SOIL ANALYSIS REPORT FOR HOME GARDENS 05/13/13

SOIL AND PLANT TISSUE TESTING LAB
WEST EXPERIMENT STATION
UNIVERSITY OF MASSACHUSETTS
AMHERST, MA 01003

LAB NUMBER: S130507-533
BAG NUMBER: 0

SOIL WEIGHT: 3.08 g/5cc
CROP: VEG

TOWN OF MARBLEHEAD/A. PETTY
7 WIDGER RD
MARBLEHEAD, MA 01945

COMMENTS: PETTYA@MARBLEHEAD.ORG

SAMPLE ID: TSC01

RECOMMENDATIONS FOR HOME GARDENS:

SOIL PH ADJUSTMENT:
Your soil pH is slightly higher than desired for most vegetables. Cole crops may prefer the current pH since they are more resistant clubroot infection under slightly alkaline conditions. Take care, however, not to incorporate any amendment that would further raise soil pH.

FERTILIZER:
Your soil contains very high levels of phosphorus and potassium. If you have very recently fertilized these results may be misleading. If so retest in two months before further soil fertilization. Otherwise supply only nitrogen at 1/4 lb per 100 sq ft. Possible sources are 1/2 lb of a Urea (45-0-0) or 4 lbs of dried blood (an organic fertilizer).

SOIL pH 7.2
BUFFER pH 7.3

ORGANIC MATTER: 22.0 % (Desirable range 4-10%)

NUTRIENT LEVELS:	PPM	Low Medium High Very High
Phosphorus (P)	143	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Potassium (K)	1418	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Calcium (Ca)	5709	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Magnesium (Mg)	894	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

CATION EXCH CAP
39.6 Meq/100g

PERCENT BASE SATURATION
K= 9.2 Mg=18.6 Ca=72.3

MICRONUTRIENT LEVELS
ALL NORMAL

EXTRACTABLE ALUMINUM: 16 ppm (Soil range: 10-250 ppm)

The lead level in this soil is low.

VISIT soiltest.umass.edu FOR FURTHER INFORMATION ON SOIL TESTING AT UMASS.

SOIL ANALYSIS REPORT FOR RESEARCH 05/13/13

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G

ANALYSIS REPORT

SAMPLE ID: TSC01
SOIL TYPE:

SOIL PH 7.2
BUFFER PH 7.3

ALUMINUM (AL): 16 PPM (Soil Range: 10-300)
ORGANIC MATTER: 22.0 %. Desirable range 4-8%.

NUTRIENT LEVELS:		PPM	LOW MEDIUM HIGH VERY HIGH
PHOSPHORUS	(P)	143	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
POTASSIUM	(K)	1418	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
CALCIUM	(CA)	5709	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
MAGNESIUM	(MG)	894	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

CATION EXCH CAP
39.6 MEQ/100G

PERCENT BASE SATURATION
K= 9.2 MG=18.6 CA=72.3

MICRONUTRIENT		PPM	SOIL RANGE	MICRONUTRIENT		PPM	SOIL RANGE
Boron	(B)	5.6	0.1-2.0	Copper	(Cu)	0.8	0.3-8.0
Manganese	(Mn)	21.3	3 - 20	Iron	(Fe)	7.1	1.0- 40
Zinc	(Zn)	12.2	0.1- 70	Sulfur	(S)	103	1.0- 40

EXTRACTED LEAD (PB) 6 PPM.

ESTIMATED TOTAL LEAD IS 96 PPM.

COMMENTS

COMPUTER PROGRAM & RECOMMENDATIONS BY DEPT OF PLANT & SOIL SCI UMASS-AMHERST.

UMass Extension

CENTER FOR AGRICULTURE

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Amherst, MA 01003
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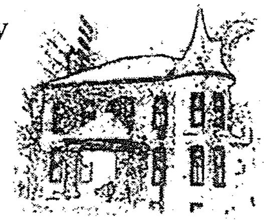

West Experiment Station

Soil Test Interpretation & Recommendations

The primary goal of soil testing is to provide guidelines for the efficient use of soil amendments, such as lime and fertilizers. The recommendations that we provide with your soil test report are specific to the crop selection that you identify on your soil sample submission form.

Numerical results reported on your soil test reflect the properties of the sample submitted and the testing procedures used by the UMass Soil and Plant Tissue Testing Laboratory. The analytical methods used by the UMass Laboratory were developed for climate and soil types common to the Northeastern U.S. Interpretation of the results, along with lime and fertilizer recommendations, are based on field and greenhouse trials conducted in Massachusetts and other Northeastern states.

Implementing the provided recommendations will correct the nutrient status of your soil for the crop that you indicated. It may or may not solve a given plant growth problem; other factors may need to be evaluated. Problems directly related to disease, insects, weather, and cultural practices cannot be diagnosed by a soil fertility test.

SOIL TEST RESULTS

Soil pH, Buffer pH, and pH adjustments -- Soil pH is a measure of the soil's acidity and is a primary factor controlling nutrient availability, microbial processes, and plant growth. When pH is maintained at the proper level, plant nutrient availability is optimized, toxic elements are often at reduced availability, and beneficial soil organisms are most active. Most plants grow best in a soil pH between 6 and 7, and the majority does best in the middle part of this range. Some notable acid-loving exceptions are blueberry and rhododendron, which grow well under the nutritional conditions imparted by soil acidity.

Due to the climate and geology of New England, soils here tend to be naturally acidic (4.5-5.5) and must often be amended with materials that neutralize soil acidity. Many products are available to accomplish this, but ground limestone is the most common. By convention, lime requirements are made in amounts (tons/acre or lb/1000 sq ft) of agricultural limestone to be added assuming Calcium Carbonate Equivalence (CCE) is 100%. Application rates for liming materials with higher or lower CCE should be adjusted accordingly.

Occasionally soil pH must be lowered, because either the plant requires acid soil or the soil was previously over-limed. Incorporating elemental sulfur is the most effective way to lower soil pH. Once applied, the sulfur oxidizes to sulfuric acid. One to two pounds of sulfur per 100 sq ft will lower the pH of most New England soils by approximately half a unit.

Buffer pH is a value used by the lab to determine lime requirement. It is the resulting pH after a buffering solution has been equilibrated with the soil. The change in pH of the buffering solution is a measure of the soil's capacity to resist pH change after lime has been added. The extent to which the buffer pH is lower than 6.8 is directly related to the amount of limestone needed.

Cation Exchange Capacity and Percentage Base Saturation–Cation exchange capacity (CEC) is an important measure of the ability of soils to retain and supply nutrients. The bulk of this capacity in limied New England soils resides in finely divided soil organic matter; a smaller contribution comes from the clay minerals in soil. The basic nutrient cations (positively charged ions) of Calcium (Ca^{++}), Magnesium (Mg^{++}), and Potassium (K^{+}), and the acidic cations of Aluminum (Al^{+++}) and Hydrogen (H^{+}) account for nearly all the absorbed cations in the soil. Very sandy soils with low organic matter commonly have CEC's less than 5 meq/100 g. New England soils with very high CEC's (greater than 40) are invariably rich in organic matter. A CEC between 10 and 15 is typical for most soils found in the region.

Individual Nutrients

Nitrogen (N) –Nitrogen is <u>essential</u> to nearly every aspect of plant growth. Nitrogen is absorbed from the soil as nitrate (NO_3^-) and ammonium (NH_4^+). Soil NO_3^- and NH_4^+ levels can fluctuate widely with soil and weather conditions over very short periods of time. For this reason, NO_3^- and NH_4^+ are not routinely tested, and we make recommendations based on the assumption that very little NO_3^- and NH_4^+ remain in the soil after the growing season; however, adjustments are often made for soils recently or continuously supplied with manure or compost, which contain nitrogen that will be released during the growing season.

Under certain specific conditions soil NO_3 testing can be useful for predicting fertilizer needs. The Pre-sidedress Soil Nitrate Test (PSNT) has been shown to successfully predict sidedress fertilizer N needs for a few crops (e.g., corn, pumpkin, peppers), but the PSNT requires stricter sampling (depth and timing) and handling than a standard soil fertility sample. Contact the laboratory for more information on this test.

Phosphorus (P) –Among other important functions, phosphorus provides plants with a means of using the energy harnessed by photosynthesis to drive its metabolism. A deficiency of this nutrient can lead to impaired vegetative growth, weak root systems, poor fruit and seed quality, and low yield; however excessive soil phosphorus levels are a concern due to the potential negative impact on water quality. Phosphorus does not generally leach from soils, but where soil P levels are excessive, runoff losses can occur. Phosphorus enrichment is a leading source of water quality impairment of many lakes, streams, and rivers.

Soil phosphorus exists in a wide range of forms. Some phosphorus is present as part of soil organic matter and becomes available to plants as the organic matter decomposes. Most inorganic soil phosphorus is bound tightly to the surface of soil minerals (e.g., iron and aluminum oxides). Warm, moist, well-aerated soils at a pH level of about 6.5 optimize the release of both of these forms. Plants require fairly large quantities of phosphorus, but the levels of phosphorus available to plant roots at any given time are usually quite low. Soil tests attempt to assess the ability of soil to supply phosphorus from bound forms during the growing season. When a soil test indicates that phosphorus is low and fertilizer in needed, the rate recommended is intended to satisfy immediate crop needs and begin to build soil phosphorus levels to the optimum range (i.e., build and maintain). By convention, phosphorus recommendations are expressed, as P_2O_5 to correlate with fertilizer analysis.

If your soil test results indicate excessive, or *Very High*, soil phosphorus levels, phosphorus application should be significantly reduced or eliminated, and steps should be taken to minimize the risk of surface water contamination by limiting runoff losses.

Potassium (K) – Potassium rivals nitrogen as the nutrient absorbed in greatest amounts by plants. Like nitrogen, crops take up a relatively large proportion of plant-available potassium each growing season. Plants deficient in potassium are unable to utilize nitrogen and water efficiently and are susceptible to disease. Most available potassium exists as an exchangeable cation (see above). The slow release of potassium from native soil minerals and from fixed forms in clays can replenish some of the potassium lost by crop removal and leaching. This ability, however, is limited and variable. Fertilization is often necessary to maintain optimum yields.

When a soil test indicates that fertilizer potassium is required, the rate of fertilizer recommended is intended to satisfy crop needs and build soil potassium levels to the optimum range. Sandy soils with very low CEC will tend to lose substantial quantities due to leaching and will require more frequent applications of fertilizer. Even when soils test in the optimum range, some potassium generally is recommended to account for crop removal. By convention, potassium recommendations are expressed, as K_2O to correlate with fertilizer analysis.

Calcium (Ca) – Calcium is essential in the proper functioning of plant cell walls and membranes. Sufficient calcium must also be present in actively growing plant parts, especially storage organs such as fruits and roots. Properly limed soils with constant and adequate moisture will normally supply sufficient calcium to plants. If soil calcium levels are less than optimal and lime is not required, gypsum (calcium sulfate) may be recommended.

Magnesium (Mg) – Magnesium acts together with phosphorus to drive plant metabolism and is part of chlorophyll, a vital substance for photosynthesis. Like calcium, magnesium is ordinarily supplied through liming. If magnesium levels are low and lime is required, dolomitic lime (rich in Mg) will be recommended. If Mg is low and lime is not required, Epsom salts (magnesium sulfate) may be recommended.

Micronutrients – Micronutrients are elements essential to plants, but required in very small amounts. In most properly limed soils they are available in sufficient quantities. Five of these (iron, manganese, zinc, copper, and boron) are tested routinely. Micronutrient deficiencies and response to micronutrient fertilizers rarely are observed in the Northeast. For this reason, soil test recommendations for micronutrients are not available. Your soil test values are compared to levels normally found in Northeast soils. When levels are below this range, we recommend collecting a plant tissue sample to determine if a deficiency exists and a micronutrient fertilizer is required.

Aluminum (Al)–Aluminum is <u>not</u> a plant nutrient and at elevated levels it can be extremely <u>toxic</u> to plant roots and limit the ability of plants to take up phosphorus by reducing phosphorus solubility. Aluminum sensitivity varies greatly with plant type. Acid-loving plants, such as rhododendrons and blueberries can tolerate moderately high aluminum levels, whereas lettuce, carrots and beets are very sensitive. Extractable aluminum increases greatly at soil pH below 5.5. Proper liming will lower aluminum solubility to acceptable levels.

Lead (Pb)–This laboratory routinely tests for extractable lead. Lead is naturally present in most New England soils in the range of 15-40 parts per million (ppm or mg/kg) total lead. At these levels lead generally is thought to present minimal danger to people or plants. Soil pollution with lead-based paint and the tetraethyl lead of past automotive fuels have increased soil lead levels to several thousand ppm in some places. Unless the estimated total lead level in your soil exceeds 150 ppm, it is simply reported as low and can be considered safe (assuming the sample submitted was representative of the area of concern). Estimated total lead levels above 300 ppm are a concern. In such cases, consult the separate insert on soil lead levels.

Soluble Salts–Soluble salts, such as those used on roads to promote melting and those present in many commercial (and some natural) fertilizers, can cause severe water stress and nutritional imbalances in plants. Generally, seedlings are more sensitive than established plants to elevated soluble salts levels, and great variation exists between plant species. Most soils tested by the UMass laboratory have values between 0.08 and 0.50 dS/m (mmho/cm) with the middle of range typical of most fertile mineral soils; values greater than 0.60 may cause damage to sensitive plants (such as onions, etc.). The level of soluble salts can change rapidly in the soil due to leaching, so the effects of time and growing conditions are important considerations when evaluating the significance of the soluble salts level. Excessive levels can often be corrected by leaching with liberal amounts (2- 4 inches) of fresh water. Normal off-season precipitation usually will correct salt problems resulting from over-fertilization.

Prepared by John Spargo, Assistant Extension Professor of Soil and Nutrient Management and Director, UMass Soil and Plant Tissue Testing Laboratory; Allen Barker, Professor of Soil Fertility and Plant Nutrition, Stockbridge School of Agriculture; and Tracy Allen, Laboratory Supervisor, UMass Soil and Plant Tissue Testing Laboratory. Revised January 2012.

Using Lime and Fertilizer in the Home Landscape

The recommendations provided on your soil test have hopefully been written in a way that is both understandable and convenient for you to use. It is difficult to express these in a way that matches every individual's preference. Some wish to use only natural soil amendments. Others request recommendations in terms of soluble synthetic fertilizers. Most soil tests state the number of pounds of nutrient to apply per given area (to be incorporated through a specified depth). In home gardens the small amounts recommended may be difficult to weigh accurately. It is often much easier to apply a volume of fertilizer (cup, liter, etc.). Your soil test will state the amounts of Nitrogen, Phosphorus, and Potassium recommended for your crop in terms of lbs per specified soil area (or volume). It will then provide you with one way of supplying these nutrients. Use the following tables as an aid in implementing this recommendation or to devise alternatives based on your basic N, P, K soil test recommendation.

Fertilizer Products and Their Properties

Table 1 converts weights to volumes for several fertilizer groups. For example, if your soil test recommendation calls for 3 lbs Bone Meal, under Organic Meals and Blends you find that a one cup measure holds 1/3 lb of Bone Meal. That means 3 cups would hold 1 lb, and 9 cups would hold 3 lbs. One could measure out 9 cups or use a cut-off 2 liter soda container, which also holds 3 lbs of Bone Meal. When measuring volumes scoop the material and level the container top (do not pack).

Table 1. Density Equivalents

	Density Units			
Fertilizer Groups	grams/cc	lbs/cup	lbs/2 liters	lbs/gal (oz/cup)
Organic Meals, Blends, and Wood Ash	0.7	1/3	3	6
Ground Rock Dusts (ex. Lime, Rock Phosphate, Greensand)	1.4	3/4	6	12
Coarse and Medium Granulated Synthetic Blends (ex. 5-10-10 graden fertilizer)	1.0	1/2	4.5	8.5
Fine Granulated and Flaked Synthetic Blends (ex. many turf fertilizers)	0.7	1/3	3	6
Composts	0.35	1/6	1.5	3
Powdered Sulfur	1.0	1/2	4.5	8.5
Urea and Other High Nitrogen Fertilizers	0.80	1/3	3.5	7

Some Convenient Containers for Measuring Fertilizers

12 oz Coffee Can = 1 liter
Dry Wall Compound Bucket = 5 gallons
Kitchen Measuring Cup = Graduated
Cut-off 2 liter Soda Bottle = 2 liters
Cut-off 1/2 gallon Milk Container = 1/2 gallon

SUPPLYING INDIVIDUAL NUTRIENTS

If your soil test calls for a quantity of nitrogen, phosphorus, or potassium expressed in fractions of a pound per 100 square feet, you may use one of the combinations listed below to meet that recommendation.

1/4 lb nitrogen (N):

1 bushel (1.25 cubic feet) well-rotted or composted manure plus 1 lb dried blood (12-0-0)
OR
3 to 4 lbs dried blood (12-0-0)
OR
1/2 lb urea (42-0-0)

1/4 lb phosphorus (P2O5)

3 to 4 lbs bone meal (0-12-0)
OR
1/2 lb triple superphosphate (0-45-0)

1/4 lb potassium (K2O)

4 to 5 lbs wood ash (0-0-5) (use only if soil pH is les than 6.3 and reduce lime recommendation by 3 to 4 lbs)
OR
1/2 lb muriate of potash (0-0-60) or potassium sulfate (0-0-50) (potassium sulfate is preferred but is more difficult to find)

If recommendation calls for 1/2 lb of nutrient, simply double the quantity recommended for 1/4 lb.

For annual flowers use 1/2 the amount recommended for vegetables.

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Soil Lead: Testing, Interpretation, & Recommendations

Soil Lead Contamination Lead is naturally present in all soils. It occurs generally in the range of 15 to 40 parts lead per million parts of soil (ppm), or 15 to 40 milligrams lead per kilogram of soil (mg/kg). Pollution can increase soil lead levels to several thousand ppm; the major cause of soil lead contamination in populated areas is the weathering, chipping, scraping, sanding, and sand-blasting of structures bearing lead-based paint.

In the past, significant causes of soil contamination by lead included the use of tetraethyl lead as an anti-knock ingredient in gasoline and lead arsenate as an insecticide in fruit orchards. Automotive lead emissions have effectively ceased with the phasing out of leaded fuels, and with the development of more effective pesticides and Integrated Pest Management (IPM), lead arsenate is no longer in use. Unfortunately, lead persists in soil for many hundreds of years and past use of these products continues to present problems in some areas.

Soil lead becomes a health risk when directly ingested or inhaled as dust. Garden produce, which has accumulated lead in its tissue or has soil particles adhering to it, can also be a hazard if eaten. Lead poisoning is a particular concern for young children (under 6) because their rapidly developing bodies are very sensitive to the effects of lead, and their play habits tend to increase exposure.

Soil Lead Levels, Distribution, and Sampling Procedures used by the UMass Soil Testing Lab to screen soils for lead contamination are the same ones used for routine measurement of plant nutrients. The Modified Morgan extracting solution, dilute glacial acetic acid and ammonium hydroxide, removes a reproducible fraction of the total soil lead. The "extractable" lead is a measure of the reactive lead in the soil. A correlation between extractable lead and ESTIMATED TOTAL LEAD has been determined by testing a large number of soils (>300) using both the routine extraction procedure and a more rigorous total soil digestion. Test results report an ESTIMATED TOTAL LEAD level based on this relationship. Information derived from a variety of sources has resulted in classifying soil lead levels as follows:

Lead Level	**Extracted Lead**	***Estimated Total Lead**
	--------------------mg/kg or ppm--------------------	
Low	**less than 22**	**less than 299**
Medium	**22 to 126**	**300 to 999**
High	**127 to 293**	**1000 to 2000**
Very High	**greater than 293**	**greater than 2000**

The listed categories are those of the UMass Soil Testing Lab. They are meant to correspond to the recommendations listed below. ***If Estimated Total Lead levels are above 300 ppm, young children and pregnant women should avoid contact with the soil. Estimated Total Lead Levels above 2000 ppm are considered a concern for all users and may represent a hazardous waste situation.** Contact your state's Department of Environmental Protection or your local health department for more information.

The screening test offered by the UMass Soil Testing Lab is only meant to identify areas where lead contamination may be a concern. Soils that are known to be contaminated with higher levels of lead, should be tested for Total Sorbed Lead (using EPA method 3050 or 3051) with appropriate actions taken. There are a number of public and private labs in the Northeast offering this test; contact the soil UMass Soil and Plant Tissue Testing Lab for more information.

Due to the nature of the contamination process, lead in soil may be very unevenly distributed. The lead in paint removed from a structure will generally be concentrated near the source, but levels may vary greatly over small distances (e.g., one foot). Lead arsenate residues in old orchards closely reflect the locations of sprayed trees. *Consider these facts carefully when sampling.* If the purpose of testing is to establish the extent of play area contamination, combine several, small, randomly taken samples from the surface 1- to 2-inches to create one sample for testing. If the concern is for lead uptake by garden vegetables, combine several vertical slices from the top 6- to 8-inches of soil to create a sample.

Good Gardening Practices to Reduce Lead Exposure

1. Locate gardens away from old painted structures and heavily travelled roads.
2. Give planting preferences to fruiting crops (tomatoes, squash, peas, sunflowers, corn, etc.).
3. Incorporate organic materials such as high quality compost, humus, and peat moss.
4. Lime soil as recommended by soil test (a soil pH of 6.5 to 7.0 will minimize lead availability).
5. Wash hands immediately after gardening and prior to eating
6. Discard outer leaves before eating leafy vegetables. Peel root crops. Wash all produce thoroughly.
7. Protect garden from airborne particulates using a fence or hedge (fine dust has the highest lead concentration).
8. Keep dust in the garden to a minimum by maintaining a well-mulched, vegetated, and/or moist soil surface.

Recommendations

Low - Follow the good gardening practices listed above.

Medium - In addition to following good gardening practices:

- Restrict access of children to these soils by maintaining dense cover.
- Do not grow leafy green vegetables or root crops in this soil; instead, grow them in raised beds built with non-contaminated soil and organic amendments.

High - In addition to following good gardening practices:

- Do not grow food crops in this soil and do not allow children access to it.
- Keep soil covered and take steps described above to reduce lead availability.
- Grow food crops in containers filled with growing media or clean topsoil; or create lined, raised beds filled with non-contaminated soil and organic amendments.

Very High

- Contact your local Health Department, Cooperative Extension, or the Department of Environmental Protection office for advice on lead abatement measures that should be taken.

Additional Resources

Lead in residential soils: Sources, testing, and reducing exposure. 1999. Penn State University Cooperative Extension. http://cropsoil.psu.edu/extension/facts/lead-in-soil.pdf

Lead safe yards: Developing and implementing a monitoring, assessment, and outreach program for you community. 2001. U.S. EPA Office of Research and Development. EPA/625/R-00/012. http://www.epa.gov/nrmrl/pubs/625r00012/625r00012.html

Lead contaminated soil: Minimizing health risks. 2010. Rutgers University Cooperative Extension. FS336. http://www.njaes.rutgers.edu/pubs/download-free.asp?strPubID=FS336

Lead in garden soils. University of Connecticut Soil and Nutrient Analysis Lab, Cooperative Extension. http://www.soiltest.uconn.edu/factsheets/LeadGardenSoils.pdf

Prepared by Tracy Allen, Lab Supervisor, UMass Soil and Plant Tissue Testing Laboratory; John Spargo, Assistant Extension Professor of Soil and Nutrient Management and Director, UMass Soil and Plant Tissue Testing Laboratory; and Baoshan Xing, Professor of Soil Chemistry. January 2012.

This factsheet is a revision of a previous UMass Soil and Plant Tissue Testing Laboratory document.