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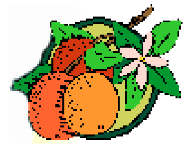
Fertilizing Citrus in the Foothills



Publication Number 31-011C
(2020 update)

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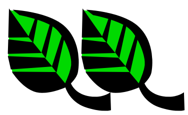
Citrus trees are not very nutrient demanding, but production of a high quality crop requires adequate amounts of essential nutrients. Most foothill growers need to add nitrogen and zinc annually. Manganese deficiencies are fairly common, and boron may also be deficient. Potassium is important in fruit development and may need to be supplemented. In some acid foothill soils, phosphorus may be unavailable. However, many of our agricultural soils have excess phosphorus, so do not apply phosphorus without a soil test.



Leaf tissue analysis is the best tool growers have for determining tree nutrient status. By providing an accurate assessment of plant, rather than soil, nutrient status, deficiencies can be identified and corrected. Analysis may indicate high or low nutrient levels that may not be optimal, but are not yet manifesting symptoms. Starting in the fourth year, samples should be taken every other year and analyzed for nitrogen, phosphorus, potassium, zinc, manganese, and boron.

Applying fertilizer based on soil and tissue analysis is critically important. A common practice has been to use 15-15-15 or 16-16-16 NPK + sulfur fertilizers on citrus in the foothills. The use of these over multiple years without regular soil and tissue analysis has detrimental effects on orchard health and productivity. These effects include excess soil phosphorus, low pH as a result of of the sulfur, and increased micronutrient deficiencies.

Macronutrients

Nitrogen (N)

Citrus grown in the foothills generally needs supplemental nitrogen. Nitrogen deficiency manifests as an overall yellowing of foliage, beginning with the older leaves and progressing to younger growth. Poor flowering, which affects yields, and stunted growth are also symptomatic of insufficient nitrogen. In cases of severe deficiency, leaves drop and foliage becomes sparse. Temporary N deficiencies often occur in winter or early spring. These may be caused by low N reserves in the tree; low soil temperatures which reduce N mineralization rates; and/or lack of root activity due to low temperatures and saturated soils.

Nitrogen may come from a variety of sources. It may be applied to the soil in granular form, through the irrigation system (fertigation), or foliar sprays. Nitrogen may come from legume cover crops, compost, and/or composted manures applied to the tree rows. In the foothills, rainfall deposits 10 to 25 lbs. of N per acre per year. It is important to include all nitrogen inputs in determining fertilizer needs, in order to avoid applying excess nitrogen.

Winter nitrogen applications are not recommended as much of the N will be lost to run-off or leaching, contributing to nitrate pollution of waterways. Nitrogen applications are best split into three or more applications, starting in March.

Pre- and post-bloom (after petal fall) foliar applications are an effective alternative to soil application. Research has shown that foliar applications of low biuret urea, up to a quarter of the N requirement, can significantly increase fruit set and yield in oranges (Lovatt). Spring applications are critical as the highest demand for nitrogen is from bloom through June. Adequate nitrogen is important during this period for growth flushes, flowering, and fruit set.

Nitrogen applications should be completed by the end of June to avoid stimulating late growth flushes. These are susceptible to cold and insect damage and impact fruit quality. High N levels in late summer and fall contribute to poor fruit color, thicker rinds, and less juice. Excess nitrogen may delay maturity, reduce fruit quality, and increase the number of large, rough fruit.

Young citrus trees require nitrogen for good growth and development. In the year after planting, new trees need two ounces of nitrogen per tree. However, fertilizer

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growth flush. Apply when new growth is almost fully expanded, but not yet hardened off.

Manganese (Mn)

Manganese deficiency is common in foothill citrus, often in combination with zinc deficiency. Temporary deficiencies occur in late winter due to low soil temperatures and reduced root activity. Symptoms may disappear as temperatures rise and roots become active, but persistent symptoms should be treated. If leaf symptoms persist for several months, yields may decline.

Mn deficiency symptoms are visible on new leaves as a yellowing between the veins (interveinal chlorosis). Leaves are normal size, but the midrib and veins are blotchy or mottled green. The spring growth flush may exhibit more obvious symptoms, especially on the north side of the tree. As the severity increases, interveinal areas become lighter in color, almost white, and leaves drop prematurely.

Mild Mn deficiency reduces tree vigor and yield slightly. Severe deficiency will cause defoliation and significantly reduced vigor and yields. Mn deficiency frequently occurs in combination with zinc which may mask its symptoms. Leaf tissue analysis should be used to determine which nutrients are deficient.

Manganese deficiency can be corrected with a foliar spray of 1 pound of manganese sulfate (MnSO4) in 100 gallons of water, at a rate of 800 gallons per acre. 7½ pounds of low-biuret urea may be added to the mixture to facilitate Mn uptake. Zinc and manganese deficiency often occur at the same time, and 1 pound of zinc sulfate may be added to the spray to correct both problems. For the most effective application, apply in the spring when new leaves are half to two-thirds expanded.

Boron (B)

Boron deficiencies are common in some foothill areas, particularly soils that have been graded; others have excess B. Deficiency symptoms include leaf bronzing and death of terminal growing points, causing rosettes with multiple buds. Leaves become thickened, curl downward, and upper leaf veins may enlarge and split. Premature leaf drop begins at the top of the tree, leading to defoliation. Growth is severely affected, especially in young trees.

Boron is included in some blended fertilizers with micronutrients, and regular application of this type of fertilizer is usually sufficient. However, in cases of deficiency on young trees, apply 1 to 2 ounces of borax around the base of each tree in the spring. Boric acid may be applied as a foliar spray after bloom. Manures and composts contain trace amounts of boron, and these may also be applied.

If you suspect a deficiency, do not apply boron until you have leaf analysis results. The range between deficiency and excess is very narrow. Excess B can be very damaging to trees.

Iron (Fe)

Iron deficiencies are not common in foothill citrus, but they may occur where drainage is poor. Trifoliate rootstocks, including the recommended mandarin rootstocks Rich 16-6 and Rubidoux, are less able to take up iron than some other rootstocks.

Iron deficiency is commonly called iron chlorosis because the symptoms are light yellow to whitish colored young leaves with green veins. Sometimes, just one branch of a tree may be affected. When the deficiency is severe, the leaves may be small, thin, and fragile and fall off prematurely. Fruit are also small and pale colored. Dieback occurs at the top and on the outside of the tree.

Iron deficiency is not easy to correct. Foliar application of iron is not effective. Soil application of iron chelates is more effective than foliar application, but not consistent. Changing irrigation practices or improving drainage may correct deficiency problems.

Leaf Analysis

Citrus leaf sampling should occur when nutrient levels in leaf tissues are stable, from mid-August to mid-October, depending on species and harvest date. Mandarin leaf analysis should be completed by mid-late September. University of California researchers have established critical ranges for specific nutrients in that period. Tissue analysis may indicate deficiencies or problems that are beginning to develop. The results can be used to modify your fertilizer program.

To sample leaf tissue, collect leaves from the spring growth flush (4 to 7 months old) from non-fruiting branches. Each set of samples should represent a block of similar-aged trees of a single variety and rootstock, growing in similar conditions. Walk diagonally through the orchard block, randomly picking leaves, one leaf from each sample tree. Pick average-sized, undamaged applications are often unnecessary due to available N from rainfall, mulch, and other sources.

Trees need about 4 oz. actual nitrogen per tree in the second and third years. Young trees do not have well developed root systems, so split the nitrogen into three applications from March through June. From the fourth year on, citrus are treated as mature trees, requiring ½ to ¾ pound of actual nitrogen per tree per year. Use the lower recommendations for trees on trifoliate rootstocks (Rich 16-6, Rubidoux), which grow slowly.

To calculate nitrogen needs, use the nutrient analysis on the fertilizer bag and the amount recommended for the age of the tree or recommendations from your leaf analysis. For example, you have young trees, each of which needs 3 ounces of nitrogen from fertilizer (the remaining 1 oz. would come from compost). Using a 15-15-15 fertilizer, which has 15% by weight of Nitrogen, Phosphorus, and Potassium, you will need to apply 20 ounces of the fertilizer to each tree to obtain 3 oz. actual N. (3 oz. N ÷ 0.15 [15% N] = 20 oz. [1¼ lb.] of 15-15-15 fertilizer to supply 3 oz. N).

While 15-15-15 is commonly used in the foothills, it is not recommended, unless soil and tissue analyses indicate that phosphorus is needed.

Phosphorus (P)

Citrus needs phosphorus for optimal yield and quality, but excessive P has detrimental impacts on fruit production and quality. Phosphorus may be fixed in insoluble compounds in some soils, and not available to plants. In other foothill soils, especially old orchard ground, phosphorus levels may be very high. Thus, it is critical to test your soil before applying phosphorus.

Deficiency symptoms appear first on older leaves as P is moved out of older tissues to where it is needed in younger tissues. Older leaves lose their deep green color and luster and may become slightly variegated, bronzed, or purplish. Leaves may drop prematurely. Flower and fruit set are diminished and yields decline. Fruit on trees deficient in P have thick, coarse rinds, lower juice content, and maturity is delayed. Roots may be stunted.

Application of a water-soluble P fertilizer to the soil will correct deficiencies. Research has shown that a pre-bloom foliar application of phosphite may increase yield. An early summer application may increase fruit size and total soluble solids (Lovatt).

Potassium (K)

Moderate potassium deficiencies occasionally occur in the foothills. Often there are no visual symptoms. A mild to moderate deficiency affects the rate of photosynthesis, reducing growth, and may result in poor fruit quality and decreased yields.

Severe potassium deficiency is rare. It is characterized by yellow to yellow-bronze patterning on older leaves and tip burning. Old leaves persist on the tree. Fruit are small, with smooth, thin peel and may be prone to splitting. Wood may fail to harden off, remaining green and subject to frost injury. Excess nitrogen and/or insufficient soil moisture may induce potassium deficiency.

To correct a K deficiency indicated on your soil or tissue analysis, make a foliar application of 30 pounds of potassium nitrate in 100 gallons of water. Apply when leaves of the first spring growth flush are expanding (March-April). One spray is sufficient for a mild deficiency. Potassium nitrate applied through drip is also effective. Soil application of 10 pounds of potassium sulfate, banded at the drip line of each tree, will also correct a K deficiency and lasts several years.

Micronutrients

Zinc (Zn)

Zinc deficiency is very common and can be very damaging to citrus production. It is often called "little leaf" or "mottle leaf" because of the reduced leaf size and the distinctive leaf pattern. New leaves are mottled, pale yellow, and smaller than normal. Symptoms may be more noticeable on the south side and near the top of the tree.

In mild zinc deficiency, interveinal areas are yellow- or cream- colored, but veins remain green. As the deficiency worsens, mottling increases and veins turn yellow. In severe deficiency, leaf tips and margins brown and die. Twigs die back and trees appear bushy and stunted.

Excess phosphorus or nitrogen exacerbates zinc deficiency. Insufficient zinc affects tree vigor, resulting in reduced production, smaller fruit, and low fruit quality.

If there is insufficient zinc in the soil, zinc will not be translocated to new growth flushes. Apply one pound of zinc sulfate (ZnSO4) in 100 gallons of water to each new leaves from each side (N-S-E-W) of normal, healthy trees. Generally, each sample should include a minimum of 50 leaves. Check with your lab for specific instructions.

If one area of the orchard is less productive, sample it separately and compare the results to those from healthier areas. Follow the same sampling procedure, choose normal-looking or slightly affected leaves, do not pick the worst affected leaves. Severely affected leaves may not give a true picture of nutrient status as the tree may have removed most nutrients.

Place the leaves in a paper bag, and hold in a cooler or refrigerator until they are sent to the lab. The samples should be sent to the lab as soon as possible so that the results are accurate. It is best to use a lab that washes the leaves as part of the analysis.

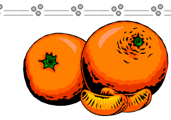
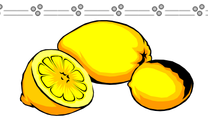
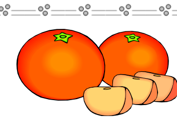
The first time you do a leaf analysis, sample all of the nutrients. Once you have a baseline, check only the elements where a problem is suspected.

The most common deficiencies in the foothills are nitrogen, zinc, and manganese. Boron, potassium, and phosphorus are sometimes deficient. Leaf analysis is a helpful guide, but monitoring is critical. Careful observation is needed to detect changes in tree appearance, growth rate, or fruit production. Be sure that a nutrient deficiency is the problem before applying fertilizer.

Critical Nutrient Levels for Citrus (oranges):

	Deficient Below	**Optimum**	**Excess**
Nitrogen (N)	**2.2%**	**2.4 - 2.6%**	**>2.8%**
Phosphorus (P)	**0.09%**	**0.12 - 0.16%**	**>0.30%**
Potassium (K)	**0.40%**	**0.70 - 1.09%**	**>2.30%**
Zinc (Zn)	**16 ppm**	**25 -100 ppm**	**>300 ppm**
Manganese (Mn)	**16 ppm**	**25 - 200 ppm**	**>1000 ppm**
Boron (B)	**21 ppm**	**31-100 ppm**	**>260 ppm**

n.b. mandarins may have slightly different levels, but should be close to this range.
From ***Soil and Plant-Tissue Testing in California, Citrus Production Manual***.

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