Understanding and Interpreting Soil and Plant Tissue Lab Reports

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Summary

Reports differ substantially from lab to lab. Test results can be given in a variety of units that can be confusing, and lab reports differ in the quality of information provided, including units, reference ranges, interpretation, methods used, quality control used, and method detection limits.

A lab report should have clear identification of the samples tested, clear identification of the tests performed, and understandable units. It can be helpful if the report includes an interpretation of the results, information on what testing procedure was used, and the method detection limits. The type and quality of the information provided in reports differs substantially between labs.

The labels of test methods can be confusing. Labs tend to label tests by client expectation or need. For example, a lab might erroneously label EC results as "soluble salts", or nitrate-N as "nitrogen" to make the report simpler. There is no simple way of understanding these misnomers without knowing the methods used to test the samples.

Units can also be different between labs and are a big source of confusion. Fertility soil tests are typically reported as per mass of solid, such as meq/100 g, mg/kg (ppm), or percent; whereas, soil salinity tests are reported as per volume of liquid, such as meq/L or mg/L (ppm). To convert from a liquid to a solid basis, the saturation percentage can be used. Note that many labs do not offer saturation percentage as a routine test. Plant tests are typically on a per mass of solid basis, such as mg/kg (ppm) or percent; whereas, water and wastewater are as per volume of liquid, mg/L (ppm) or meq/L. Note that "ppm" is a poorly defined unit because it can mean mg/kg or mg/L.

It is an important function of the testing lab to demonstrate that test results are both accurate and precise on every set of samples tested. Accuracy is the closeness of the measured value to the "true value". Precision is the agreement between replicate measurements. Unfortunately, precision and accuracy data are typically not provided. Duplicate analysis results are typically used to assess the precision of a method, and reference materials (samples of known concentration) are used to assess accuracy. It is a good idea to add you own duplicates and samples with known concentration to the samples you submit. Samples with known concentration can be purchased at http://www.naptprogram.org.

Many labs report an optimum range or interpret results as high, sufficient, or low. It is not always clear how the lab established these ranges. Many of these ranges originally come from University of California (UC) research using UC methods; however, not all labs follow UC methods, or they use modified UC methods. UC recommendations may not be appropriate. This is one reason it is important to have information on what method was used. Knowing the method used can also be important when you are referencing the method in a paper, verifying that an appropriate method was used, or when trying to compare test results from another lab. Unfortunately, many labs do not report the method used. This information may be located on their website or be available by request.

Method detection limit (MDL), also called limit of quantitation (LOQ), is the lowest concentration that can be measured accurately and with precision. Significant figures are an additional way of assessing the lowest accurate result possible. Knowledge of the MDL is important because method error increases dramatically as the results approach the MDL. Numbers smaller than the method detection limit or smaller than the last significant figure are essentially random. Since many labs do not report MDL, it is common to mistakenly put value in results near the MDL that actually have very high error.

It is important to carefully check the results in a report. Verify that results are reasonable based on sample location and history. Verify that results are reasonable based on chemistry. For example, carbonate should not be present at low pH, and the sum of exchangeable cations in soil should be close to the cation exchange capacity (CEC). The sum of the cations in a water sample should be close to the sum of the anions. Total nitrogen should be more than the sum of nitrate-N and ammonium-N. Total carbon should be greater than organic carbon. Verify that results are reasonable based on possible lab errors. Check the quality control data if it is provided. Look for common lab errors such as switched samples, double weighed samples, identical sample results, and dilution errors (all values seem off by a constant factor).

Agricultural labs are not accredited or certified. Especially for research samples, it is a good idea to use a lab that participates in a proficiency program (NAPT or ALP). Check lab results by submitting duplicate samples and samples with known values. These can be purchased from the NAPT or ALP proficiency programs.