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Recognizing and Treating Iron Deficiency in the Home Yard

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Iron deficiency is a frequent problem for many ornamental plants growing in the low desert areas of Arizona. The underlying cause for this disorder is the high pH levels of our soils. Calcium carbonate ($CaCO_3$) deposits are a common feature of high pH desert soils. Calcium carbonate accumulates in desert soils because precipitation is not sufficient to wash or leach these naturally occurring materials out of the soil. Calcium carbonate may be visible as light colored concretions (lumps) which range in size from less than one inch to several inches across or as a solid layer, ranging from a few inches to several feet in thickness, although calcium carbonate is often present even when it is cannot be seen. If these deposits form solid layers they are known as caliche. When calcium carbonate dissolves in water, it raises pH to 8.0 to 8.5, and this is the pH range of most desert soils. In this high pH environment, iron solubility is greatly reduced. In desert soils there is usually plenty of iron; it just is not soluble enough to provide adequate nutrition to susceptible plants. Over-watering plants growing in calcareous soils can induce or worsen iron deficiency. Additionally, cold winter soils may induce iron deficiency, which often disappears when soils warm in the spring.

If an adequate amount of iron is not available to plants, iron deficiency (iron chlorosis) will result. This condition may be recognized by the nature of deficiency symptoms. The symptoms of iron deficiency appear on the youngest, newest leaves. The area between the leaf veins becomes pale yellow or white (this is called interveinal chlorosis). Usually, no noticeable physical deformity occurs, but in severe cases the youngest leaves may be entirely white and stunted. Iron deficiency symptoms in some common ornamentals are shown in figures 1 through 4. It may be difficult to distinguish iron deficiency symptoms from those of other nutrients, particularly zinc, which has similar symptoms in many plants. In iron deficient leaves, interveinal chlorotic lesions are angular and outlined by the leaf veins, whereas the chlorotic lesions in zinc deficient leaves are more rounded and the edges less sharp (figure 5).

Soil testing can tell you the pH and the calcium carbonate levels in your soil, and laboratory analyses can give you an indication of the amount of plant-available iron your soil contains (see Walworth 2012a, and Shalau, 2010). However,

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Figure1. Iron deficiency is common in domestic roses.

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Figure 2. Grapes showing iron deficiency. Note that the older leaves at the bottom of the photograph show normal coloration.

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Figure 3. Mulberry showing iron deficiency symptoms.

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Figure 4. Iron deficient purple orchid tree.

susceptibility to iron deficiency varies greatly between plants, and it is not uncommon to see a plant with severe iron deficiency growing adjacent to one in identical soil with no symptoms at all. Desert plants evolved in high pH soils and are less susceptible to iron deficiency because they have mechanisms that enable them to solubilize and absorb iron from high pH soils. In contrast, plants from regions with acidic soils do not have this ability. Most humid tropical and subtropical regions fall into this category and therefore many of the ornamental and crop plants we have imported from these areas are susceptible to iron deficiency. Examples include citrus, roses, gardenia, crepe myrtle, and many others. Members of the Ericaceae or Heath family such as azaleas, rhododendrons, and blueberries are extremely susceptible to iron deficiency.

The easiest way to avoid iron deficiency is to grow desert-adapted plants such as mesquite, ironwood, palo verde, acacia, agave, yucca, cactus, etc. These plants rarely, if ever, suffer from iron deficiency. Koenig and Juhns (2010) and Tindall et al (1996) contain lists of the degree of iron deficiency susceptibility among crop and ornamental plants.

There are several methods of correcting iron deficiency once it is identified.

1. Acidify the soil

The ultimate cause of iron deficiency is high soil pH. Theoretically, this situation can be remedied directly by lowering soil pH, however this solution is not practical under most circumstances. Desert soils with caliche are very well buffered, which means that the pH is extremely difficult to change long-term. Also, it may not be practical to change the pH of soil in which perennial plants are already established because amendments cannot be adequately incorporated into the soil. This remedy is most likely to succeed in containers or beds where only small volumes of soil are treated and plants are replaced frequently (e.g. bedding plants or vegetables).

Adding powdered or prilled (pelleted) elemental sulfur to soil will add acidity. The amount needed will vary depending on soil texture and the calcium carbonate content. The following

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Figure 5. Iron deficiency symptoms (top photo) and zinc deficiency symptoms (bottom photo) in pecan leaves.

rates are suggested as starting points: one-half ounce (14 grams) per cubic foot of soil in sandy soils, one ounce (28 grams) per cubic foot of soil in silty soils, and two ounces (56 grams) per cubic foot in clay soils. Sulfur should be thoroughly mixed with the soil. Application of too much sulfur can over-acidify the soil, a situation that should be avoided (soil pH should be kept above 6.0). See Hart et al (2003) for additional information on acidifying soils.

Note that not all forms of sulfur will acidify soil. For example, gypsum ($CaSO_4.2H_2O$), which is a useful amendment for soils affected by high levels of sodium, does not acidify soil and will not help correct or avoid iron deficiency. For more information on the use of gypsum see Walworth (2012b).

2. Apply iron fertilizer to the soil

Chelated iron fertilizers, in which the iron is combined with an organic chemical called a chelate that helps keep the iron in a plant-available form, are most appropriate for application to the soil. Fertilizing high pH soils with non-chelated iron fertilizers such as ferrous sulfate ($FeSO_4.2H_2O$) is not recommended because this iron will not be available to plants.

Chelated iron fertilizers include Fe-DTPA, Fe-EDDHA, and Fe-EDTA. Iron added in these forms will remain available longer than non-chelated iron, although even these forms of iron will not remain available to plants indefinitely in high pH soils. Fe-EDDHA is more effective in high pH soils than Fe-DTPA or Fe-EDTA. When buying chelated iron, read the fertilizer label to make sure that all the iron is in chelated form. Some fertilizer labels indicate that the fertilizer contains chelated iron, but careful reading of the label reveals that only a few percent of the iron is chelated.

Apply Fe-EDDHA fertilizer at a rate of approximately 2 to 3 lbs/1000 ft^2 of soil (3 to 5 oz/100 ft^2). This treatment may have to be repeated several times during the growing season. Frequency will depend on soil and plant properties, and is best gauged by observing plant performance.

The chelates discussed above are man-made. Natural chelates can be found in soil organic matter. Practices that increase levels of soil organic matter, such as adding manure to soil, can help maintain iron in a plant-available state.

3. Apply iron directly to the plant foliage

An effective means of supplying iron deficient plants with supplemental iron is by spraying fertilizer on the plant leaves. An inexpensive and commonly used material for this purpose is ferrous sulfate ($FeSO_4.2H_2O$). Mix 1 to 2 oz of ferrous sulfate in 1 gallon of water. An equivalent rate of chelated iron can be used instead, but the more expensive chelated forms of iron offer little advantage for foliar application. Adding a couple of drops of liquid dishwashing soap per gallon will help wet the leaves and improve penetration, particularly on plants with waxy or hairy leaves.

Spray this solution on the plant leaves during cool weather. In hot weather apply in the evening to avoid burning leaf tissue. Do not use a stronger solution that recommended, as leaf tissue is quite sensitive and easily can be damaged. Spraying a small portion of the plant, then waiting a day to check for possible foliar damage may be prudent for high-value plants.

Although foliar iron application is very effective, it is not a permanent solution. Iron sprayed on leaves moves very little within the plant and new leaves that form after foliar iron application may soon begin to show deficiency symptoms. At this time an additional application will be necessary. For rapidly growing plants, sprays may have to be repeated every few weeks. Application frequency can be determined by regular visual inspection of plants.

Iron deficiencies are more easily avoided than corrected. It may be possible to avoid the problem through the use of sulfur during soil preparation for potted plants and making sure adequate drainage is provided, although susceptible species may still exhibit problems. The most successful means of averting iron deficiencies is to avoid sensitive plants. In general, desert species are better adapted to Arizona soils than are plants from other parts of the world. Many plant guides contain information about the susceptibility of plant species to iron deficiency and can help in the selection of appropriate plants.

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