Best Practices for Healthy Urban Gardens #12

The Healing City Soils program is a partnership between the Compost Education Centre and Royal Roads University. The program offers home gardeners free soil testing for heavy metals as well as information and workshops to better understand, manage, and build healthy soil for healthy gardens.

web: www.compost.bc.ca/healing-city-soils

email: healingcitysoilsvictoria@gmail.com

Whether you are already growing food or are planning to start a garden, ensuring the soil is healthy is important. Urban soils can sometimes contain heavy metals and other contaminants that can get into or onto our veggies and fruits and have health risks. We recommend that all gardeners follow healthy gardening practices to help reduce exposure to heavy metals and other contaminants. Generally, maintaining a neutral soil pH, adding organic matter and compost to your soil, mulching your garden soil and thoroughly washing your garden produce can reduce your exposure to many soil contaminants so you can enjoy the many health benefits of eating fresh garden-grown fruits and vegetables.

Considerations for what course of action to take:

***What contaminants are in your soil and at what levels*:**

Please see Factsheet #11: Soil Contamination for information on how to assess the contamination level of your garden soil. It is recommended to get your soil tested for heavy metals. While there are some gardening practices that generally reduce your risk of exposure to most toxins, each heavy metal behaves differently in soil, and has different capacity to get into or onto your food, so knowing what's present in your soil can help you make informed choices and take action to minimize potential exposure to contaminants. Through the Healing City Soils Program, you can learn about your site history and look at THIS MAP to get a sense of soil contamination levels in your neighborhood.

Where the contamination may be coming from and how it can get into or onto your food crops:

Exposure to contamination as a home gardener is usually not through the uptake and accumulation of contaminants in the vegetables that you are growing, rather it is through the soil and dust that you come into contact with while gardening. Therefore, it is always a good idea to wash vegetables before eating them. This is especially true for root and tuber crops because they are in direct contact with soil; herbs and leafy vegetables (lettuce, spinach, collard greens) are also easily potentially contaminated by soil splash and dust.

Contaminants, particularly lead, cadmium, zinc and PAH's (see table on page 4) can also be introduced onto your plants and into your soil from the atmosphere (air) through rain, wind blowing dust from the street, and vehicle emissions– this can be more significant for leafy crops growing on the boulevards of busy streets and less so for residential backyards. Washing leafy crops can remove up to 80% of lead contamination, and much of the lead can be removed from vegetables such as carrots and potatoes by peeling. However, in situations where lead contamination is moderate to severe, growing these types of crops directly in the contaminated soil is probably not the best choice.

Urban garden crops can uptake contaminants through their root systems in some cases, though this is a less significant exposure pathway due to the existence of natural barriers that limit heavy metal transfer into plant tissue. In most situations, unless soil is acidic (low pH) or very low in organic matter, very little lead is transferred from contaminated soils ***into*** garden crops through plant roots. Roots are likely to have a higher concentration of lead than leaves and stems, and fruits or seeds are likely to be lowest in lead of all plant parts. However, Cadmium, arsenic and zinc are more readily taken up from contaminated soils into roots and plant tops.

Best Practices for All Gardeners

It is recommended that all gardeners, regardless of their level of soil contamination, follow the safe gardening practices outlined below, even if your soil test results show heavy metals levels below guidance values. This is because we typically test only for certain soil contaminants, and only in a small number of locations in your garden, and contaminants may be continually deposited by air into or onto your garden crops. Here are some safe gardening guidelines:

- ***Wash garden vegetables thoroughly before eating them.*** Washing vegetables with a 1% vinegar solution (1 part vinegar to 100 parts water) or a food-safe soap is best. This is especially important for root crops (like carrots or beets), which grow directly in the soil, and for leafy greens and herbs, which are especially likely to be contaminated by soil and dust. Consider peeling vegetables like carrots and beets and removing the outer leaves of crops like head lettuce and cabbage.
- ***Wash your hands after gardening and always before eating.*** Teach children often to avoid touching their mouths after digging in the soil. Consider wearing gloves while gardening, and remove the gloves when leaving the garden.
- ***Mulch your soil and add organic matter to your garden often:*** Mulch with composted leaves, straw, woodchips, aged manure or compost (or a ground cover like clover) to cover your soil and add organic matter (mulch) to your garden regularly (see Factsheet #7: Mulching for more information). This will reduce dust and splash onto veggies, help maintain a good nutrient balance and has the potential to bind metals including lead, and to some extent zinc and copper, in stable forms limiting their solubility. Avoid leaf mulch obtained along highways or city streets as it may contain higher than normal lead levels.
- ***Don't grow edible produce directly adjacent to buildings or busy streets*:** lead levels are likely highest within 10 feet of buildings because of lead in paint flaking off onto the soil, or within close proximity to a busy road.
- ***Maintain a neutral soil pH (6.5-7.5):*** monitor your soil pH and keep it at neutral by adding organic matter regularly and lime if needed. This is not only optimal for most veggie growth, but many metals, including lead, zinc, and cadmium that are more bioavailable in acid soils, are often immobilized or bound up in neutral and basic soils.

In most cases there is no immediate health concern, but there may be some increased risk if you have a regular exposure to certain contaminants over a certain period of time. It is particularly important to minimize exposure to lead in soil, especially for young children. Select and grow vegetable crops that are less likely to have contaminants on or into their edible parts. If metals are a concern in your garden soil, consider growing only fruits or vegetable fruits, such as tomatoes, or planting fruit and nut trees. Some studies have shown that fruits and vegetable fruits are less likely to have metals on or in their edible parts, whereas herbs (such as thyme) and leafy crops (such as lettuce) had the highest levels, followed by root crops (such as carrots).

Suitable crops to grow if you have low to moderate levels of soil contamination:

Most Suitable:

- **Vegetable Fruits and Seeds**: tomatoes, eggplant, peppers, okra (seed pods only), squash (summer and winter), corn, cucumber, melons, peas and beans (shelled or cleaned very thoroughly), onions (bulb only)
- **Tree Fruits**: apples, pears
- **Berries:** blueberries, strawberries, raspberries, blackberries (if cleaned very thoroughly)

Least Suitable:

- **Green Leafy Vegetables:** lettuce, endive, alfalfa, chicory, spinach, Swiss chard, beet leaves, collards, cabbage, kale, mustard greens
- **Other Vegetables:** broccoli, brussel sprouts, dandelion, kohlrabi, cauliflower
- **Root Crops:** carrots, potatoes, turnips, beets, radish
- **Grains:** amaranth, rice, sorghum (*can be grown in raised bed or container gardens)

Growing in raised beds or container gardens:

- Fill raised beds with clean soil and compost at least 40cm/16 inches deep
- Add additional clean soil and compost annually
- A layer of landscape fabric will prevent plant roots from entering the contaminated soil below the bed
- Avoid use of railroad ties, telephone poles, pressure-treated wood and previously painted wood to build your beds because they contain chemicals that could migrate into soil
- Keep in mind that raised beds won't eliminate airborne contaminants or soil dust and splashback.

Common Soil Contaminants: Sources, Health Effects, Tendencies in Soil

Contaminant	Potential Sources	Tendencies in Soil	Health Impacts	What You Can Do
Lead (Pb) Heavy metal	Lead paint (homes built before 1978); leaded gasoline (phased out in 1990's); battery disposal; plumbing; textiles and dyes; roofing; chemical pesticides and insecticides in orchards, vineyards and gardens (until 1960's); industry: mining, manufacturing.	Adsorbs strongly on organic matter and clays, and tends to bind in plant roots so is not very soluble nor easily transferred ***into*** food crops, unless the soil is acidic, low in organic matter or very high in lead. More likely to be ***on*** the outside of food crops-ie- leafy greens, outside of root vegetables.	Especially of concern for young children– can harm a young child's growth, behavior, and ability to learn. Lead can affect almost every organ and system in your body, especially the nervous system. Can damage the brain and kidneys, cause anemia and affect the reproductive system.	Don't plant within 10ft of buildings and alongside busy roads. Maintain a neutral soil pH and add organic matter to your soil. Mulch to control dust. Thoroughly wash veggies and peel root veg. Phosphorous can help bind lead in an insoluble form– add chicken manure or fish bones. Avoid growing leafy and root veg. if you have high
Zinc (Zn) Heavy metal	Found in galvanized steel (used in roofing, pipes, and gutters); wire fences; rubber (tires) and road surface runoff; metal alloys, batteries, and pigments; electroplating waste, mine spoils, emissions from coal burning, smelting and incinerators and in some fertilizers, manure and sewage sludge and composts.	Generally adsorbed on clays and organic matter above pH 6.0 but is relatively easily released to the soluble and plant-available form. It is quite soluble and plant-available if soil pH is low (less than 5.5). Tends to accumulate in the surface layer of soil (binding to organic matter).	Small amounts of zinc in the diet are essential for good health. Too much zinc can alter the copper content of red blood cells and reduce the level of an important enzyme in red blood cells. Zinc is an essential micronutrient for plants, but it can be toxic to plants at levels above 50 ppm and may cause toxicity and stunted growth in some crops.	Maintain near-neutral pH in your garden soil so that zinc is not soluble enough to be toxic to plants, with organic matter/compost additions. Phytoremediation is possible because of the relatively high extent to which zinc can be taken up by crops. See factsheet #13 "Backyard Bioremediation."
Arsenic (As) Heavy metal	Historically used in pressure-treated lumber (the older "CCA" type) so often found near decks, playgrounds, swingsets, railings and other structures built with treated wood. Found in some pesticides, and in coal ash.	Usually exists as the arsenate form, which behaves chemically like phosphate and is therefore fairly easily taken up by plants. It adsorbs poorly on organic matter but well on clays and iron oxides. It is more available to plants in non-acid (pH greater than 6.0) than acid (pH less than 6.0) soils.	Arsenic is a known human carcinogen and can cause skin cancer and cancer in the liver, bladder, and lungs. Arsenic in soil at levels slightly or moderately above the guidance value poses no immediate risk, but there may be some increased risk if you are routinely exposed over a long time. There is some evidence that long-term exposure to arsenic in children may result in lower IQ scores.	Unlike most metals, arsenic is not immobilized by organic matter additions or liming, and these measures may actually increase arsenic availability to crops. Soluble iron (ferrous) salts or iron oxide additions have helped to reduce arsenic availability in experimental situations. Phytoremediation has been demonstrated using certain fern species, which act as "hyperaccumulator" crops that take up large amounts of arsenic.
Cadmium (Cd) Heavy metal	Found in galvanized steel, and metal pipes; electroplating waste; batteries; pigments; plastics; coal burning and incinerator emissions; phosphate fertilizers and gasoline.	Generally adsorbed more strongly on clays and organic matter as soil pH increases, but it is relatively easily released to the soluble and plant-available form compared to other metals. Uptake into food crops, especially leafy greens, may be a concern if soil has high levels of salts or if soil is acidic.	Cadmium is a known human carcinogen. Cadmium in soil at levels slightly or moderately above the guidance value poses no immediate risk, but there may be some increased risk if you are exposed a lot over a long time- for headaches, immune disorders, kidney and liver damage.	Maintain a neutral soil pH. Avoid growing leafy vegetables, such as lettuce and spinach, and potatoes and grains if you have high cadmium levels in your garden soil, or grow in raised beds filled with clean soil and compost. Phytoremediation is possible, see factsheet #13, "Backyard Bioremediation."

Common Soil Contaminants: Sources, Health Effects, Tendencies in Soil, continued

Contaminant	Potential Sources	Tendencies in Soil	Health Impacts	What You Can Do
Copper (Cu) Heavy metal	Historically used in pressure-treated lumber (the older "CCA" type) and is found in some newer treated lumber products; plumbing; electrical fixtures and wires; fungicides, pesticides and fertilizers in orchards, vineyards and gardens; dairy manure and sewage sludge composts.	Adsorbs very strongly on organic matter when soil pH is greater than 5.5, but also on clay minerals at near-neutral pH (6.5 – 7.5). The solubility of copper is generally quite low in soil unless pH is unusually low (less than 5.5) or high (greater than 7.5). Found most often in the surface layer of soil.	Small amounts of copper in the diet are essential for good health; too much copper may damage the liver and irritate the gastrointestinal tract. *Copper in soil may be toxic to plants at levels above 50 ppm in soil, and cause stunted growth in some crops; more likely to be a concern if pH is	Regular organic matter additions and liming (for acid soils [pH less than 6.0]) should reduce copper uptake and toxicity to crops. Excessive copper in food crops is unlikely because this metal is strongly retained in fine roots with relatively little transferred to aboveground portions of plants. Phytoremediation is possible, see factsheet #13.
Nickel Heavy metal	Used in the manufacture of steel and other metal alloys; found in electroplating and in some kinds of batteries; and in emissions from incinerators and fossil-fuel combustion.	Adsorbs fairly strongly on organic matter when soil pH is greater than 5.5, but also on clay minerals at near-neutral pH. The solubility of nickel is generally low in soil unless pH is unusually low (less than 5.5) or high (greater than 7.5).	Small amounts of nickel in the diet are essential for good health; too much nickel exposure in animals can cause a wide variety of adverse effects, but the most sensitive effects appear to be decreased body and organ weights.	Nickel is taken up more readily into plants than some other metals (such as copper), but relatively little nickel can be expected in the edible portions of food crops. Phytoremediation is possible. See factsheet #13 "Backyard Bioremediation."
Polycyclic aromatic hydrocarbons (PAH's) Organic contaminant	Associated with the incomplete combustion of fossil fuels, from wood stoves, backyard fires, vehicle exhaust; higher in high traffic areas and near roads, autoshops, machine repair shops, and junk vehicle storage; creosote-treated timbers.	In soils, PAHs are most likely to stick tightly to particles; though certain PAHs move through soil to contaminate underground water.	Potential carcinogen. Some PAHs have caused cancer in lab tests through inhalation, ingestion or skin application.	Microorganisms can break down PAHs in soil or water after a period of weeks to months. Bioremediation is possible, see factsheet #13. Generally healthy soil building practices including adding good quality compost, applying compost tea and organic matter can help break down

Additional Resources:

- "A gardeners guide to healthy gardens," University of Minnesota: http://misadocuments.info/Urban_Soil_Contaminants.pdf
- You can find more information about healthy gardening practices on the Healthy Soils, Healthy Communities web page: http://cwmi.css.cornell.edu/healthysoils.htm

Compost Education Centre

1216 North Park St.
Victoria, BC V8T 1C9
250-386-9676
info@compost.bc.ca
www.compost.bc.ca
Wednesday - Saturday
10am-4pm

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