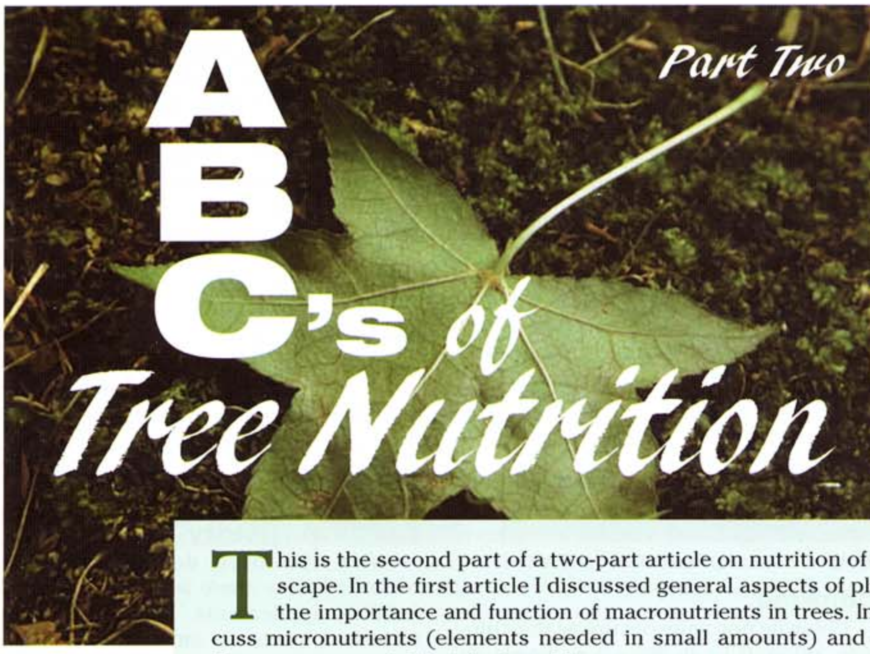

ABC's of Tree Nutrition

Part Two

By Dr. Bert Cregg,
Department of Horticulture, Department of Forestry, Michigan State University

This is the second part of a two-part article on nutrition of trees in the landscape. In the first article I discussed general aspects of plant nutrition and the importance and function of macronutrients in trees. In this article I discuss micronutrients (elements needed in small amounts) and suggest ways to diagnose suspected nutrient problems.

Micronutrients

Micronutrients are those elements needed in plants in relatively small amounts. By small amounts we mean concentrations in the plant that are measured in parts per million (ppm). Macronutrient concentrations, in contrast, are usually expressed measured in percent (%). For example, typical leaf nitrogen concentration of landscape trees is 2.5-3.5% while some micros such as copper or molybdenum may be present in as low as 10 ppm (0.001%). Although micros occur in small amounts, they are nevertheless essential for plant physiological function and growth. Micronutrient problems are most common in container growing where plants are grown in soilless media made up largely of bark or peat moss, which has low inherent fertility. In general, most soils provide adequate micronutrients for tree growth. However there are certain environmental conditions and trees that are associated with micronutrient disorders.

Iron

Iron is probably the micronutrient that is most commonly deficient in landscape plants in Michigan. Physiologically one of the most important functions of iron is the synthesis of chlorophyll. Therefore, trees that are deficient in iron will show a pronounced chlorosis (Fig. 1). While most soils contain sufficient amounts of iron, iron availability is reduced as soil pH increases. Plants are considered iron efficient or iron inefficient. Those that are iron inefficient are especially susceptible to iron chlorosis. The 'poster child' for pH induced iron chlorosis is pin oak. Pin oaks in Michigan often exhibit iron chlorosis due to elevated pH. Iron chlorosis can be treated with trunk injection of chelated iron. However, these treatments address symptoms rather than the underlying cause. Some researchers have reported success in treating iron chlorosis with surface applications of elemental sulfur or ammonium sulfate to drive down soil pH and increase iron availability. It should be noted that the pH-lowering effect of these treatments is transitory and they need to be repeated every few years. The best long-term solution, of course, is to conduct a soil test and avoid plating pin oaks on high pH sites.

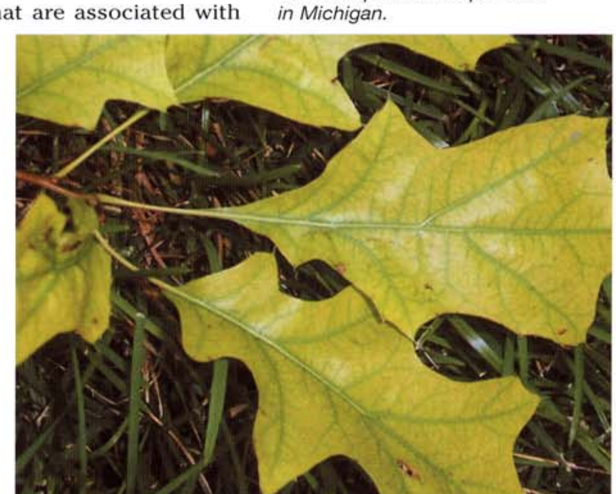

Figure 1. Iron chlorosis is a common problem of pin oaks in Michigan.

Continued on page 22

ABC's of Tree Nutrition

Continued from page 21

Boron

Boron deficiencies can occur in certain tree species and we observe it periodically in nurseries and forest plantations. Boron can be a difficult element with which to deal because boron has a relatively narrow range between deficiency and toxicity. More than one nursery grower has damaged or even lost a crop by misapplying boron when treating for a deficiency. If foliar or soil sampling indicates a boron deficiency, proceed with caution when applying a fertilizer containing boron. Double-check your calculations and spreader calibration. Err on the side of caution: consider applying half the recommended rate initially and applying the second once you've had a chance to see the trees respond.

Manganese

Biochemical functions of manganese are similar to magnesium and it is involved in many enzymatic processes related to energy capture and use. Manganese deficiencies can occur in Michigan, particularly as soil pH increases. Manganese is immobile in the plant; therefore symptoms are expressed on new leaves. Manganese deficiency may be characterized by flecking, chlorosis that appears as dots rather than chlorosis of the whole leaf.

Copper

Copper is taken up by plants in very small amounts (2-20 ppm). Most of the copper in plants is bound in the chloroplasts. Copper containing proteins are part of the electron chain in photosynthesis. Although copper is taken up in small amount, deficiencies can occur. Copper may be deficient in soils that are heavily leached or in soils with extremely high organic matter such as reclaimed peats. There is also some evidence that high rates of nitrogen or phosphorus fertilizers can reduce copper uptake. Copper deficiency may appear as a twisting of leaves or needles (Fig. 2).

Figure 2. Copper deficiency can result in a characteristic twisting of needles of conifers.

Zinc

Sufficiency levels for zinc are typically in the range of 20-50 ppm. Zinc appears to function much like manganese and magnesium and is involved in enzyme activation. Zinc deficient plants will show intervenal chlorosis but in more extreme cases will be stunted and leaves will curl and become rosetted.

Molybdenum

Molybdenum is an essential component of enzymes related to nitrogen metabolism. Therefore, molybdenum deficiency may resemble nitrogen deficiency since the plant's ability to utilize nitrogen is impaired. Molybdenum is needed in small amounts and is rarely limiting in most soils. An exception is extremely acid soil conditions where molybdenum uptake may be limited.

Chlorine

Chlorine normally occurs as the chloride anion (Cl-) in very low levels in plants (2-20 ppm) and while it is an essential element, its role in plant physiology is still not well understood. In landscapes, excess chloride is the primary concern. The application of sodium chloride as deicing material in the winter increases the level of chloride in roadside plants, often to toxic levels.

Diagnosing Nutrient Disorders

Identifying nutrient problems in landscape plants can often be a difficult chore and can involve significant detective work. Although many nutrition guides and extension publications imply that nutrient deficiencies can be diagnosed from visible symptoms on leaves, in reality the situation is rarely that simple. If you suspect a nutritional problem in your landscape, the following framework should be useful for sleuthing the problem.

Eliminate Other Causes

Some nutrient deficiencies can look like other biotic or abiotoic injuries. For example, leaf scorch caused by drought or high temperature will result in wilting and leaf necrosis (dead areas on leafs) that can look like a potassium deficiency. Eliminating environmental causes will require knowledge of the history of the site. Has the site been flooded recently? Has rainfall or irrigation been adequate or has the planting been subjected to drought stress? Is there evidence of insects or disease? Remember many insect pests are extremely small and may require a hand-lense to see. Also, the pest organism may have done its damage and moved on while the damage remains.

Cultural History

What has been done on the site recently? Have their been any recently fertilizer applications. Remember some fertilizers such as ammonium nitrate have a relatively high salt index and can cause salt injury. Some elements like boron or chloride can cause a direct toxicity injury while others can interfere with uptake of other elements (e.g., potassium-induced magnesium deficiency). Have there been any grade changes on the site? Raising a grade can deprive roots of oxygen whereas reducing grades can remove surface feeder roots and lead to drought injury. Have any herbicides been applied recently? Broad-spectrum herbicides such as 2-4-D can drift and cause injury to broad-leaved trees and shrubs.

Visible Symptoms

As indicated earlier in these articles, many nutrient deficiencies have characteristic symptoms that can aid in diagnosis. Also, certain trees are prone to specific nutrient disorders (e.g., iron chlorosis in pin oak). However, many nutrient disorders and abiotic or biotic stresses have similar symptoms. Therefore, visible symptoms alone may not be sufficient to diagnose a nutrient problem.

Test Don't Guess

Soil and foliar analysis are usually required to make a complete diagnosis of a nutrient problem. And even these techniques have limitations.

Figure 3. Soil samples can be collected with a soil probe (shown), a trowel or a shovel. Take 10-15 samples, mix them together in a clean bucket and pour sample into a soil test box or a ziplock baggie.

Soil Sampling

Numerous private labs and the MSU Soil and Plant Nutrient lab conduct soil nutrient analyses. To collect a soil for analysis use a soil probe, shovel or trowel to collect 10 to 15 samples in the area of interest. Scrape away surface mulch and organic matter and sample to depth of 7" (Fig. 3). Mix the samples together in a large, clean bucket and pour the samples into a soil test box (available from county extension offices or the MSU Soil and Plant nutrient lab) or use a plastic zip-lock bag. If only part of a planting is showing problems, collect a separate set of samples in the affected and unaffected areas. Label one sample as 'good' and the other as 'bad.' Depending on the lab, results for a standard soil test will usually include soil pH, available phosphorus, potassium, calcium, and magnesium and lime and fertilizer recommendations. Additional elements can also be determined, if requested. While soil sampling is useful and necessary, it is important to realize there are limitations. First, nitrogen, the element that is used in the largest amounts and the most limiting, is difficult to assess in soil samples because N is dynamic in the soil and is constantly being converted among various fractions. Therefore N is not reported on standard nutrient tests. Secondly, a nutrient test may not reflect availability of certain elements. For example, a soil may have adequate levels of iron or magnesium, but plant availability may be limited due to high soil pH.

Foliar Sampling

In theory, analysis of foliar nutrition provides the best means to assess the nutrient status of plants in the landscape. Foliar sampling integrates soil supply and availability with plant uptake factors. The limitation for foliar sampling in landscape situations is that we deal with a large number of different species. Unlike agronomic crops such as corn or wheat, good reference guidelines do not exist for the various elements for all landscape plants. Foliar samples should be collected on recently matured leaves (Fig.4). A brown paper lunch bag about half full will provide and adequate amount of material for sampling. One of the most effective ways to use foliar sampling in a landscape setting is to collect separate samples from 'good' and 'bad' plants. This will allow a side-by-side comparison when the results are returned.

Figure 4. Collect foliar samples from recently matured leaves. Nutrient concentrations change rapidly in leaves that are still expanding.

Summary

Plant nutrition is critical to overall plant performance and health. Plant nutrition is determined by complex and dynamic interactions between the soil and the plant. Likewise, diagnosing plant nutrition problems is often a complex process. This requires gathering information on the history of the site especially recent cultural treatments and careful observation of potential abiotic or biotic problems. Because reference information on nutrition of landscape plants is often sketchy, the best approach for soil and foliar sampling is to collect separate samples of areas and plants that are growing well and those that are having problems. By comparing nutrient status of 'good' and 'bad' samples, the nutrients that are limiting will often become evident. Likewise underlying causes, such as high soil pH, may also become evident.

For more information on soil and plant sampling contact your county extension office or the MSU Soil and Plant Nutrient Laboratory, A81 Plant and Soil Science Building, East Lansing, MI 48824-1325.