Detecting Lead Hotspots in Urban Gardens Requires Different Sampling Strategies

Analyzing soil lead in an urban garden plot is important and sampling approaches may involve tradeoffs between finding ‘hotspots’ versus looking at the average amount of lead when checking for safe levels.

Washington, D.C. – The local food movement is gaining traction in cities across America, with urban gardens contributing a healthy source of fresh produce for local citizens as well as providing a social outlet for gardeners and creating open spaces for residents to enjoy. Urban gardening is not without risks, however. Many garden plots within cities were previously inhabited by residences or industrial buildings that disposed of toxic chemicals on site, creating potential health hazards from the use of lead in paint, gasoline and industrial activities.

To properly assess the risk of soil contamination in urban gardens, researchers from Wayne State University (WSU) in Detroit, Michigan, analyzed the lead content in soil across a local urban garden plot and evaluated the results of several sampling strategies, some of which failed to detect a lead “hotspot” in one corner of the plot. The research team of Lauren Bugdalski, WSU student, Lawrence Lemke, Ph.D., associate professor of geology and student mentor, and Shawn McElmurry, Ph.D., assistant professor of civil and environmental engineering, summarized their findings in the article “Spatial Variation of Soil Lead in an Urban Community Garden: Implications for Risk-Based Sampling” in the journal Risk Analysis, published by the Society for Risk Analysis. The research emerged from Bugdalski’s undergraduate work and was supported by a grant from WSU to expand undergraduate research opportunities.

Ingesting or inhaling even small amounts of lead can cause neurological disorders in children and adults. Not only is lead more easily absorbed into children’s growing bodies, they can have higher exposures because they are more likely to accidentally ingest contaminated soil when playing outside. The current permissible contaminant level for lead in soil, set by the Environmental Protection Agency, is 400 parts per million (ppm) for residential soils where children are likely to play.

Current EPA guidance for sampling residential plots for lead recommends analyzing as few as two composite samples to ensure that the plot is safe for activities such as gardening or children’s play. Given the varied nature of soils and the potential for multiple sources of lead contamination, the Wayne State researchers concluded that two samples might not be sufficient to detect contaminated hotspots. They designed a study to analyze several sampling approaches to determine how best to increase the possibility of detecting contaminated hotspots while also minimizing sampling costs.
Lemke said that soil sampling is important because "the highest risk of exposure generally comes from dust and soil sticking to unwashed vegetables, not from direct uptake into the vegetable plants themselves. The easiest way to reduce this risk is to thoroughly wash fresh vegetables, especially leafy plants, before eating them."

The researchers sampled 80 sites across a 49 x 98 foot garden plot. The soil lead concentration measured at the sites was highly variable across the plot, and 2 percent of the samples exceeded the 400 ppm EPA threshold for lead. A prominent hotspot was detected in the northwest corner of the plot, where gardening or other activities would pose undue risks. Examination of historic city documents indicated that a paint shop had been located on the property, explaining the origin of the contaminated hotspot. The researchers then used statistics to determine an appropriate number of samples that would be needed to detect the contamination hotspot under various scenarios. Based on their models, the collection of 20 samples in the 49 x 98 foot plot would be needed to be 95 percent confident that the hotspot would be detected. If the goal of urban plot sampling is to detect hotspots, increasing the standard number of individual samples collected will increase the chance of detection. This comes at a cost, however, in terms of the price of the sampling analysis and effort involved.

A common practice is to average several soil samples in close proximity to create a “mixture” of the sampled site. However, the researchers cautioned that this practice could lead to failure to detect a hotspot entirely, as nearby low-concentration samples could dilute the average to permissible levels. One alternative they suggest is to analyze individual samples before mixing them to increase the chance of detecting hotspots while also reducing the risk of overestimating the average concentration throughout the plot.

Given the importance of eliminating lead exposure in urban areas where children play and food is grown, the researchers suggest that standard practices for assessing soil lead concentrations should be reassessed. They also recommend that garden organizers interested in an untested plot should “check local libraries or online for ‘Sanborn Fire Insurance Maps’ which show local land uses often going back 100 years to see if there is a possibility that contaminants were used onsite,” according to Lemke. He also urged gardeners to check with their local Cooperative Extension service or university to provide assistance with cost-effective soil sampling.

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