FERTILIZING CITRUS IN THE FOOTHILLS

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Citrus trees are not very nutrient demanding, but production of a high quality crop requires adequate amounts of the essential nutrients. Most growers need to add nitrogen and zinc on an annual basis. Manganese deficiencies are fairly common, and in the foothills, boron and iron may also be deficient. Potassium is important in fruit development and may need to be supplemented. In acid foothill soils, phosphorus is often unavailable and may need to be added.

The best tool growers have for determining tree nutrient status is leaf tissue analysis. 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.

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. N deficiencies often occur in winter or early spring because of low N reserves in the tree, low soil temperatures which reduce N mineralization rates, and lack of root activity due to low temperatures and saturated soils.

Nitrogen may be applied to the soil in granular form, through the irrigation system, or sprayed on the foliage. Nitrogen fertilizers are usually split into three or more applications, starting in late February or early March. Winter nitrogen applications are not very effective as much of the N will be lost to run-off or leaching, contributing to nitrate pollution of waterways. Pre- and post-bloom (after petal fall) foliar N 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 development of growth flushes, flowering, and fruit set.

N fertilizer applications should be completed by mid-August to avoid stimulation of late growth flushes that are susceptible to cold damage or impacts on fruit quality. High N levels in late summer and fall may also contribute to poor fruit color, thicker rinds, and less juicy fruit. Excessive amounts of nitrogen will reduce fruit size and quality, and may delay maturity.

Young citrus trees require nitrogen for good growth and development. Two to four ounces of actual nitrogen per tree are required the first year, ¼- ½ lb. the second year, and ½ to ¾ lb. the third year. Young trees do not have well developed root systems, so either a slow release form should be used or the nitrogen should be split into 5 or 6 applications from late February through August. From the fourth year on, citrus are treated as mature trees, requiring 1 to 1½ pounds of actual nitrogen per tree per year. Use the lower recommendations for trees on rootstocks with trifoliate parentage (e.g. Rich 16-6, Rubidoux, C-35).

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To calculate nitrogen needs, use the nutrient analysis on the fertilizer bag and the recommended amount for the age of the tree or recommendations from your leaf analysis. For example, you have a grove of new trees, each of which requires 3 ounces of actual N. 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. ÷ 0.15 [15% N] = 20 oz. [1¼ lb.] of 15-15-15 fertilizer to supply 3 oz. N).

Phosphorus (P)

In some foothill soils, phosphorus may be fixed in insoluble compounds and not available to plants. Thus, citrus may need regular applications of phosphorus for optimal yield and quality. 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 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 (Nutri-phite 0-28-26) increases yield and an application in early summer increases fruit size and total soluble solids (Lovatt).

Potassium (K)

Moderate potassium deficiencies may occur in the foothills, but 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 deficiencies may be recognized by yellow to yellow-bronze patterning on older leaves behind the fruit, and tip burning as the deficiency intensifies. Old leaves persist on the tree. Fruit are often smaller, with smooth, thin peel and may be more subject to splitting. Wood may fail to harden off, remaining green and subject to frost injury. Excessive nitrogen applications or insufficient soil moisture may induce potassium deficiencies.

To correct a K deficiency, 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 (usually April). One spray will suffice for a mild deficiency, but several applications may be necessary in more severe cases. Potassium nitrate applied through the drip system is also very 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 of the tree and near the top. In mild cases, interveinal areas are yellow or cream colored, but veins remain green. As the deficiency worsens, mottling becomes more pronounced and veins begin to yellow. In severe deficiency, leaf tips and margins brown and die. Twigs die back and trees appear bushy and stunted.

Zinc deficiency may be brought on or exacerbated by excess phosphorus or nitrogen. Insufficient zinc affects tree vigor, resulting in reduced production, smaller fruit size, and lower fruit quality. If there is insufficient zinc in the soil, zinc will not be translocated to new growth flushes. It is usually necessary to make a foliar application of one pound of zinc sulfate ($ZnSO_4$) in 100 gallons of water to each new growth flush. Apply when new growth is almost fully expanded, but not yet hardened off.

Manganese (Mn)

Manganese deficiency is quite common in California citrus. In cold winter areas, temporary deficiencies may appear 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. Yields are generally diminished if leaf symptoms persist for more than five months.

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, often more visible on the north side of the tree. As the severity of the deficiency increases, inter-veinal 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 or iron, 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 ($MnSO_4$) 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 growth is between half and two-thirds expanded.

Boron (B)

Some foothill areas, particularly those that have been graded, are subject to boron deficiencies, but others have excess B. Deficiency symptoms include bronzing of the leaves and death of terminal growing points, causing rosettes of 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 results from the leaf analysis. The range between deficiency and excess is very narrow, and excess B can be very damaging to trees.

Iron (Fe)

Although red foothill soils may contain a lot of iron, it may not be available to plants, so iron deficiencies do occur, especially where drainage is poor. In addition, trifoliate rootstocks, which include the recommended mandarin rootstocks Rich 16-6 and Rubidoux, as well as the commonly planted C-35, are less able to take up iron than 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 consistently. Changing irrigation practices or improving drainage may correct deficiency problems.

Leaf Analysis

Citrus leaf analysis should be done when nutrient levels in leaf tissues are stable, usually from mid-August through mid-October. University of California researchers have established critical ranges for specific nutrients in that period. Such analysis may indicate specific deficiencies or problems that are just beginning to develop. These 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 a single variety and rootstock and be similar aged trees growing in similar conditions. Walk diagonally through the orchard block, randomly picking leaves, one leaf from each sample tree. Pick average-sized, undamaged leaves from normal, healthy trees. Be sure that the sample includes leaves picked from each side (N-S-E-W) of the trees. Generally, each sample should include a minimum of 50 leaves, but check with your lab for specific instructions.

If one area of the orchard is weaker than others, 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 moved most nutrients out of them.

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.

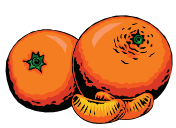
The first time you do a leaf analysis, sample all of the elements. Once you have a baseline, check only the elements where a problem is suspected. The most common deficiencies in the foothills are nitrogen, zinc, and manganese. Boron, potassium, and phosphorus are sometimes deficient. Leaf analysis is a helpful guide in orchard nutrition, 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 really the problem before applying a fertilizer.

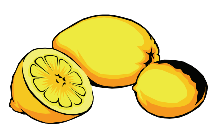
Critical Nutrient Levels for Citrus (oranges):

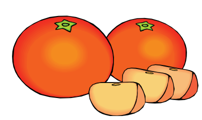
	Deficient Below	Optimum	Excess
Nitrogen (N)	**2.2% >2.8%**	**2.4 - 2.6%**	
Phosphorus (P)	**0.09%**	**0.12 - 0.16%**	**>0.30%**
Potassium (K)	**0.40%**	**0.70 - 1.09%**	**>2.30%**
Zinc (Zn)	**16 ppm**	**25 -100 ppm**	**>300 ppm**
Manganese (Mn) ppm	**16 ppm**	**25 - 200 ppm**	**>1000**
Boron (B)	**21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







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