



## Micronutrient Deficiencies in Citrus: Iron, Zinc, and Manganese<sup>1</sup>

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Plant nutrients are classified as macronutrients and micronutrients. “Macronutrient” refers to elements needed in large amounts, and “micronutrient” signifies nutrients that are essential to plants but are needed only in small amounts. The micronutrients are Fe, Zn, Mn, B, Cu, Mo, Cl, and Ni.

When macronutrients are supplied in relatively high proportions compared with micronutrients to stimulate growth of newly planted citrus trees, extreme depletion of micronutrients can develop as a result of marked top growth, and micronutrient deficiencies can appear. Therefore, a balance between macronutrients and micronutrients is needed. Citrus micronutrient deficiencies are most commonly observed on previously uncultivated soils, shallow soils with high water table, extremely sandy areas, and calcareous soils. Since mineral nutrition is a major factor in maximizing yield of high quality fruit, it is essential to understand the functions of mineral elements, diagnose nutrient deficiencies, and provide needed fertilizers in sufficient amounts. This fact sheet describes and discusses deficiencies that occur commonly in the field and the symptoms that can be used to guide for fertilizer practices.

### Iron (Fe)

Iron deficiency is common on Florida's calcareous soils. A calcareous soil contains a high concentration of calcium carbonate and has a pH of about 8.3. These soils may contain appreciable iron, but it exists in a form that is only slightly available to plants. Iron deficiency can also be attributed to low soil Fe concentration in white sandy areas near lakes and places known locally as “sand-soaked areas”. Iron deficiency can be induced by high levels of P or accumulation of heavy metals, primarily Cu, in the soil. In Florida, Fe deficiency is commonly associated with Zn and Mn deficiencies.

The symptom of Fe deficiency is known as “iron chlorosis” and is called “lime-induced chlorosis” when it occurs on calcareous soils. Deficiency symptoms occur on young leaves, which appear light yellowish to white in color, with the veins greener than the remainder of the leaf. In acute cases, the leaves are reduced in size, fragile, very thin, and they can shed early. The trees die back severely on the periphery and especially at the top. Some trees may have a dead top with the lower limbs carrying almost normal foliage. Eventually tree canopy volume decreases and fruit set and yield are

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reduced. The fruit tend to be small with reduced soluble solids and acidity in the juice. Sometimes only a branch of a tree may be affected, or perhaps only a few trees in an orchard will be chlorotic. In severe cases, the entire tree is affected. It loses part of its leaves, becomes unproductive and dieback results.

Iron deficiency is usually associated with high soil alkalinity, but it is also associated with excessive irrigation, prolonged wet soil conditions or poor drainage, and low soil temperature. Some areas affected with Fe chlorosis in south Florida have been substantially helped or completely cured by careful control of irrigation and drainage. Iron deficiency sometimes occurs where excess salts are present in the soil and in other situations that are not clearly understood.

Iron deficiency is one of the most difficult deficiencies to correct, especially on calcareous soils. Foliar application of Fe is not recommended due to lack of effectiveness and risk of leaf and fruit burn. At best, foliar sprays of Fe produce a speckled greening of the leaves rather than an overall greening. The most reliable means of correcting citrus Fe chlorosis is by soil application of iron chelates. However, Fe chelates are not equally effective. See the Table 1.

**Table 1.** Iron Chelates

Iron Chelates	Effective pH Range
Fe-EDTA	4.0 to 6.5
Fe-HEDTA	4.0 to 6.5
Fe-DTPA (Sequestrene 330 or equivalent)	4.0 to 7.5
Fe-EDDHA (Sequestrene 138 Fe or equivalent)	4.0 to 9.0

Iron sulfate does not provide sufficient available iron when applied to either acid or alkaline soils because it quickly transforms to iron oxide. Citrus rootstocks vary in their ability to absorb Fe. Trifoliolate orange and its hybrids (Swingle citrumelo and Carrizo citrange) are the least able to do so. Fortunately, Fe deficiency is not so widespread as some of the other micronutrient deficiencies and presents a less important commercial problem, except in specific small areas of the Florida citrus industry.

## Zinc (Zn)

Zinc deficiency has traditionally been the most widespread deficiency in citrus. Zinc deficiency is commonly known as “rosette” or “frenching” in Florida. Rosetting does not usually occur in citrus. Zinc deficiency symptoms are characterized by irregular green bands along the midrib and main veins on a background of light yellow to almost white. The relative amounts of green and yellow tissue vary from a condition of mild Zn deficiency in which there are only small yellow patches between the larger lateral veins to a condition in which only a basal portion of the midrib is green and the remainder of the leaf is light yellow to white.

In less acute stages, the leaves are almost normal in size, while in severe cases the leaves are pointed, abnormally narrow with the tendency to stand upright, and extremely reduced in size. In mild cases, Zn deficiency symptoms appear on occasional weak twigs. Fruit formed on these twigs are drastically reduced in size and have an unusually smooth light-colored thin skin and very low juice content.

As Zn deficiency progresses, leaves are affected over the entire periphery of the tree and twigs become thin and die back rapidly. A profuse development of “water sprouts” occurs on the main branches and trunk with leaves free of deficiency symptoms. Fruit grown on these water sprouts are large, coarse and woody. The tree has dense growth in the center and a dying appearance over its periphery, which give the tree a very bushy appearance. Affected leaves have irregular chlorotic areas between the leaf veins. As they develop, new leaves become progressively smaller. The number of blossoms and fruit set is greatly reduced, and fruit that are produced are of poor quality.

Zinc deficiency symptoms can be so severe that they may mask or noticeably alter the symptoms of other deficiencies or disorders. Deficiencies of Mg and Cu can also reduce Zn uptake through root injury, giving rise to characteristic symptoms of Zn deficiency, even though there is sufficient available Zn in the soil. A Zn deficiency can develop due to soil depletion or formation of insoluble Zn compounds. Excessive P or N can also induce or

aggravate Zn deficiency. Soils receiving large and frequent amounts of poultry manure often show deficiency symptoms.

A single foliar spray of a solution containing 2 to 4 lbs of elemental Zn per acre from Zn sulfate, oxide, or nitrate can correct Zn deficiency. Under severe deficiency conditions, a foliar Zn spray may be necessary on each major growth flush to keep the trees free of symptoms because Zn does not translocate readily to successive growth flushes. Adding 2 to 3 lbs per acre of hydrated lime to the spray can reduce potential foliage injury. Maximum benefit is obtained if spray is applied to young leaves when they are two-thirds to nearly fully expanded, before hardening off. Treatment on the spring flush is preferable. Zinc dusts are less effective than sprays. Soil application of Zn in the fertilizer is neither an economical nor an effective way to correct Zn deficiency. One of the early diagnostic symptoms of a disorder known as young tree decline or “blight” is a Zn deficiency pattern in the leaves. Correction of the symptoms will not alleviate the disorder, and trees will never recover from the disease.

### **Manganese (Mn)**

Manganese deficiency occurs commonly in Florida and it is also known in many other areas of the world. It is particularly evident in the spring after a cold winter. There has been a delay in the recognition of Mn deficiency symptoms due to masking by severe Zn or Fe deficiencies. Sometimes the deficiency can be confused with symptoms of Fe and Zn deficiency or B toxicity. Manganese deficiency leads to a chlorosis in the interveinal tissue of leaves, but the veins remain dark green. Young leaves commonly show a fine pattern or network of green veins on a lighter green background but the pattern is not so distinct as with Zn or Fe deficiencies because the leaf is greener. By the time the leaves reach full size, the pattern becomes more distinct as a band of green along the midrib and principal lateral veins, with light green areas between the veins.

In more severe cases, the color of the leaf becomes dull-green or yellowish-green along the midrib and main lateral veins, and pale and dull in the interveinal areas. Whitish opaque spots may develop

in the interveins, which give the leaf a whitish or gray appearance. The leaves are not reduced in size or changed in shape by Mn deficiency, but affected leaves prematurely fall from the tree. No particular twig symptoms are related to Mn deficiency. Growth is reduced in an acutely affected tree, giving it a weak appearance.

Manganese deficiency may greatly reduce crop volume and the fruit color. The fruit may become smaller and softer than normal and the rind pale in color. Manganese deficiency is frequently associated with Zn deficiency. A combination of the two deficiency symptoms on leaves is called “marl frentching” or “marl chlorosis,” and is characterized by dark green veins with dull whitish green areas between the veins. In such combinations, the Mn deficiency is acute and the Zn deficiency is relatively mild.

In Florida, Mn deficiency occurs on both acidic and alkaline soils. It is probably due to leaching in the acid soils and to insolubility in the alkaline soils. It can be associated with deficiencies of Zn, Fe, and Cu on both acid and alkaline soil and with Mg deficiency on acidic sandy soils. For deficient trees on alkaline soils, foliar Mn sprays are recommended. On acid soils, Mn can be included in fertilizer applied to the soil. Foliar spray application quickly clears up the deficiency pattern on young leaves, but older leaves respond less rapidly and less completely. When Mn is sprayed on Mn-deficient orange trees, fruit yield, total soluble solids in the juice and pounds solids per box of fruit increase. A foliar spray of a solution containing 2 to 3 lbs per acre of elemental Mn applied to two-third to fully expanded spring or summer flush leaves is recommended. If N is needed, adding 7 to 10 lbs per acre of low biuret urea will increase foliar Mn uptake.