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Interpreting the Results of Heavy Metal Soil Tests

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INTERPRETING THE RESULTS OF SOIL TESTS FOR HEAVY METALS

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Agricultural soils normally contain low background levels of heavy metals. Contamination from industrial activities or byproducts can increase the natural levels of heavy metals in soil, creating a health hazard to people, livestock and plants. Fertilizers and other soil amendments also add small amounts of heavy metals to the soil, which can build up over time with repeated applications.

The actual toxicity of a heavy metal will be affected by soil texture, organic matter, and pH. The health effects of exposure to heavy metals depend on the amount and duration of exposure, i.e. the volume of contaminated soil or food consumed over time.

It is not clear exactly what levels of heavy metals in soil are safe or unsafe, so the following information is provided only to help you understand your test results and the relative level of risk they represent. In soils with elevated heavy metal levels, which may pose higher levels of risk, you should consider whether remedial actions are appropriate, or whether crops should be grown at all.

UVM Heavy Metals Soil Test

The test provided by UVM is only a screen for heavy metals and does not measure the actual total metal content of the soil. This low-cost test uses a weak acid to extract heavy metals. The amount of metal extracted is roughly proportional to the total amount present. Maximum levels for heavy metals in soils established by regulatory agencies are based on total heavy metal content (see below) and require a more involved and expensive test. If your UVM test results indicate an elevated level of heavy metal(s), well above the median levels in Table 1 you should consider submitting another sample for a total heavy metal analysis.

Table 1 shows the aggregated results of thousands of UVM heavy metal soil tests from across many soil types and management practices on farms and gardens in Vermont. The table includes the median result for each element, which is the point where half the test results were above and half the test results were below. The 95% and 99% result levels are the points where only 5% and 1% of all test results, respectively, were higher. The maximum level is the highest test result recorded for that element from the number of tests shown in the bottom row. Test results above the 95% level may be cause for concern, and thus some remedial action (see below). An extremely high level may be cause for extreme action, such as abandonment of production, but such results are rare, as indicated by the fact that the maximum levels found for each element are many times higher than the 99% level for each element. (All results are mg/kg of soil, which is the same as ppm.)

Table 1. Combined results of field, horticulture and homeowner soil tests for heavy metals. University of Vermont Agricultural and Environmental Testing Lab, 2007-2011. Results are for extracted heavy metals using pH 4.8 ammonium acetate. (Arsenic is not listed because it is not effectively extracted.)						
mg/kg of soil	Copper	Cadmium	Chromium	Nickel	Lead	Zinc
Median	0.20	0.05	0.05	0.15	0.35	1.05
95%*	0.75	0.10	0.15	0.50	2.20	6.90
99%**	1.75	0.20	0.20	1.20	18.30	24.30
Maximum	60.50	2.25	1.05	11.65	2129.00	370.50
Number of tests	17,209	11,958	11,638	12,252	17,183	17,302
* 5% of all test results were higher than this level. **1% of all test results were higher than this level.						

<u>Interpreting TOTAL Heavy Metals Soil Test Results</u>

The US Environmental Protection Agency (EPA) and NY Department of Environmental Conservation (NYS DEC) have guidelines for determining the safety of various land uses based on total soil metal concentrations. Table 2 shows these limits, which are used to guide clean-up efforts. EPA levels are used to guide clean-up efforts of contaminated sites; NYS DEC levels are based on removing human health risks; unrestricted use includes agriculture.

Table 2. Levels of heavy metals in soil used to guide cleanup and land use decisions (mg/kg)			
	US EPA	NYS DEC	
	Soil level requiring clean-up	Unrestricted use*	Residential use
Copper (Cu)	--	50	270
Cadmium (Cd)	70	2.5	2.5
Chromium (Cr)	230	30	36
Nickel (Ni)	1600	30	140
Lead (Pb)	400	63	400
Zinc (Zn)	23,600	109	2200
*Includes agricultural use.			

Lead is a Special Concern

There has been a lot of attention paid to lead levels in soil because it is well-known to cause adverse health effects, and is relatively widespread as a result of its historical use in many commercial products, from gasoline to paint. Table 3 shows the guidelines for garden soil use based on total lead content that have been developed by the states of New Jersey and Pennsylvania.

Table 3. Soil lead contamination levels and recommended actions.

Contamination level	Total Lead in soil mg/kg		Recommended Action
	PA	NJ	
none / very low	< 150	< 100	No need to be concerned about lead exposure.
low / elevated	150 - 400	100 - 300	Conduct best management practices (BMPs) to minimize lead exposure from vegetable gardens: apply phosphate fertilizer, maintain high pH for fruiting vegetables, keep soil mulched to minimize dust and lead inhalation.
medium / significant	400 - 1000	300 - 400	Conduct BMPs; do not grow leafy vegetables.
high / cleanup	> 1000	> 400	Do not grow a vegetable garden. Contact local health department for lead abatement measures.

Best Management Practices for Soils with Elevated Levels of Heavy Metals

Although heavy metals remain in soil for a very long time, there are some steps that can be taken to reduce the level of risk they pose. In some cases, heavy metal concentrations can be ‘diluted’ with deep tillage; for example, to distribute contaminated surface sediment that was deposited by flooding. In garden plots, dilution can be achieved by the addition of uncontaminated soil. Adding organic matter to the soil can help ‘tie up’ heavy metals chemically, reducing their availability for potential plant uptake. Similarly, liming to a neutral pH and maintaining optimal soil phosphorus levels can reduce heavy metal availability to plants. For some heavy metals, such as lead, there is little evidence that it is accumulated within crops; the main health hazard is through soil ingestion and inhalation. Soils high in heavy metals pose a greater health risk to children than to adults because children are still growing, and they are more likely to ingest soil directly.

To reduce health risks in soils with elevated heavy metal content, food crops should be thoroughly washed to remove as much soil as possible. Outer leaves of leafy greens should be removed and root crops should be peeled to further reduce risk.

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The information in this document reflects our best effort to interpret regulatory guidelines and scientific research, and to translate this into practical management options. However, growers are fully responsible for their own management decisions, for the quality of the food they sell, and for compliance with all applicable laws and regulations.

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