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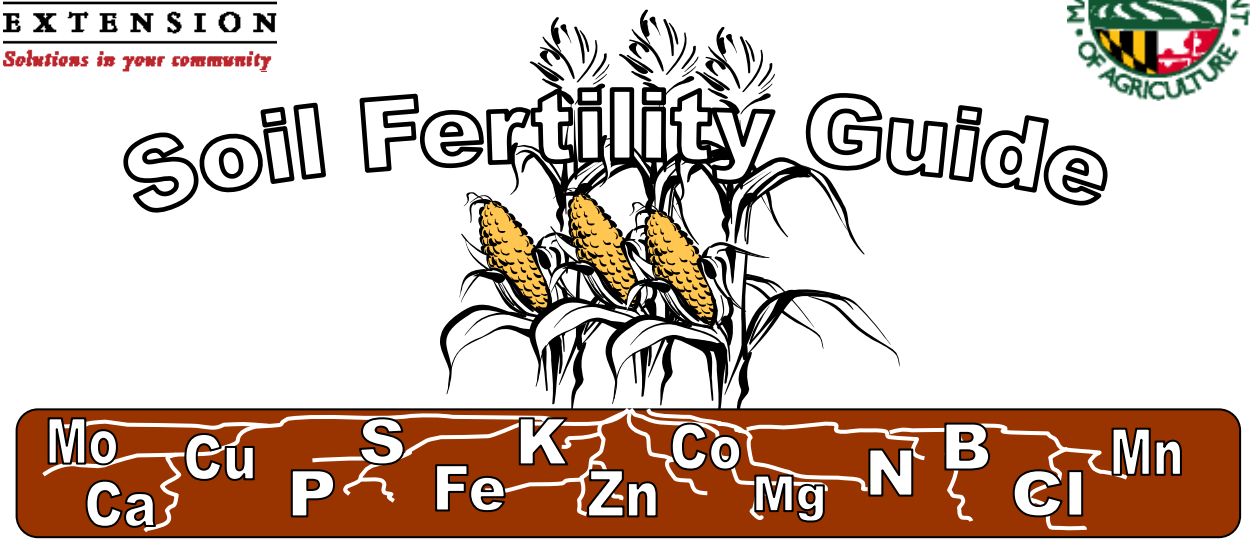
Soil Fertility Guide



PL-1

PLANT TISSUE ANALYSIS

Introduction

Plant tissue analysis is a laboratory determination of the total elemental content of plants or of certain plant parts. It is used for a variety of purposes including monitoring the nutrient status of crops and troubleshooting problem areas. It also serves as the basis for nutrient recommendations for perennial fruit crops.

Plant tissue analysis should not be confused with tissue testing. Tissue testing typically refers to a field test that involves taking sap samples from fresh plant tissue and analyzing the samples on site. Plant tissue analysis is performed on dried plant tissue that has been processed in a laboratory.

Interpreting Plant Tissue Analysis Information

When using plant tissue analysis information from a laboratory, you need to use interpretive guidance in order to determine the nutrient status categories. Plant and soil scientists have spent years performing experiments in order to develop this interpretive guidance for plant tissue analysis.

Figure 1 on page 2 is a graphical depiction of interpretive guidance for a generic crop. The nutrient concentration ranges (% or ppm) for each nutrient status category and the shape of the growth curve will change for each crop.

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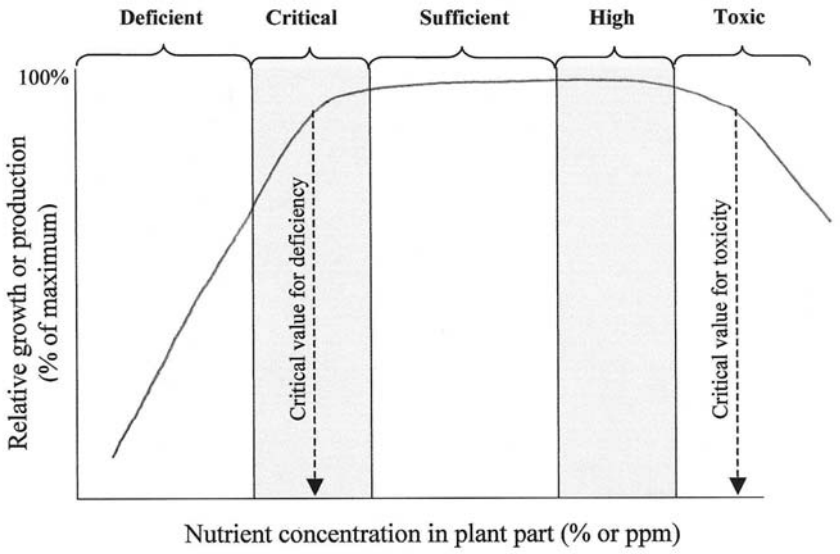

Figure 1. An illustration of the meaning of plant tissue analysis interpretive terminology (© Australasian Soil and Plant Analysis Council Inc. 1997; Modified from p. 78 in *Plant Analysis: An Interpretation Manual* (DJ Reuter et al.), with permission from CSIRO PUBLISHING, Melbourne Australia – http://www.publish.csiro.au/pid/437.htm)

Table 1 on page 3 gives a more detailed explanation of the nutrient status categories encountered when interpreting plant tissue nutrient concentration data for manganese (Mn) in corn. For corn, a plant tissue analysis showing a value of 16 for Mn would indicate that the nutrient status category is the critical range. Nutrients may need to be added to bring plant tissue levels into the sufficient range and improve crop yield. If nutrient applications to the current crop are not feasible they can be made before planting future crops.

Table 1. Nutrient status category terminology using corn as an example

Nutrient Status Category	Definition	Manganese (Mn) in corn[#] (ppm*)
deficient	• concentration of a nutrient associated with visible deficiency symptoms • deficiencies severely reduce growth and production	less than 15
critical value or range (marginal)	• concentration of a nutrient below which production is adversely affected • producers should strive to keep all nutrient levels above their critical value or critical range	16 – 19
sufficient range (adequate/normal/ optimal)	• concentration of a nutrient that is optimal for plant growth and production • if all nutrient concentrations for a crop are within each nutrient's sufficiency range, nutrient status should not be considered a limiting factor for crop production	20 – 150
high	• concentration of a nutrient that is greater than needed for optimal growth • in some crops, this level of nutrients may be associated with undesirable quality or vigor	151 – 200
toxic (excessive)	• concentration of a nutrient, greater than optimal, that is associated with reduced growth and production • this is usually observed only for minor nutrients	greater than 200

[#] An example taken from *Plant Analysis: An Interpretation Manual*
[*] ppm = parts per million

Important Basics of Plant Tissue Analysis

RULE 1: The amount of a specific nutrient that is sufficient or adequate for plant growth varies from crop to crop.

Table 2 shows the sufficiency ranges in percentages (%) of dry weight for N, P and K for five different crops.

Table 2. Sufficiency ranges of N, P and K for five selected crops

Crop	N (%)*	P (%)*	K (%)*
corn	2.70 – 4.00	0.25 – 0.50	1.70 – 3.00
wheat	1.75 – 3.00	0.21 – 0.50	1.50 – 3.00
soybeans	4.00 – 5.50	0.26 – 0.50	1.70 – 2.50
cucumbers	4.50 – 6.00	0.34 – 0.75	3.90 – 5.00
tomatoes	4.50 – 6.00	0.25 – 0.75	2.90 – 5.00

***** Information obtained from *Plant Nutrition Manual*

Caveat – If a producer is using plant tissue analysis as a monitoring tool, access to interpretive information for the specific crops being monitored (like those shown in Table 2) is essential.

RULE 2: The amount of a specific nutrient for a particular crop that is adequate for growth varies across the season. The concentration of many nutrients decreases as the crop matures.

As shown in Figure 2, the optimal concentration of nitrate in potato petioles decreases as the season progresses.

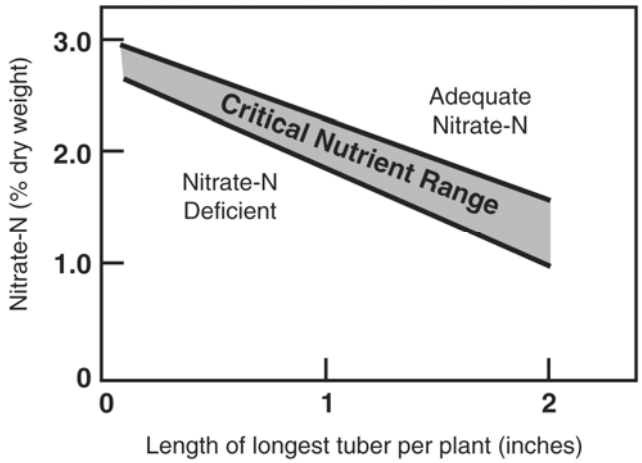

Figure 2. Nutrient status categories for nitrate-N in potato petioles over time
(© 1990 From Journal of Plant Nutrition by Williams & Maier. Modified and used with permission by Taylor & Francis Group, LLC, http://www.taylorandfrancis.com)

Caveat – Collect plant tissue samples at the same growth stage that was used in the development of the interpretive guidance.

RULE 3: The amount of a specific nutrient that is adequate for plant growth may vary from one plant part to another plant part.

Table 3 shows five crops and the appropriate sampling time as well as the appropriate plant part to sample.

Table 3. Sampling time and plant part for five crops

Crop	Sampling Time	Plant Part
corn	initial silk	ear leaf
wheat	just prior to heading	top two leaves
soybeans	prior to pod set	most recent leaf
cucumbers	flower to small fruit set	fifth leaf from growing tip
tomatoes	mid-bloom	leaf adjacent to top flower cluster

Caveat – Collect plant tissue samples from the same plant part used in the development of the interpretive guidance.

Collecting Plant Tissue Samples

Just like in soil sampling, it is important to collect a representative plant tissue sample. This involves taking samples from many plants (25 – 50, depending upon size of plant part) throughout the entire area of interest. Two sampling patterns are shown in Figure 3.

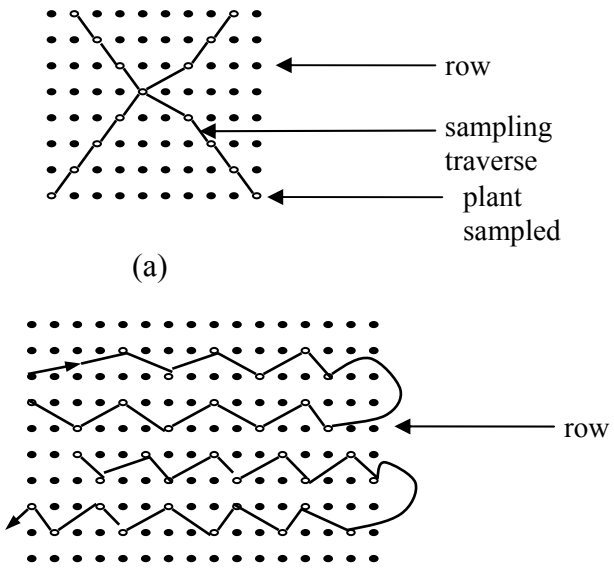

Figure 3. Sampling patterns for collecting representative samples
(© Australasian Soil and Plant Analysis Council Inc. 1997; Modified from p. 78 in *Plant Analysis: An Interpretation Manual* (DJ Reuter et al.), with permission from CSIRO PUBLISHING, Melbourne Australia – http://www.publish.csiro.au/pid/437.htm)

Do not include diseased leaves in the sample unless your intent is to determine the nutrient status of the diseased tissue.

Many agricultural testing laboratories provide nutrient status information along with plant tissue nutrient analysis. If that is the case, contact your laboratory for any guidance they can provide on sampling time, plant part, and number of plants to sample.

Analyzing Plant Tissue for Nutrient Content

Plant tissue analysis is a laboratory procedure that involves certain steps (see Table 4).

Table 4. Laboratory procedures for analyzing plant tissue samples

Step	Action
1	Preliminary preparation • drying, grinding, and mixing plant tissue
2	Destruction of organic matrix • strong acids or very high temperatures are used during this step
3	Analysis of mineral residue for nutrient content • many different techniques can be used for this step

Plant tissue analysis is a more time-consuming process than soil testing, therefore leading to longer turn-around times for agricultural analytical laboratories. Plant tissue analysis is also more expensive than soil testing.

Using Plant Tissue Analysis in a Monitoring Program

For some producers, especially producers of high-value vegetable crops, plant tissue analysis is used as part of a monitoring program that also includes soil testing.

Plant tissue analysis can confirm the adequacy of all nutrients or identify an inadequacy of one or more nutrients.

Plant tissue samples should be collected from the correct plant part at the appropriate stage of development.

Using Plant Tissue Analysis as a Trouble-shooting Tool

Producers often face situations where the crop in one part of a field is doing poorly even though it has been managed the same way as the part of the field where the crop is growing well.

The first step in information gathering should be to collect soil samples from both areas (the healthy area and the problem area).

If the soil tests reveal a difference, address the fertility issues. If soil tests indicate similar results, analysis of plant tissue samples from both the healthy area and the problem area should be taken. They may indicate the nature of the problem, assuming the problem is nutritional.

Plant Tissue Analysis as a Basis of Nutrient Recommendations

Although soil tests are most commonly used as a basis of generating nutrient recommendations for row crops and hay and pasture, soil testing alone has not proven useful for perennial crops like tree fruits and small fruits. Perennial fruit crops have deep root systems, take up nutrients for a larger portion of the growing season, and have efficient mechanisms for recycling nutrients from season to season.

Fruit scientists have found that nutrient concentrations in plant tissue do a better job of indicating the nutrient status than soil tests alone. For these reasons, nutrient recommendations for mature (bearing) perennial fruit crops are based primarily on plant tissue nutrient concentrations and only secondarily rely on soil tests.

As with any crop, sampling the appropriate plant part at the appropriate time is critical for reliable, valid plant tissue analyses of perennial fruit tissue. Consult Table 5 on page 8 to determine the appropriate time to sample, number of samples, plant part to sample, and the sampling location on the plant for each fruit crop. Figure 4, also on page 8, has additional information on the proper sampling location for fruit trees. On fruit trees, the current year's growth extends from the last set of bud scale scars to the bud.

Table 5. Plant tissue sampling information for perennial fruit crops

Crop	Time to Sample	Number of Samples/Plant Part to Sample	Sampling Location on Plant
blueberries	1st week of harvest	40 leaves (detach petioles)	Current year's growth.
brambles	Aug 1st – Aug 20th	60 leaves (detach petioles)	Select the most recent fully expanded leaf blade of each primocane.
fruit trees	Jul 15th – Sept 1st	50 leaves and petioles	Select shoots at eye level from around the outside of the tree that make a vertical angle of 45-60 degrees to the ground. Remove 1 or 2 leaves from the mid-portion of the current year's growth. (See Figure 4.)
grapes	at full bloom	75 petioles	Remove the petiole across from the first blossom cluster, closest to the cordon or permanent cane.

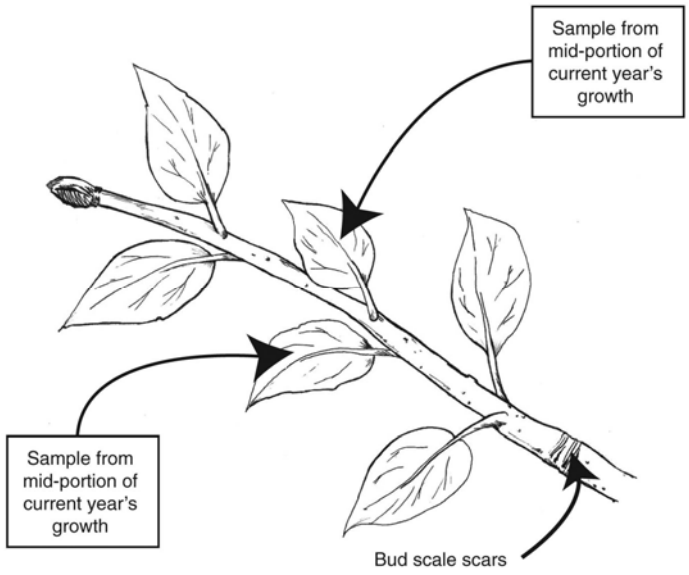

Figure 4. Proper sampling locations for fruit trees (Drawn by Pete Mazzocchi, Former Senior Graphic Designer, UMCP, College of AGNR)

In Maryland, there are four nutrient status categories for tree fruits and small fruits: deficient, low, normal, and high. Nutrient concentrations associated with each category vary from species to species. Furthermore, nutrient concentrations for nitrogen in apples actually vary among cultivars. (Apples are the only tree fruit crop in Maryland where nitrogen recommendations vary across cultivars.) Table 6 shows the variation for two groups of apples and three other fruit crops.

Table 6. Normal or adequate N, P and K concentrations in plant tissue of four perennial fruit crops

Fruit Crop	**N (%)***	**P (%)***	**K (%)***
apples			
soft	1.80 – 2.10	0.15 – 0.31	1.20 – 2.01
fresh market	2.20 – 2.25	0.15 – 0.31	1.20 – 2.01
peaches	2.50 – 3.41	0.15 – 0.31	2.10 – 3.01
brambles	2.00 – 3.00	0.25 – 0.40	1.50 – 2.50
blueberries	1.70 – 2.10	0.07 – 0.18	0.40 – 0.65

***** Information obtained from *NM-5, Nutrient Management for Tree Fruits and Small Fruits*

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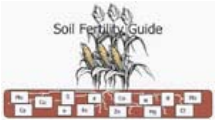

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