Chapter 11

Recommended Soil Tests for Extractable Lead

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Lead occurs naturally in soils but may be significantly elevated in areas impacted by human activities. High soil lead levels in New England are primarily associated with the past use of lead-based paints, leaded gasoline and lead-arsenate insecticides. Occasionally, they may be due to scrap metal disposal or previous industrial use. These lead-containing products have been taken off the market decades ago but lead is a persistent pollutant and will remain in the soil almost indefinitely.

In certain situations soils contaminated with lead can present a human health risk. Lead poisoning can affect all age groups but children are particularly at risk because they most commonly engage in hand-to-mouth activities through which lead can be ingested. Soils used for edible plant production are a concern with regards to the level of lead in the soil as well as the potential for lead to be taken up by plants. Inhaling dust while playing or gardening in contaminated soil is also an ingestion pathway.

Because of the potentially severe mental and physical effects of lead poisoning, soil testing laboratories routinely receive requests for lead testing. Total soil lead tests involve the use of hazardous chemicals and the purchase of equipment not typically used for routine soil fertility testing. Small laboratories often lack the personnel and time, as well, to devote to this task.

Presently all soil testing laboratories in the Northeast region analyze their sample extracts either by inductively coupled (argon) plasmaoptical emission spectrometer (ICP-OES) or by directly coupled (argon) plasmaoptical emission spectrometers (DCP-OES). These instruments allow for simultaneously measurements of multiple elements including lead.

In-house relationships have been developed at several of the soil testing laboratories that permit a prediction of total soil lead from the lead values obtained by using routine soil nutrient extraction solutions. Development of these relationships is based on the regression analysis of extractable lead on total soil lead determined by EPA 3050/3051 or by X-ray fluorescence. The y-intercept value on some regression equations may preclude the detection of low soil lead levels. Because the purpose of the lead scan is to flag samples with potentially elevated levels of lead, accurate estimates for low soil lead values are not required.

Although the general relationships found between extractable lead and total soil lead often have wide margins of error (Hamel et. al., 2003; Sims et.al., 1991), extractable lead readings are a useful indicator of the estimated total soil lead level and can reasonably predict if further, direct measurement of total soil lead content is necessary. Scanning for lead, while analyzing the soil for plant nutrients, is a quick, easy and inexpensive way to inform clients of a potential soil hazard.

Four laboratories in the northeast presently measure extractable lead for clients using routine soil nutrient extraction solutions. The University of Massachusetts Soil and Plant Analysis Laboratory uses Morgan extracting solution, the Rutgers Soil Testing Laboratory uses Mehlich 3, and both the University of Maine Soil Testing Laboratory and the University of Connecticut Soil Nutrient Analysis Laboratory use Modified Morgan. At Rutgers, the lead scan is a separate extraction with an additional fee.

The others offer an estimation of total soil lead as part of their standard nutrient analysis package. The Cornell Soil Nutrient Analysis Laboratory and the Pennsylvania State Agricultural Analytical Services Laboratory measure total soil lead using ASTM D5435-93 or EPA 3050/51 + 6010 methods. The University of Delaware Soil Testing Laboratory uses a nitric acid method cited in Cheney et. al.,1981. Each of these labs provide lead analysis for an additional fee. (The West Virginia University Soil Testing Laboratory does not offer lead testing.) (needed ?)

Interpretation of lead scan results can vary by laboratory but there is a general consensus that estimated total soil lead levels above 400 to 500 parts per million (ppm) are of significant concern. The U. S. Environmental Protection Agency established new standards for lead in soils in 2001. Soils that contain 400 ppm total lead are considered a cause for concern in children's play areas, and those containing 1200 ppm total lead are considered a concern for all users.

Table 11-1. Interpretation of level of concern by state.

	Level of Concern (Total Estimated Lead, ppm)			
State	**Low**	**Moderate**	**High**	**Very High**
CT	100 or less	101 - 300	301 – 400	> 400
MA	500 or less	500 – 1000	1000 – 3000	> 3000
ME	< 300	300 – 500	> 500	
NJ	100 or less	101 - 300	301 – 400	> 400

A dilemma ensues when laboratories make recommendations to growers of edible crops, i.e. vegetable gardeners. Plants take up lead to varying degrees, dependent on species, plant physiological factors and soil properties. Recommendations for the soil lead levels where food plants should not be grown range from 300-400 mg/kg (Hamel, 2004; Finster et al, 2004) to 1000-2000 mg/kg (Logan, 1993; Stehouwer, 1999). Typically lead uptake by plants follows the order: roots>leaves>fruits. In some cases, fruiting vegetables like tomatoes may be safely ingested even when grown in soils with significant contamination whereas leafy vegetables and root crops may pose a health risk even in moderately contaminated soils. Lead uptake can be significantly reduced in many cases by increasing soil pH, phosphorus, and organic matter content (Pendias & Pendias, 1992). Surface contamination of edible crops can be reduced by mulching plants to reduce rain/irrigation spatter and by thorough washing.

Lead interpretation sheets, developed by each individual laboratory, accompany soil test results exhibiting elevated soil lead levels in an effort to educate clients on potential hazards and management options.

Summary of Methods

Soil samples are extracted using Mehlich 3, Morgan or Modified Morgan according to Chapter 5 in this manual (Recommended Soil Tests for Macronutrients: Phosphorus, Potassium, Calcium and Magnesium). Lead content of samples is measured by ICP or DCP and converted through in-house regression equations to total estimated soil lead.

Reagents:

1. Make reagents as directed for macronutrients. Follow normal reagent makeup and extraction procedure used for routine nutrient analysis (See ***Chapter 5 – Recommended Soil Tests for Macro and Micronutrients and Cation Exchange Capacity by Summation***).

2. ICP Standards: Suggested ranges for working standards are: 0 – 100 mg/L Pb

Analysis and Quality Control:

1. To check for linearity, measure a control standard containing twice the lead as the highest standard.

2. Include an in-house reference soil sample with known lead values with each set of soils analyzed.

3. At the start of each run following calibration measure a secondary source or Least Control Standard (LCS). If the LCS deviates more than 5 percent from known values, diagnose the problem, recalibrate and rerun samples.

Reporting:

1. If estimated total lead content from a regression equation is reported, it should be explicitly labeled as an estimate.

2. If extractable lead is used only as a screening tool to flag samples for further direct measurement, general interpretation categories can be used on the initial report.

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