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EXTENSION & PLANT SCIENCE AND LANDSCAPE ARCHITECTURE

Plant Tissue Analysis Interpretation Sheet

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At least 16 elements are essential for proper plant growth and development. Water and air supply carbon, hydrogen and oxygen. The soil and the organic matter in the soil are the primary sources of nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, boron, copper, iron, manganese, zinc, molybdenum and chlorine. Many cultivated crops need more of these nutrients than our native Connecticut soils provide so soils are supplemented with either synthetic or natural/organic fertilizers to provide the plants with the nutrients they require and in order to obtain maximum plant production and yields.

Nutrient management plans for various crops of commercial importance are typically developed using results from both soil tests and plant tissue analysis. Visual observations are also very important and often are the first clues a grower receives that a problem may exist. Sometimes, however, symptoms are noted when the nutritional deficiency has already developed and yield reductions cannot be reversed.

Reasons for Plant Tissue Analysis

Plant tissue analysis is the quantitative determination of essential elements in plant tissue. The premise behind plant tissue analysis is that there are optimum levels of each plant nutrient for a particular species (and sometimes cultivar) of plant. When these levels are maintained, production and growth will be maximized.

The two main purposes of plant tissue analysis are to determine the nutrient status of the crop and to identify any suspected nutritional deficiencies that would adversely affect plant growth. Results from plant tissue analysis also can be used to evaluate fertility programs, to determine the availability of elements for which soil tests are not readily available, to examine interactions among plant nutrients, to identify essential or non-essential element toxicities, and also to predict the levels of essential elements required by plants at critical growth stages. Plant tissue analysis may also reduced growers' costs by ensuring that fertilizers are applied only when warranted.

What We Test For?

The levels of carbon, hydrogen and oxygen in plants are not evaluated at our lab because they are mainly derived from air and water and rarely limit plant growth. The UConn Plant Tissue Analysis includes results for 11of the essential elements including nitrogen, phosphorus, potassium, calcium, magnesium, boron, copper, iron, manganese, zinc and molybdenum. Testing is not performed for chlorine and sulfur because they are almost always sufficient under average field conditions in Connecticut. Lead testing is included to address concerns of those growing food crops in potentially contaminated soils. In addition, aluminum and sodium are included in our analyses because aluminum toxicity is a concern for some plants under acidic soil conditions and sodium is thought to be beneficial to crops such as beets and celery.

Interpretation of Results

Results from the University of Connecticut Plant Tissue Analysis are meant to serve as an indicator of a plant's nutritional status. Although plant tissue analysis has been in use for quite some time, there is still considerable interpretative data lacking for some elements, certain crops, specific stages of plant growth, and for some elements hazardous to human health.

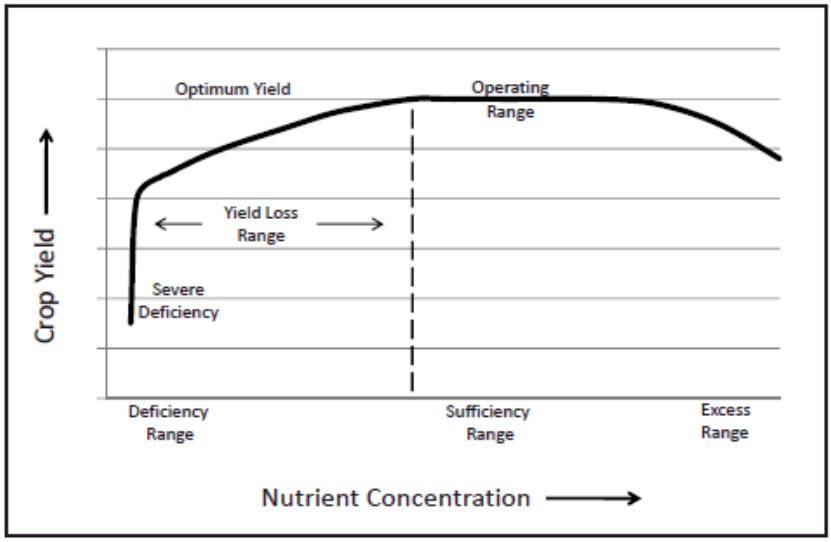

Figure 1.

(Reprinted with permission from R. L. Mikkelsen from Plant Nutrition Today, Fall 2009, No. 3.)

For each essential plant nutrient there exists a curve similar to Figure 1. On the right one can see that a deficiency in a nutrient will cause plant growth and production to be reduced to very low levels. As that nutrient level increases, plant growth and productivity will also increase until a plateau is reached where the addition of that one nutrient no longer results in increased yield. The values on this plateau are generally thought to represent the sufficiency range for that particular element. The actual values delineating the sufficiency range of an essential element would be wider for nutrients needed in large amounts, like nitrogen and potassium, and much narrower for those needed in trace quantities such as boron or zinc. At a certain point, the addition of more of this one particular nutrient would cause growth and yield to decline. This may be caused by adverse physiological effects occurring within the plant (toxicity) or nutrient interactions.

Often plant tissue samples are submitted because of a suspected nutrient deficiency or toxicity. While these problems would be found on either end of sufficiency ranges, do take into account that the actual nutrient level where growth reduction or injury would occur may vary depending on the amounts of other plant nutrients, the plant's growth rate, and environmental factors so an absolute value where a deficiency or toxicity would occur may not be able to be specifically defined.

It is also imperative that the sample submitted be collected in an identical manner and stage of growth as the reference sample which is used to compare and interpret the results. Please follow the species specific sampling instructions for most reliable results.

Plant analysis results can be interpreted in several ways. Most typically the values obtained through testing are compared to an established norm. The three most common systems of plant analysis interpretation are use of critical values, sufficiency ranges or DRIS norms. The UConn lab presents plant analysis results and comparison **sufficiency ranges**. **Sufficiency**

ranges are published for plants where enough research and survey work has been done to reliably establish deficiency, sufficiency and toxicity levels over a broad range of growing conditions. For a few crops, sufficiency ranges have not been published and **survey ranges** are used. For a **survey range** the upper and lower limits of sufficiency are not as clear cut and more work needs to be done to determine these values. Use **survey ranges** as a general guide for determining if sufficient nutrients are present or not. Occasionally results are presented compared to **survey averages** which are exactly what they imply – average values for a number of healthy, well-established, productive plants.

How to Use Plant Tissue Analysis Results

All natural systems are complex. Different plants require different amounts of the same nutrients at different stages of plant growth. Nutrient levels that are sufficient for young plants may not be able to sustain healthy, productive mature ones.

Use plant tissue analysis results as a tool to evaluate the concentrations of essential elements in indicator tissues of the plants of interest. This should be a vital component of a crop's nutrient management plan along with soil testing, consulting with specialists, and knowledge acquired through commercial grower resources and university research. Plant tissue samples should be taken at first sign of a nutritional problem. As a general rule of thumb, results from those samples taken either before or at flowering are typically more reliable than those taken at later stages of maturity. Often a comparison of healthy and unhealthy plant tissue along with their corresponding soil samples would give an accurate representation of the nutrient status of the crop in question.

Fertilizer Recommendations

Plant tissue analysis results from the UConn Soil Nutrient Analysis Laboratory will not include fertilizer recommendations at the present time.

Sampling Advice

Because the nutrient levels in plant tissue vary throughout the growing season, it is important that sampling directions be followed closely for results to be most useful. Please read our detailed instructions which are listed on the back of the sample questionnaire and also under sampling instructions for specific crops on our website, www.soiltest.uconn.edu. In general, samples should be collected from plants of the same variety, size, vigor and age at the same time each year. Most often newly formed but fully expanded leaves are collected. For some plants, like grapes, petioles are sampled. Avoid leaves that are diseased, injured or that have been sprayed with pesticides or nutrients. Our laboratory encourages growers to rinse leaves or other plant parts to remove soil and other contaminants before submitting samples.

Soil Testing

Soil tests are generally recommended prior to planting to determine soil pH and organic matter levels, limestone requirements, and both macro- and micro- nutrients. Soil tests are especially important before planting perennial crops like fruit trees, small fruit, asparagus and Christmas trees. This is because once crops are established, any necessary soil amendments and/or fertilizers cannot be easily incorporated into the plant's rooting zone and are typically surface applied. It may take several years for them to reach the area of plant root growth and for the desired change(s) in the soil to occur. Soil pH testing is also very important since the pH of the soil directly affects the availability of

all plant nutrients. Once the soil has been amended according to the initial soil test recommendations, usually retesting every three years to monitor soil pH and nutrients is adequate for good crop production.

Although soil testing is a valuable tool, all too often the results from a soil test are poorly correlated with the results from a plant tissue analysis. This is because there are many factors, aside from the amount of available nutrients in the soil that would affect the nutrient concentration of plant tissues. Soil test results indicate what nutrients are available to the plants. They are not able to discern what the plant actually takes up. Plant tissue testing is especially valuable when used with perennial crops like small and tree fruit, Christmas trees and ornamentals as it can provide information about the plant's nutrient status before problems develop or yield reductions occur.

Abiotic and Biotic Factors Affecting Plant Tissue Nutrient Levels

It is obvious that the growth of a particular species of plant is restricted if the required essential nutrient(s) are not present in the soil. But a wide range of factors affect nutrient uptake. These include soil moisture levels and temperature, soil texture and structure, soil pH, crop species and variety, rootstock, disease and insect problems, weather conditions and cultural practices.

The amount of nutrients in plant tissues varies seasonally with age, maturity, plant part submitted for analysis, crop load, rootstock, and sometimes even cultivar. Plant nutrients can also interact with each other. For instance, high levels of potassium in plants may result in a magnesium deficiency. When interpreting the results of a plant tissue test, all the above factors, and their positive or negative effects,

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