

Chlorosis: An Abiotic Problem of Shade Trees

Chlorosis is a common problem of oaks growing in the urban areas of Minnesota. Eastern pin oaks tend to be highly susceptible, but many other tree species including white oaks, maples and birch also suffer from this condition.



White oak (on the right) with chlorosis next to a healthy white oak.

The most visible symptom of chlorosis is a general yellowing or pale green coloring of the foliage. A variety of patterns may appear on the leaves including pale green to yellow splotches, tips, and margins, or in the interveinal parts of the leaves (the veins tend to remain darker). As this condition worsens leaves lose their ability to capture light energy used to manufacture food through the process of photosynthesis. As the tree's level of stored energy decreases, branches and whole portions of the tree begin to die off. The tree also becomes vulnerable to opportunistic insects and diseases as it loses its ability to defend against these invaders.

For some trees this condition is temporary and may not persist from year to year. However, for others it has become chronic, slowly decreasing the overall vigor and ability of the

tree to survive. As the tree declines over time it loses its' aesthetic value or dies outright necessitating removal.

Chlorosis has become a very serious urban shade tree problem. It has been a frustration for urban foresters, arborists, and tree owners for many years. As research continues, the scope of possible causes continues to broaden. The idea of a simple treatment for all cases of chlorosis really does not exist. An understanding of all the variables involved is essential for accurate diagnosis and treatment.

Cause

Chlorosis is the cessation of chlorophyll formation in leaves. (Chlorophyll is the green pigment essential in photosynthesis.) This inability to make chlorophyll may be caused by a deficiency of elements like iron, manganese, zinc, or copper. The availability of these micronutrients in the soil solution and the plant's ability to take them up is reduced when soil pH exceeds 6.5. As the soil pH levels increase, the concentration of nitrogen, potassium and phosphorus increases in the foliage, causing the disruption in the formation of chlorophyll. Simply prescribing tree fertilization without analysis of current element levels in the foliage or soil could result in excesses that compound the situation.

As we begin to understand what brings about the chlorotic condition in trees, the root system must not be overlooked as a possible contributing factor. The absorption of water, oxygen, and most nutrients required by the tree is done at the root level. If the roots are damaged (i.e. construction damage) or if the root system's overall health has declined,

absorption may be limited as well.

Chlorosis probably involves multiple factors, including but not limited to nutrient imbalance, high soil pH, and a damaged and/or ineffective root system.

Treatment

Prevention is the best control. Do not plant trees susceptible to chlorosis, such as Eastern pin oaks, in soils with a pH above 7.0 or in soils low in organic matter. Be careful not to damage roots during construction. Because potassium and phosphorus excesses have been associated with chlorosis problems, avoid these fertilizers unless a soil test indicates a deficiency. If possible avoid using alkaline water when irrigating plants. (Municipal water systems tend to be alkaline.) Do not use lime on turf under the canopy of shade trees, (lime raises the pH of the soil).

Take advantage of readily available soil acidifiers by mulching grass clippings when mowing. Mulch leaves over the lawn using the lawn mower in the fall instead of raking them off the yard. Better yet is to mulch the area around trees with organic mulches (wood chips or shredded bark) and avoid rock mulches that can raise the soil pH. (See our fact sheet *Wood Chip and Bark Mulch in the Landscape*

for more information about the benefit of mulching.)

The treatments available for chlorosis must address the variables associated with each individual site or tree. Specific measurements of nutrient balance and pH are necessary for any successful treatment. If the problem is related to high soil pH, restoration of leaf color can be accomplished and maintained for several years by topsoil and subsoil acidification using elemental sulfur as the primary soil amendment. The goal is to lower the soil pH below 6.5 however this is just a temporary fix. Soils will revert to the higher pH over time. Organic mulches will slow the rate at which the soil reverts to the higher pH.

It is also possible to directly inject iron into the tree. With most tree species this is best done in the fall as the process may cause some temporary defoliation.

Tree growth regulators have also shown promise as a treatment for chlorosis.

After assessing your site and plant health your Consulting Arborist can make specific recommendations regarding care and treatment of your important landscape plants.

Steps for treating the Symptoms and Causes of Chlorosis

Not all steps are necessary on all sites and some steps may require repeating an indeterminate number of times in order to maintain efficacy.

- ◆ Soil test and/or tissue analysis to determine nutrient deficiency
- ◆ Rootcare fertilization with mycorrhizae and additional nutrients as determined by the tests
- ◆ Soil injection of elemental sulfur and/or iron sulfate to lower soil pH
- ◆ Macro or micro-infusion of an iron solution into the root flares of the tree
- ◆ Root Regeneration to alleviate compaction and add organic matter to poor soils
- ◆ Removal of limestone-based rock mulch or lawn grasses under the canopy of the tree
- ◆ Mulch root zone area with organic mulches (i.e. shredded bark or cypress)
- ◆ Water deeply and infrequently, avoid frequent shallow irrigation
- ◆ Apply a tree growth regulator