Colorado Master Gardener

GARDENING SERIES

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Iron Chlorosis

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Outline. . .

Symptoms

The term **chlorosis** means a general yellowing of the leaves. Many factors contribute to chlorosis.

Iron chlorosis refers to a yellowing caused by an iron deficiency in the leaf tissues. The primary symptoms of iron deficiency include **interveinal chlorosis**, i.e., a general yellowing of leaves with veins remaining green. In severe cases, leaves may become pale yellow or whitish, but veins retain a greenish cast. Angular shaped brown spots may develop between veins and leaf margins may scorch (brown along the edge).

Iron chlorosis shows first and more severely on newer growth at the branch tips. Growing leaves may be smaller than usual. Leaves may eventually curl, dry up, and fall. Fruits may be small with a bitter flavor. Mildly affected plants become unsightly and grow poorly. In severe cases, or if iron chlorosis persists over several years, individual limbs or the entire plant may die.

It is common for iron chlorosis to show on a single branch or on one side of a tree. This is particularly common for plant species with marginal winter hardiness and on the southwest side following winter injury. Plant species and varieties vary greatly in their susceptibility to iron deficiency.

On junipers, pines, and other evergreens, chlorosis usually develops as an overall yellowing of needles.

Iron is necessary for the formation of chlorophyll, which produces the green color in plants and is necessary for photosynthesis (sugar production in plants). A reduction in chlorophyll during the growing season reduces plant growth, vigor, and tolerance to stressful conditions. Plants with reduced vigor from iron chlorosis are prone to winter injury. Winter injury may also aggravate an iron chlorosis problem. Weakened plants also are more susceptible to other diseases and insect infestations.

Similar Symptoms

Iron chlorosis symptoms can be confused with other problems. Zinc and manganese deficiencies result in similar leaf symptoms. Iron chlorosis appears first on the younger or terminal leaves. Under severe conditions it may progress into older and lower leaves. By comparison, zinc and manganese deficiencies

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appear first on older, interior leaves. It's not uncommon for maple trees to show a response to both iron and manganese treatments.

Damage from soil sterilants (i.e., Pramitol, Atrazine, Simazine, Ureabor, and Diuron) used to prevent weeds result in similar symptoms. With these weed killers, the area along the vein remains green. With iron chlorosis, just the vein itself remains green.

Natural aging of tissues may create similar symptoms in some plants. Root and trunk damage and some virus, mycoplasmas, and vascular wilt diseases may cause similar leaf symptoms.

Causes and Complicating Factors

The factors leading to iron chlorosis are complex and not fully understood. A number of chemical reactions control iron availability and contribute to the complexity of iron chemistry in soils. Many Colorado soils are naturally high in lime (calcium carbonate and other calcium compounds) driving the soil pH above 7.5. On these calcareous soils, iron chlorosis is common on susceptible plants.

Colorado soils are abundant in iron, as evidenced by the popular *red rock* formations. In alkaline soils (pH above 7.0), iron is rapidly fixed through a chemical reaction into insoluble, solid forms that cannot be absorbed by plant roots. Such iron will be tied up indefinitely unless soil pH changes. Soil applications of iron alone are ineffective, as the applied iron will quickly be converted to these unavailable solid forms.

Many other environmental factors create or contribute to iron deficiency. These factors need to be evaluated and reduced to the extent possible. In some situations, attention to watering and soil conditions will satisfactorily correct minor iron chlorosis problems.

Water stress – Overly wet or dry soil predispose plants to iron chlorosis. Iron chlorosis is more prevalent following wet springs, and where gardeners over-water in the spring. Pay attention to watering frequency and depth, particularly in the spring, to correct most iron chlorosis problems.

It is common for gardeners to allow sprinkler control settings to remain unchanged from the high summer water needs to the lower water needs of spring and fall. In this situation, the yard receives around 40 percent more water needed. Changing the controller to meet seasonal needs will conserve water and correct iron chlorosis in most situations. For details refer to Colorado State University Cooperative Extension fact sheets 7.755, *Water-Wise Gardening: Watering Efficiently;* 7.757, *Irrigation Management: Converting Inches to Minutes;* and 7.758, *Irrigation Management: Methods to Schedule Irrigation*.

Soil compaction and soil oxygen – Soil compaction and other conditions that limit soil air infiltration (like surface crusting and use of plastic mulch) predispose plants to iron chlorosis by limiting effective rooting depth. These are a key contributing factor in clayey soils. Using organic mulch (like wood or back chips) helps prevent and reduce soil compaction. Avoid using plastic under rock mulch on iron chlorosis prone plants. For details on mulching and soil compaction refer to fact sheets 7.760, *Mulching with Wood/Bark Chips, Grass Clippings and Rock,* and 7.724, *Soil Compaction*.

Plant competition – On susceptible plants, competition from adjacent lawns or flowers may aggravate iron chlorosis. Remove grass under the tree canopy by mulching the area with several layers of newspaper covered with wood chips or by spraying with glyphosate (Round-up). Note that digging the grass may damage roots. Avoid flowerbeds under chlorosis susceptible plants.

Winter injury – Trees with cankers and other winter injuries are prone to iron deficiency. Light-colored trunk wraps help prevent winter injury. Remove the wrap each spring to prevent girdling injury as the tree grows.

Soil organic matter – Organic matter is a key to successful gardening in Colorado's soils. Ideally, the soil's organic content is brought up to 5 percent. However, excessive amounts may aggravate iron problems.

Excessive salt levels – High soil salt levels adversely affect uptake of water and nutrients, including iron. For details see fact sheet 0.503, *Salt-Affected Soils*.

Soil temperature and light intensity – Extreme soil temperatures and high light intensity may increase iron chlorosis problems. Use an organic mulch to moderate soil temperature. Shading may help some crops.

Acid-loving plants – Acid loving plants are highly susceptible to iron chlorosis and not suited to Colorado's soil conditions. These include blueberries, azaleas, rhododendron, flowering dogwood, and heather.

Nutrients – Excessive levels (from over application) of phosphate, manganese, copper, or zinc may also aggravate iron chlorosis.

Plant Selection: Right Plant, Right Place

In Colorado's high pH soils, the best method to prevent iron chlorosis is to select plant species tolerant to high soil pH and less affected by low iron availability. Avoid planting the more susceptible species (see table below) on soils prone to iron chlorosis problems (pH above 7.5, compacted, clayish, or wet soils).

Table 1. Examples of plants with high susceptibility to iron chlorosis.

Amur maple	Dawn redwood	Northern red oak
Apple	Douglas-fir	Peach
Arborvitae	Elm	Pear
Aspen	Flowering dogwoods	Pin oak
Azalea	Grape	Pine
Beech	Honeylocust	Raspberry
Birch	Horse chestnut	Red maple
Boxelder	Juniper	Rhododendron
Bumald spiraea	Linden	Silver maple
Cherry	London plane tree (Sycamore)	Spruce
Cotoneaster	Magnolia	Sweetgum
Crabapple	Mountain-ash	some 250 other species

Iron Additives

Unfortunately, there is no easy, inexpensive, or long-term correction for iron chlorosis. Treatments may be rather expensive and give disappointing results. Since plant and soil conditions vary greatly, there is no single approach that is consistently best.

The first step in using iron additives is to know the soil pH and free lime (calcium) content, that directly impacts the success of any approach. Determine the soil **pH** by conducting a soil test. When the pH is above 7.5, effective approaches are limited.

To check for **free lime**, place some crumbled soil in a small cup. Moisten the soil with vinegar. If the soil-vinegar mix fizzes or bubbles, it has free lime. High lime content is typical of soils with a pH above 7.5. A standard approach in treating iron chlorosis is to lower the soil's pH. Lowering the pH is impractical to impossible if the soil contains free lime.

There are four general approaches to iron treatments: 1) lowering the soil's pH; 2) soil iron treatments; 3) foliar sprays; and 4) tree injections. Each has advantages and disadvantages. Each option gives variable results depending on plant species and soil conditions.

The two principal types of iron-containing products used for iron application include **iron chelates** and **inorganic iron compounds** (such as iron sulfate, ferrous sulfate). Several types of iron chelates are marketed under a variety of trade names. Soil pH dictates the type of chelate to use. Treatment of any iron product made mid-season may not produce satisfactory results.

Lowering Soil pH with Sulfur Products

A standard approach used in many products is to lower the soil pH. This approach merits consideration only if the soil does NOT have free lime (high calcium). Lowering the soil pH may show effectiveness over a period of years.

However, due to the high pH and lime content of many Colorado soils, this approach seldom merits consideration. If irrigation water is hard, the calcium (lime) in the water counters any acidifying effect. (As a side note, it is observed that in some older gardens the pH has dropped below natural levels as the lime content is slowly leached out with decades of irrigation.)

The pH is lowered by soil applications of sulfur products. See product labels for the specific application rate. (Using aluminum sulfate to lower soil pH is not recommended due to a potential for aluminum toxicity.) For more details on lowering pH, refer to fact sheet 7.727, *Soil pH*.

Soil Applications of Iron Sulfate Plus Sulfur

A simple approach is to apply a mixture of equal amounts of iron (ferrous) sulfate and sulfur to the soil. Examples of products include Copperas, Jirdon Super Iron Green, HiYield Soil Acidifier Plus Micros, and Fertilome Soil Acidifier Plus Iron. Over a period of months to years, an improvement may be noticed. When it is effective, treatments may last up to three or four years, depending on soil conditions. This approach merits consideration only on soils without free lime.

For trees, apply the mixture in holes around the dripline (outer reaches of the branches) of the tree, as described for chelates below. Over time, the sulfur reacts to lower soil pH in a localized area. Broadcast applications dilute the material over a larger area are less likely to give satisfactory results. Treat rows of berries or small shrubs by placing the mix in a furrow 4 inches deep and 12 to 24 inches away from the plant. See specific label directions for application rates. For best results, treat the soil in spring.

Soil Applications of Iron Chelates

Soil application of iron chelates may give a rapid response if the correct chelate is used and other contributing factors are minimal. Applications after May 1 are less likely to show results. Treatments may last less than a season to a couple of years.

Treat trees by placing the iron product in rings of holes in the ground beneath the dripline. Make holes 1½ to 2 inches in diameter, 6 to 12 inches deep and 12 inches apart in rings 2 feet apart. On smaller trees make 2 to 3 rings of holes. For large trees, 4 to 5 or more rings of holes, and rings may need to extend beyond the drip line. No holes should be made within 2½ to 4 feet of the tree trunk on established trees.

Figure 2: Place iron soil additives in a ring of holes around the dripline of the tree.

Drill holes in the soil with a power or hand auger, bulb planter, or small trowel, removing the soil core. Using a punch bar that makes holes by compacting the surrounding soil may be less effective. To avoid damage to shallow utility lines, have the area blue-staked before you begin.

On soils with a pH above 7.5, only special chelates formulated for a high pH are effective. Examples include EDDHMA (Miller's Ferriplus) or EDDHA (Fe Sequestrene 138). Due to its higher cost, these products have limited availability. See product label for the specific application rate.

On acid to slightly alkaline soils, try other chelates like EDTA (Fe Sequestrene 330, Fertilome Liquid Iron) and DTPA (Miller's Iron Chelate DP).

They loose effectiveness quickly as the pH rises above 7.2 to 7.5. See product label for the specific application rate.

Soil Applications of Iron Sucrate

Iron sucrate, a relatively new iron source, is manufactured using iron oxide and molasses to form an iron-containing organic complex with limited water solubility. It has an advantage that it is less prone to staining (due to its very low solubility

It merits consideration in high pH soils. Additional research is needed for Colorado soils. It is marketed as Lilly Miller Iron Safe.

Foliar Sprays

Foliar sprays provide quick response, often in a matter of days. However, the treatment is often spotty and temporary. Multiple applications per season may be needed. Effects will not carry over into subsequent years.

Foliar applications are generally not recommended due to application limitations. Complete coverage is essential. Individual leaves not treated may remain chlorotic. Coverage on large trees is impractical to impossible.

There is a small margin between a concentration that will green up the leaves and a concentration that will burn. Leaf tissues are prone to turn black from an iron burn. Following an iron sulfate foliar treatment, it is common to see leaves that remain chlorotic, leaves that greened up, and leaves with black burn spots on the same plant. Spray hitting the sidewalk, house, and other objects may leave a permanent rusty discoloration. Chelated iron sprays are inactivated by sunlight.

Foliar applications may be made with some iron chelates or with iron sulfate products. Both types of products are equally effective. Iron chelates are more expensive. See product label for specific application rates and instructions. With foliar applications, spray in the evening or on cloudy days when drying time is slower. A few drops of liquid dishwashing soap or commercial wetting agent enhance sticking properties.

Trunk Injections

Several costly and effective methods using trunk implants or injections are available for large trees. Homeowners can apply some (for example Minicap Fe and Medicap Fe), while others must be applied by professional arborists. Read instructions available with commercial products for specific information about their use. Trunk injections may last from one to five years.

Trunk injection and implantation methods are controversial since injection sites can provide entry points for disease organisms and may cause localized damage. Selecting methods that use minimal hole size can minimize injury. Avoid annual treatments since damaged tissue around injection sites may girdle the tree.

Injected treatments are most effective if applied in the early spring during bud break. Avoid injecting materials on hot, dry, windy days since leaves are prone to blacken from burn. Make sure the tree has good moisture for several days before and several weeks after treatment.

Commercial formulations are available as liquids, powders, or capsules and should be used according to directions. Look for formulations that contain ferric ammonium citrate (iron citrate) or ferrous sulfate. Holes should be made with a sharp brad-point bit to ensure quick uptake and reduce injury. Pay particular attention to manufacturer recommendations on hole placement, angle, depth and diameter. Uptake is often better and more evenly distributed if holes are drilled near the soil surface on the outside of the root flares.

Professional arborists may use other materials for correcting iron chlorosis. To locate a professional arborist, look for a *tree service* listing in the yellow page section of your local telephone book. Make sure they are certified by the International Society of Arboriculture.

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