in the home environment.

of root crops (e.g., carrots).

Since plants do not take up large quantities of soil lead, the lead levels in soil considered safe for plants will be much higher than soil lead levels where eating of soil is a concern (pica). Generally, it has been considered safe to use garden produce grown in soils with total lead levels less than 300 ppm. The risk of lead poisoning through the food chain increases as the soil lead level rises above this concentration. Even at soil levels above 300 ppm, most of the risk is from lead contaminated soil or dust deposits on the plants rather than from uptake of lead by the plant.

Removing lead on roots, leaves, or fruits

There is more concern about lead contamination from external lead on unwashed produce than from actual uptake by the plant itself. If your garden is close to busy streets or highways, remove outer leaves of leafy crops, peel all root crops, and thoroughly wash the remaining produce in water containing vinegar(1 percent) or soap (0.5 percent).

Precautions for garden soils

To minimize absorption of lead by plants a number of control measures may be taken:

1. Maintain soil pH levels above 6.5. Lead is relatively unavailable to plants when the soil pH is above this level. If needed, add lime according to soil test recommendation. Lead is also less available when soil phosphorus tests are high. For information about obtaining a routine soil test, contact your local Extension office.
2. Add organic matter to your soil. In soils with high lead levels, adding one-third by volume organic matter will significantly reduce lead availability. Organic compounds bind lead and make it less available to the plant. When adding organic matter, the pH should also be maintained above 6.5. Good sources of organic matter include composted leaves, neutral (non-acid) peat, and well-rotted manure. Avoid leaf mulch obtained along highways or city streets as it may contain higher than normal lead levels.
3. Locate your garden as far away from busy streets or highways and older buildings as possible.
4. Because of the possibility of bare soil exposure to children through hand to mouth activity, soils with lead levels exceeding 100 ppm should not be used for gardening. If soil exposure to children is not a concern, then plants can be safely eaten from soils with soil lead levels up to 300 ppm.

Residential bare soil standards

The Minnesota State Legislature has established a bare soil standard of 100 ppm[4]. This level of 100 ppm is currently lower than the levels used by the United States Environmental Protection Agency and most other States. A level of 300 ppm is commonly used, which is based on measured risks of eating soil by young children. Eating soil by young children is of particular concern since intestinal absorption of lead is approximately five times greater in children than adults. It is assumed that about half of the lead in the soil eaten by children is absorbed. The amount absorbed from soils (bioavailability) is dependent on many variables including the health, diet, and age of the child.[5] Whatever soil lead limit is used depends on the frequency and duration of exposure before an assessment can be made.

The dietary exposure that results in blood levels of concern has been estimated to be 60 micrograms of lead per day for children 6 years or younger[5]. Given a soil lead level of 100 ppm (100 micrograms per gram), eating approximately two teaspoons of this soil per week would be required to give the same amount of lead found in a diet that can cause elevated blood levels of concern. This calculation is based on the assumption that half of the lead in the soil eaten by children is absorbed. For a soil that has a lead level of 300 ppm, eating about three quarters of a teaspoon per week could cause elevated blood lead levels of concern.

According to Minnesota State Rules, residential soil containing more than 100 ppm lead does not have to be removed unless the presence of paint chips is visible. Covering bare soil with sod or other materials is adequate. If your soil tests high in lead (greater than 100 ppm), it is recommended that children in the area under the age of six have a blood lead test. Contact your local health department or private physician for information about blood lead testing.

Soil tests for lead

If you suspect high levels of lead in your soil, it may be desirable to have the soil tested. The soil should be sampled by taking 6 to 12 subsamples from the area of concern. For play areas, sample to the depth to which the child has been exposed, usually one half to one inch depth. For garden soils the sampling depth should be from the surface 3 to 4 inches. Lead does not move to any great extent in soils and, unless mixing occurs, it generally stays concentrated near the soil surface. Mix the subsamples thoroughly in a plastic pail, remove about a one cup volume, and submit to a laboratory in a clean container. Lead determination in soils is expensive and not recommended on a routine basis. Several laboratories in Minnesota have the facilities to analyze soils for lead content, including the University of Minnesota Soil Testing Laboratory[6]. Contact your local Extension office or look in the phone directory under “Laboratories” to obtain information about testing laboratories offering this service to your area.

Remediation of lead-contaminated soils

Currently, the best ways of dealing with high lead soils are to 1) immobilize the lead by raising soil pH and adding organic matter followed by planting of sod, 2) mixing or covering the high lead soil with clean (low lead) soil, or 3) eliminate the lead by physically removing the soil. Information and guidelines on removal of high lead soils can be obtained from the Minnesota Pollution Control Agency.

One proposed method of removing lead from lead-contaminated soils is to grow lead accumulating plants on these soils and then harvest and remove the plants. This process, termed bioremediation, has shown promise for cleaning up soils that have been contaminated with cadmium, zinc, and copper, but at the present time is of limited value for lead. While plants differ in their ability to accumulate lead, even the lead accumulating leafy vegetables do not accumulate enough lead to make bioremediation of this metal practical. Research is currently under way to determine if some plant species can accumulate greater quantities of lead. For now, immobilization of the lead in the soil, covering/mixing high lead soils, or physical removal of lead contaminated soil are the remediation technologies available.

Summary

Lead may reach potentially toxic levels in soils close to busy streets and highways or near old buildings

where lead-based paint has peeled or been stripped off. Plants generally do not absorb or accumulate lead in quantities that would be of concern. The greatest danger of lead toxicity from soil is direct consumption of lead-contaminated soil or dust. By following the guidelines in this fact sheet, you can help reduce the risks of lead poisoning from lead contaminated soils.

For more information on the abatement of lead, call your local health department or the Lead Program of Minnesota at the Minnesota Department of Health, P.O. Box 59040, Minneapolis, MN 55459-0040.

[1] Holmgren, G.G., M.W. Meyer, R.L. Chaney, and R.B. Daniels. 1993. *Cadmium, lead, copper, and nickel in agricultural soils of the United States of America.* Journal of Environmental Quality 22:335-348.

[2] Rolfe, G.L., A. Haney, and K.A. Reinbold. 1977. Environmental contamination by lead and other heavy metals. Vol.2. Ecosystem Analysis. Institute for Environmental Studies. University of Illinois, Urbana-Champaign. 112pp.

[3]Singer, M.J. and L. Hanson. 1969. Lead accumulation in soils near highways in the Twin Cities metropolitan area. Soil Science Society of America Proceedings 33:152-153.

[4]Minnesota Department of Health. 1993. Minnesota Rules Chapter 4761.0300. Residential Lead Abatement. Standards.

[5]Carrington, C.D. and P.M. Bolger. 1992. An assessment of the hazards of lead in food. Regulatory Toxicology and Pharmacology 16:265-272.

[6]Contact the University of Minnesota at 612-625-3101 for more information on lead testing.

UNIVERSITY OF MINNESOTA
EXTENSION