KANSAS FOREST SERVICE
KANSAS STATE UNIVERSITY

Iron Chlorosis in Trees

When iron in the soil is either deficient or unavailable to trees, iron chlorosis can occur. In most Kansas soils, iron is plentiful, but unavailable to trees. Iron is readily available to trees growing in soils with a pH of 5.0 to 6.5. In soils with a pH of 7.0 (neutral) and above, iron changes to an insoluble form that is not as available to trees.

Several species of ornamental and native trees in Kansas suffer from iron chlorosis. The most susceptible species are pin oak, silver maple, baldcypress, and sweetgum. White pine, river birch, walnut, sugar maple, red maple, eastern redcedar, sycamore, ornamental pear, and some crabapple species may develop iron chlorosis. Treating iron chlorosis can be expensive. Therefore, proper selection of trees that tolerate soils with a high pH and are less effected by low iron availability is the best preventative for iron chlorosis.

Symptoms

Iron plays a major role in producing chlorophyll, the green pigment in leaves. A deficiency of iron reduces the amount of chlorophyll the leaves produce. When chlorophyll is reduced, a yellowing of leaves occurs. This is an early sign of iron chlorosis. On deciduous trees, iron chlorosis causes the leaf veins to remain green while the area between the veins is yellow-green to yellow. Leaves that emerge in early spring are frequently of normal size. Leaves emerging later in the year are often smaller and more yellow. In severe cases, the leaf color may change from yellow to white and finally brown. In advanced stages, twig dieback may be observed, especially toward the top of the tree and ends of the branches. After several years, the tree may die if the condition is not treated.

Variations in the soil, especially in urban areas, may result in iron chlorosis symptoms appearing on one side of the tree or on individual branches. In some cases, trees that have excessive amounts of moisture or are growing in an area with poor drainage may look chlorotic.

Diagnosis

Soil testing and **leaf sampling** should be done before treating a tree for iron chlorosis, especially with tree species other than pin oak. Soil testing can determine soil pH and other nutrients available to the tree. Soil samples should be taken about 6 to 8 inches below the surface of the ground. Several samples should be taken in random locations, then mixed together in a clean bucket. After the soil is mixed in the bucket, about one pint of soil is needed for testing. Soil or leaf samples can be taken to the local extension office or sent to other laboratories.

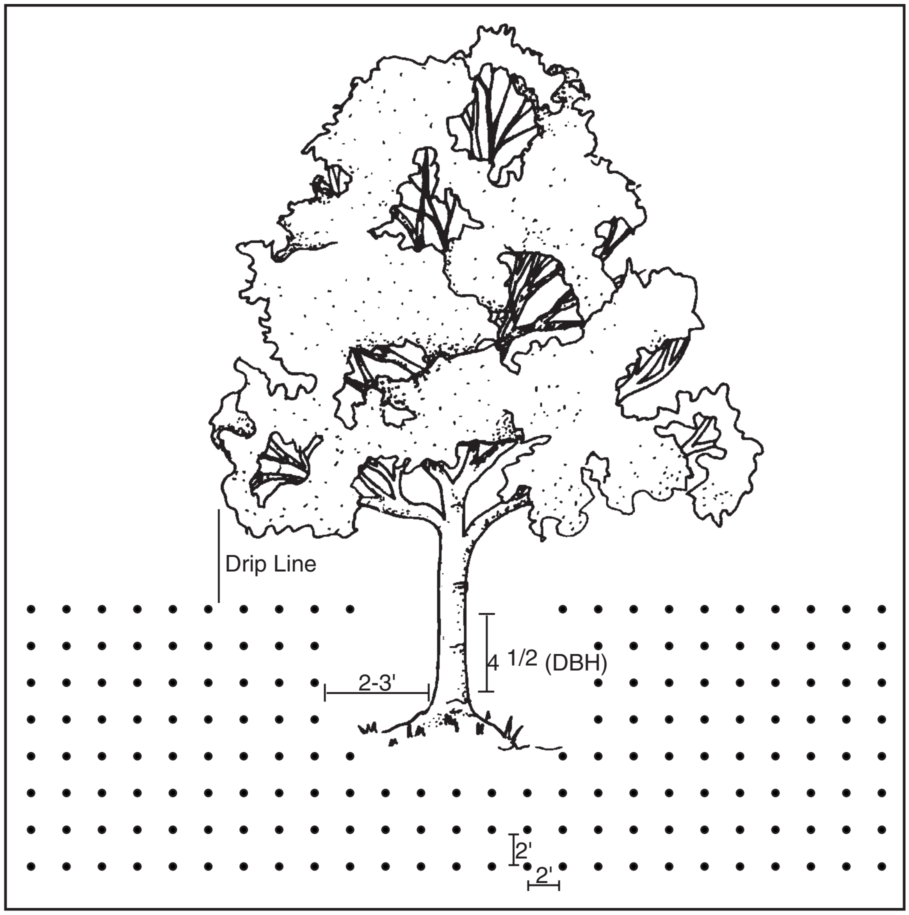
Correcting Iron Chlorosis

Once iron chlorosis or soil with a high pH is confirmed, several treatment methods can provide iron to the tree. These include foliar application, soil amendment, trunk injection, and trunk implantation.

Foliar application. If a rapid response is needed, a foliar spray with iron sulfate or iron chelate solution may be applied to the leaves when the tree is in full leaf. A rate of 5 pounds iron sulfate in 100 gallons of water (2.5 ounces iron sulfate in three gallons water) is recommended. Soybean flour (1 tablespoon per gallon) or detergent (one teaspoon per gallon) may be added to the solution to help the iron sulfate adhere to the leaves.

Iron chelates are water-soluble forms of iron that remain in the solution once added to the tree. Follow label instructions for determining the proper concentration when applying chelated iron directly to foliage. When applying either iron sulfate or iron chelate, applications made in the evening or during periods of cool weather are recommended. A foliar spray produces quick results. However, the improvement is temporary because the treatment will only affect the leaves sprayed. New growth emerging after the treatment may be chlorotic.

Soil treatment. Lowering the soil pH is a more permanent way of correcting iron chlorosis caused by soils with a high pH (above 7.0). Unfortunately, this method is one of the most difficult treatments. One procedure is to add soil amendments such as sulfur, iron sulfate, or aluminum sulfate to the soil. Sufficient quantities are needed to acidify soil and increase the amount of iron available to the tree. Iron sulfate can be applied to bare soil under the tree canopy. The application should be spread under the tree canopy to beyond the drip line (see diagram). The applications can be applied in conjunction with core cultivation to incorporate the treatment into the soil. The recommended rate is 1 pound per inch of tree diameter. Tree diameter can be attained by measuring the circumference of the tree at 4 feet above the ground then dividing by 3.14.



The best method for treating trees growing in turf-covered soil is liquid injection with a pressure applicator or placing iron sulfate in holes drilled or punched into the soil. Holes or injection sites spaced 2 feet apart and 6 to 10 inches deep can form a grid pattern under the tree (see diagram), beginning 2 to 3 feet from the trunk and extending beyond the ends of the branches (drip line). If holes or soil injections are made, calculate the treatment amount based on the product label and divide the treatment by the number of sites. Place equal amounts of the treatment at each site. In general, four to five holes per inch in tree diameter are recommended. The root systems of trees often grow well beyond the drip line. Therefore, holes or injection sites placed past the drip line are recommended. This treatment remains effective for 2 to 3 years.

Chelated iron may be used, but be sure to follow label directions for rates. For best results, the treatment should be made in early spring, just as buds begin to swell. If holes are drilled or punched into the soil, make sure there are no underground utility lines in the area.

An alternative soil treatment is the mixing of sulfur to the iron sulfate at a 1:1 ratio. The sulfur lowers the pH in a small area to make the iron more available to the tree. The recommended rate for trees 4 inches and smaller is 1 pound of iron sulfate/sulfur mix per inch of trunk diameter. The recommended rate for trees greater than 4 inches in diameter is a mixture of 2 to 3 pounds of iron sulfate/sulfur mixture per inch of trunk diameter. These mixtures should be applied as described above. Some available products are packaged with iron and sulfur combinations. If these products are used, be sure to follow all label instructions.

Iron tablets also are available for application into the root zone beneath the tree. The tablets have a quick release iron complex bound with a dispersing agent. Some tablets also contain sulfur. Obtaining even distribution of the iron in the root zone is sometimes difficult, and some branches may remain chlorotic. The tablets should be distributed in the soil as specified on the label.

Trunk injection and implantation

Iron sulfate, iron ammonium citrate, or iron chelate injected or implanted directly into the tree trunk is an effective method for greening up iron-chlorotic trees. A response is normally seen within two to three weeks if applied in the spring after leaves are fully developed. Trees treated later in the summer may not show a response until the following year. Additional treatments will vary depending on the severity of chlorosis, tree species, and individual tree response. In most cases, additional treatments may not be needed for 3 to 5 years.

Some trunk injection systems and implants can be applied by homeowners, and others must be applied by professionals. The most common treatments available to homeowners include products such as Medicaps. Medicaps consist of a plastic capsule filled with an iron citrate. Implant holes are drilled in the tree trunk where the capsule is to be placed. When implanted in the tree trunk, the capsules release the iron citrate into the water transport system of the tree. Capsule spacing is based on the diameter of the tree. Proper placement is important to obtain desired results. Follow all label instructions when using the capsules.

Trunk injection and implant systems available to commercial arborists include Mauget, Medi-Ject, Nutri Booster, and gravity-fed systems. The Mauget microinjection system consists of a capsule of iron chelate or iron ammonium citrate injected into the tree trunk through a needlelike tube. The capsule is pressurized by compressing before attaching to the tube. Small holes are drilled near the base of the trunk or root flares of the tree to fit the tubes. The Medi-Ject system contains a network of plastic tubing and T's placed in drilled holes around the tree trunk. Gravity is used to feed an iron sulfate solution directly into the trunk.

All injection systems have been field-tested and found effective under specific conditions. Results will vary with tree species, severity of chlorosis, time of year, soil moisture, and individual tree response. Following label directions, especially for rates and time of year for each treatment, should give the desired results.

Trunk Wounding

Some authorities have expressed concern over the number of wounds required with trunk injection and trunk implantation methods. Whenever holes are drilled into trees, damage to live tissue occurs. These wounds can provide entry points for disease organisms. The size of wounds will vary between each treatment. If the wounds are small, callous tissue will usually close the wounds within one year. Larger wounds will take longer to close. If trunk injection or implants are used, the homeowner should investigate the feasibility of other treatments described to avoid repeated wounding of the tree trunk.

Other Causes of Yellowing

Iron deficiency is not the only cause of leaf yellowing. Brown leaves that appear to show a severe case of iron deficiency may be caused by leaf scorch or another problem. Herbicide damage or other mineral deficiency– such as nitrogen, manganese, boron, or zinc – also may result in chlorosis symptoms. Signs of manganese deficiency, in particular, can appear similar to those of iron deficiency. Manganese deficiency can be distinguished by the broad bands of normal green color that remain next to the major veins. Leaves on the ends of the branches of manganese-deficient trees generally are not affected until late in the summer after growth has stopped.

Usually a foliar application of the deficient mineral in the summer, will result in a temporary green-up of the leaves. If the foliar application of the mineral thought to be deficient does not cause a temporary correction, this is a good indication that another mineral deficiency is causing the problem. Other possible causes should be investigated.

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