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# IRON CHLOROSIS OF WOODY PLANTS; CAUSE AND CONTROL

Chlorosis, a yellowing of the plant leaf due to a lack of chlorophyll, may be caused by a variety of factors. Among the more common causes are compacted soils, poor drainage, root damage, alkaline soils, and nutrient deficiencies. Probably the most common cause is iron chlorosis, where iron is unavailable to the plant. Iron (Fe) is an essential element for plant growth. It is required for the formation of chlorophyll, the green pigments that capture light to produce food for the plant. Iron is also necessary for the proper functioning of many plant enzyme systems that influence respiration and plant metabolism.

*Figure 1. Iron Chlorosis of Mountain Laurel.*

Chlorosis may develop because of unfavorable conditions for the utilization of iron in the plant or in the soil. Under neutral or alkaline conditions at a soil reaction (pH) above 6.5 to 6.7, iron changes into insoluble forms and becomes unavailable for uptake and utilization by the plants.

## Causes of chlorosis

Iron chlorosis can develop under conditions that reduce the availability of iron to the plant. Iron is usable by plants only as the Fe++ ion, and is available in this form only when the soil pH is between 5.0 and 6.5. The presence of relatively large amounts of zinc, manganese, or copper in the soil also contributes to iron chlorosis. Excessive amounts of these elements decrease or prevent iron absorption by the plant. Large amounts of limestone or ash, insufficient potassium, or excessive application of fertilizers that are high in phosphorus also contribute to iron chlorosis.

A deficiency of available iron is aggravated by low temperatures and plants under stress from poor root aeration or soil drainage, restricted root growth, soil salinity, or a lack of iron in the soil. In addition, many plants that are sensitive to iron chlorosis are planted without regard to their adaptability to existing soil conditions.

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Iron chlorosis occurs in a wide variety of crop and ornamental plants that grow in neutral and alkaline soils (pH above 6.5). Chlorosis is most common in Illinois near brick, stucco, or cement foundations and concrete sidewalks and drives, where high lime subsoils from basement excavations were used as fill, or where excessive amounts of limestone were applied.

Over 250 species of plants are susceptible. The crop plants that are commonly affected include apple, blackberry, blueberry, cherry, citrus, corn, flax, grape, turf and pasture grasses, mint, peach, pear, plum, quince, sorghum, soybean, and strawberry.

Woody ornamentals that are susceptible include arborvitae, azalea, bald cypress, birch, black locust, boxelder, boxwood, camellia, crabapple, cotoneaster, flowering dogwood, Douglas fir, elm, gardenia, ginkgo, honeylocust, hydrangea, juniper or red cedar, lilac, silver and sugar maples, certain oaks (bur, pin, red, shingle, white, willow), pine, poplar, privet, pyracantha, rhododendron, rose, sour gum, spirea, spruce, sweet gum, sycamore, tulip tree, walnut, and willow. The most commonly affected woody ornamentals in Illinois are the pin oak and the sweet gum.

## Symptoms

A lack of available iron produces a variety of symptoms on trees and shrubs, from a partial or complete yellowing (chlorosis) of young leaves to poor growth or the death of the plant. Symptoms may include the death (necrosis) of leaf tissues, premature leaf drop, a stunting and dieback of twigs and branches, and the failure of ornamentals to produce flowers or fruit. Occasionally, only part of a tree or shrub will show symptoms.

Chlorosis, the most common symptom, is characterized by a pale coloration of interveinal leaf tissues, yellowish green to golden yellow. The network of veins remains green (Figure 1). If severe, the leaves may be dwarfed, turn ivory colored, and appear scorched along the margins; or angular brown spots may develop between the veins. Such leaves eventually curl, wither, and drop prematurely. Trees under the stress of a high iron deficiency may have severely stunted or dead terminal twigs and branches, while the lower and older branches appear normal. In conifers, an overall yellowing of the needles occurs. If severe, the needles progressively turn brown and drop; shoots may die back.

Iron chlorosis can be confused with zinc and manganese deficiencies. Iron chlorosis can often be differentiated because the chlorosis appears first on the younger or terminal leaves, spreading later to the lower parts of the plant. Zinc and manganese deficiencies appear first on the older, basal leaves.

## Control

Iron chlorosis can be controlled when plants are supplied with available iron. The iron may be sprayed onto the chlorotic foliage, introduced into the trunk, or added to the soil. The most lasting results are obtained through treating the soil. Generally, the treatment is most effective when done by a licensed and experienced arborist with the proper tools and equipment.

1. **Foliar Treatment**. A thorough spraying of the foliage with iron (ferrous) sulfate, a soluble organic iron complex, or an iron chelate usually corrects chlorosis in leaves that are treated, but will not benefit leaves that are produced later in the season. Several sprays at 2- to 4-week intervals may be needed to keep the developing foliage green. Iron chelates are more effective in inducing recovery than spray applications of iron sulfate.

For treating shrubs, dissolve 2 1/3 ounces of iron sulfate in 3 gallons of water and thoroughly spray the foliage. Add a tablespoon of a commercial spreader-sticker to the spray mix to help the spray adhere to the leaves.

For treating trees, dissolve 1 pound of iron sulfate in 20 gallons of water and add 2 ounces of spreader-sticker. Several ounces of liquid household detergent can be substituted for the spreader-sticker. The foliage should be wetted uniformly until the spray begins to drip off the leaves.

If applying a spray of soluble organic complex or an iron chelate, follow the manufacturer's directions on the package label carefully. Spray the foliage in the late spring or early summer when the leaves are expanding in size. Sprays are best applied in the early morning or in the evening when the air is calm and both the humidity and soil moisture are high. Foliar applications of iron materials give a quick but short recovery from chlorosis, but the effects will not last more than one season.

2. **Trunk Implantation**. Introducing an iron salt into the trunk of an affected tree should control chlorosis for 2 to 4 years. Treatment is quick, neat, and effective. Recovery is often noted within 30 days. Three trunk implantation methods are available.

   A. **Implanting ferric or ferrous citrate powder.** Bore holes 3/8 to 1/2 inch in diameter and 1 to 2 inches deep into the white sapwood. Bore holes at an oblique angle, slanted downward, and 2 to 4 inches apart in a spiral around the tree beginning 1 to 3 feet above the soil line. Make a hole for each inch of trunk diameter. Trees with trunks up to 4 inches in diameter at breast height should receive 0.4 grams of ferric citrate per hole, with the holes 2 inches apart. Trees with trunk diameters of 4 to 12 inches should receive 1.4 grams per hole, with the holes spaced 3 inches apart. Trees with trunks larger than 12 inches in diameter should receive 2.8 grams per hole, with the holes 4 inches apart. Seal the holes with grafting wax, putty, glazing compound, or asphalt. Wood dowels or corks are not recommended for this purpose.

   B. **Placing plastic capsules containing ferric ammonium citrate**. Place capsules in holes bored into the sapwood as described in A above. The plastic capsules have slotted sides that allow a timed release of the iron salt into the sap and beveled heads that keep the sap from bleeding, thus promoting rapid wound closure (usually within a year). Several sizes of capsules are available. The one to use depends on the size of the tree being treated. Follow the manufacturer's recommendations concerning the size and quantity of plastic capsules needed. Encapsulated iron salts should be applied in the late spring or early summer. Research in Illinois and Ohio indicates that the use of encapsulated iron salts is a very effective method of controlling iron chlorosis, particularly in pin oak and bald cypress.

   C. **Injections of chelated iron into the trunk.** Solutions containing iron chelate can be injected under pressure into the tree trunk. A commercial product comes with the chelate solution in small plastic canisters. The iron chelate is injected into the tree in a pattern similar to that described for methods A and B. The holes made in the tree using this method are small and usually heal quickly. No foreign object or material is left in the tree trunk. Such tree injection treatments should be made by an experienced commercial arborist.

3. **Soil Treatments**. Iron chelates are commonly used and are effective. For best results, follow the directions on the package label carefully. The iron compound is placed in a series of holes, 1 1/2 to 2 inches in diameter and 12 to 15 inches deep, that are made with a punch bar or a soil auger. (A soil auger attached to an electric drill provides a quick and easy method of making holes). For uniform

distribution of the chemical, the holes should be spaced at 2- to 3-foot intervals in a series of parallel lines 2 feet apart under the complete spread of the branches and extending just beyond the drip line. No holes should be made within 2 1/2 to 4 feet of the tree trunk. Approximately 200 to 250 holes are required in a soil area of 1,000 square feet.

Another method of treating the soil is to dissolve the iron chelate in water and inject the solution into the soil, using a feeder needle or lance connected to a power sprayer that delivers 150 to 200 pounds of pressure per square inch. Up to 10 pounds of iron chelate in 200 gallons of water can be applied per 1,000 square feet. This is the maximum rate of iron chelate for highly alkaline soils (pH 8.0 to 8.5). Lesser amounts are needed for neutral soils (pH 6.5 to 7.2) and slightly alkaline soils (pH 7.2 to 7.5). Approximately 140 to 160 injection sites are required in 1,000 square feet of soil.

Soil treatment is best done when the soil is moist in April, May, or early June. If the soil is dry, irrigate immediately, using 1/2 to 1 inch of water or 300 to 600 gallons per 1,000 square feet. The trees and shrubs should green up within 30 days after application. A single soil treatment, properly done, should be effective for up to 4 years.

If chlorosis is due to inadequate soil drainage or excessive soil moisture (poor root aeration), the problem should be dealt with accordingly. Avoid overwatering. Install plastic drain tile, or make other arrangements to get rid of the excess water.