Tennessee State University

College of Agriculture Cooperative Extension

# IRON DEFICIENCY IN NURSERY PRODUCTION

Amy Dismukes, Central Region Nursery Extension Specialist and
Dr. Anthony Witcher, Nursery Production and Sustainability

## WHY IS IRON IMPORTANT?

Iron is one of the 17 essential elements (14 mineral elements and 3 non-mineral elements(C,H,O)) required for plant growth and development. Although iron is considered a micronutrient and only required in small amounts, it is a critical component for a number of plant processes. Iron is required for the production of chlorophyll, the primary pigment used in photosynthesis where light energy is absorbed and stored to produce food for the plant. Iron is also a component of several enzymes and proteins involved in respiration and plant metabolism (Hochmuth, 2017; Rout and Sahoo, 2015.

Iron is the third most limiting nutrient for plant growth and metabolism (Zuo and Zhang, 2011). When a plant lacks sufficient iron content, there is less food production, leading to reduced growth and overall decline in health. In severe cases, branch dieback can occur which contributes to secondary pest infestations (insects and pathogens) and eventual plant death.

## SYMPTOMS OF IRON DEFICIENCY

Characteristic symptoms of iron deficiency involve interveinal chlorosis (when leaves turn yellowish-green to bright yellow between leaf veins that remain green) (Bienfait and Van der Mark, 1983) (Figure 1). Interveinal chlorosis appears first on newly developed leaves and young plant growth but can spread to older leaves over time, leading to poor root formation. Iron is relatively immobile within plant leaves and shoots, so plants cannot readily transport iron from older portions of the plant to newer leaves and shoots (Hochmuth, 2017).

In severe cases of deficiency, additional symptoms may include reduced leaf size, leaf necrosis (leaves turn brown and die), early leaf drop, branch dieback, failure to produce flowers or fruit, and overall stunted growth. Fungal leaf spots are more common on leaves with iron deficiency and tend to make the necrosis appear worse. Interveinal chlorosis can also be associated with magnesium, manganese, and zinc deficiencies, but symptoms occur on older leaves (Pataky, 1996).

Figure 1. Iron deficiency symptoms (yellowing of leaf tissue and interveinal chlorosis) on willow oak (*Quercus phellos*; left) and Chinese fringe tree (*Chionanthus retusus* 'Tokyo Tower'; right).

## CAUSES OF IRON DEFICIENCY

Leaf chlorosis results from the lack of sufficient iron present in the plant and can be due to a high iron need of the plant, lack of iron in the soil, or less effective iron uptake. Most often, iron deficiency is related to high (alkaline) soil pH. Iron is water-soluble and readily absorbed by plant roots when soil pH ranges 5.0 to 6.5 (Pataky, 1996). As soil pH increases, iron is converted to an insoluble form unavailable for plant uptake.

Some woody plant species are more adapted to soils with a low pH and are less efficient at absorbing iron as soil pH increases and exceeds 6.0 (azalea, blueberry, red maple, river birch, and rhododendron). Other woody plant species susceptible to iron deficiency include American holly, dogwood, sweet gum, white pine, willow oak, and viburnum (Ward Gauthier et al., 2003). Conditions that can contribute to iron deficiency include compacted soils, poorly drained soils, damaged/unhealthy root systems, and irrigation water with high alkaline pH.

## METHODS FOR CONFIRMING IRON DEFICIENCY IN NURSERY CROPS

A soil analysis (pH and mineral nutrient content) and plant tissue analysis (complete nutrient content analysis) should be conducted by an analytical laboratory to confirm iron deficiency. For field nurseries, collect soil samples from the upper 6 inches of soil at several locations within an affected tree block then mix together (need about 1 pint of soil for testing). For container nurseries, container substrate pH can be tested following a pour-through extraction to collect about 2 ounces of leachate from a single container for analysis. For leaf tissue analysis, collect about 30 to 40 leaves from the newest foliage that exhibit chlorotic symptoms. A leaf tissue sample from healthy growing plants should also be collected and analyzed for comparison. Place leaves in a small paper bag and allow to air dry for one day prior to shipping.

## BMPs AND CORRECTIVE MEASURES FOR IRON DEFICIENCY

Monitor crops in early spring for interveinal chlorosis, especially plant species that have a history of this symptom. If the problem persists, corrective measures will be required.

### FOLIAR SPRAYS

Iron sulfate and chelated iron products applied as a foliar spray can provide a temporary green-up and be used to verify an iron deficiency. Multiple applications at 2 to 4 week intervals will be required to treat newly developed leaves and to maintain green foliage throughout the growing season. To maximize effectiveness, foliar sprays should be made early in the growing season in the morning or afternoon. This is a temporary fix and will not correct the underlying deficiency (Carlson, 2003).

### SOIL APPLICATION

Iron sulfate and chelated iron products can also be applied to the soil to increase iron content, but are most effective when dissolved in water as a drench or in fertigation. Applications should be made in the early spring as plants produce leaves, but this is a temporary fix and will not correct the underlying issue.

### pH ADJUSTMENT

High soil or/substrate pH should be corrected to provide a long-term solution to iron deficiency.

In field soils, elemental sulfur and iron sulfate applications can lower soil pH over time and make iron more readily available for plant uptake. Elemental sulfur takes longer to react in the soil (3 to 4 months) while iron sulfate reacts more quickly (3 to 4 weeks) and also provides additional iron for plant uptake. For long-term effectiveness both products should be applied in the fall, broadcast over the soil surface, and incorporated into the top 6 to 8 inches. (Table 1). Soil pH can be analyzed in the spring to verify effectiveness (Hart et al., 2003).

High pH can be avoided in container-grown crops by reducing (or eliminating) the amount of dolomitic lime incorporated into the pine bark substrate at planting. To reduce substrate pH in long-term container-grown crops, containers can be top-dressed with elemental sulfur or iron sulfate. Iron sulfate will provide additional iron for plant uptake (Halcomb and Fare, 2011).

Iron deficiencies are more easily avoided than corrected in the nursery production system. For container-grown crops, test container substrate pH prior to planting to make sure it is in the range for sensitive species (pH 5 to 6). For field-grown crops, test soil pH prior to planting to take corrective treatments in a timely manner. Soil pH should also be monitored annually for sensitive species to address potential problems. Additionally, sensitive species can be grouped in close proximity to reduce the labor and expense of monitoring pH and applying corrective soil treatments. The most successful way to avoid iron deficiencies is to be aware of plants sensitive to pH ranges and the particular needs of each plant. Taking proactive measures versus reactive measures can often assure success in production.

Table 1. Estimated amount of elemental sulfur required to lower pH of a silt loam soil[1].

| CURRENT SOIL pH | TARGET SOIL pH | | | | |
|---|---|---|---|---|---|
| | 6.5 | 6.0 | 5.5 | 5.0 | 4.5 |
| | POUNDS OF ELEMENTAL SULFUR[2] PER 100 SQ. FEET | | | | |
| 8.0 | 3.0 | 4.0 | 5.5 | 7.0 | 8.0 |
| 7.5 | 2.0 | 305.0 | 4.5 | 6.0 | 7.0 |
| 7.0 | 1.0 | 2.0 | 3.5 | 5.0 | 6.0 |
| 6.5 | | 1.0 | 2.5 | 4.0 | 4.5 |
| 6.0 | | | 1.0 | 2.5 | 3.5 |

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For additional information, contact your local nursery extension specialist, or

**Tennessee State University, Otis L. Floyd Nursery Research Center**
472 Cadillac Lane McMinnville, TN 37110
http://www.tnstate.edu/agriculture/nrc/
931-668-3023

**Funding Support**
Funding for this work was supported by Tennessee State University.

**Precautionary Statement**

To protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label.

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