



### Seasonal N Requirements

Optimal N application rates can be determined in rate trials or calculated based on N removed in fruits.

In a rate trial carried out in Tulare County in a mature navel orange orchard, researchers found that maximum production was achieved with N application rates of 1.0-1.5 lbs/tree, corresponding to 100-150 lbs N/acre. These results are consistent with earlier studies in Southern California and the San Joaquin Valley which showed that navel and Valencia orange yields were maximized with annual N rates of 1.0-1.4 lbs N/tree. The yields ranged from 15,300 to 46,100 lbs/acre. Both studies found that the fertilizer N requirements did not differ between foliar and soil applied treatments.

The average California yield is 22,500 lbs/acre, which corresponds to 300 boxes of 75 lbs. Between 26 and 42 lbs N are removed from the average field. Annual biomass N accumulation in leaves and permanent organs has been found to be 0.1-0.15 lbs/tree. Based on the tree density reported in these trials, this annual accumulation corresponds to 20-25 lbs N/acre.

Adding N accumulation in leaves and wood to the N in fruits, and assuming an N use efficiency of 70%, would result in N application rates of 70 to 95 lbs/acre. This corresponds to 0.70-0.95 lbs/tree for an orchard with a tree spacing of 22x20 feet.

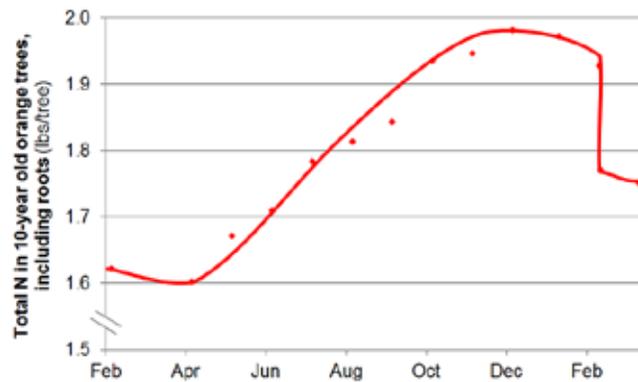
### Tissue and Soil Sampling

It may take several years until different management practices are reflected by leaf N concentrations. It is therefore especially important to take annual leaf samples after making adjustments to fertilization management. Soil nitrate-N present in spring contributes to the tree's N nutrition. High soil nitrate concentrations in late fall may be the result of excess N fertilizer applications during the growing season.



## Citrus Nitrogen Uptake

Seasonal N Uptake



Information regarding citrus fertility management, including placement, fertilizer source, phosphorus and potassium, is available at:

[www.cdafa.ca.gov/go/FREPGuide](http://www.cdafa.ca.gov/go/FREPGuide)



### SELECTED REFERENCES

Fake, C., 2004. Fertilizing citrus in the foothills. University of California Cooperative Extension Placer & Nevada Counties January 2004.

Arpaia, M.L., Lund, L.J., 2003. Nitrogen management in citrus under low volume irrigation. FREP Final Report.

Lovatt, C.J., 2014. Nutrient deficiency and correction. In: Ferguson, L., Grafton-Cardwell, E.E. (Eds.). Citrus Production Manual. pp. 161-182.

Embleton, T.W., Jones, W.W., Platt, R.G., 1976. Leaf analysis as a guide to citrus fertilization. In: Reisenauer, H.M. (Ed.). Soil and Plant-Tissue Testing in California. University of California Cooperative Extension Bulletin 1879. pp. 4-9.



# CITRUS NITROGEN Fertilization Guidelines

Online nutrient guidelines for citrus and other crops, as well as relevant references, are available at:

[www.cdafa.ca.gov/go/FREPGuide](http://www.cdafa.ca.gov/go/FREPGuide)

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Daniel Geissler and William R. Horwath, Department of Land, Air and Water Resources, UC Davis, gathered and organized the guideline information through FREP grant agreement 11-0485.





## Nitrogen Fertilization of YOUNG TREES

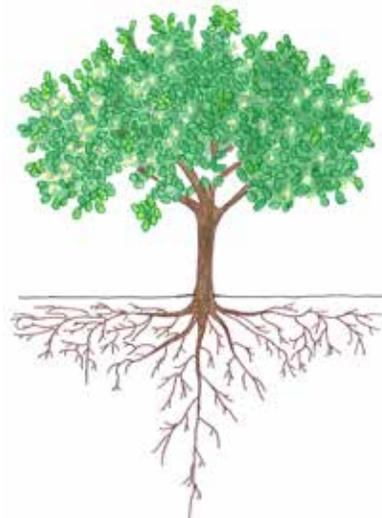
As young trees do not have well-developed root systems yet, N should be split into 4 to 6 applications from late February through August. Alternatively, slow release fertilizer can be used. Fertilizer applications in fall may reduce cold-hardiness.

### Recommended N application rates for young citrus trees

Tree age (years)	Foothills, CA	Florida	Arizona
	Application rate (lbs N/tree/year)		
1	0.13-0.25	0.15-0.3	0
2	0.25-0.5	0.3-0.6	0.15
3	0.5-0.75	0.45-0.9	0.23

Nitrogen fertilizer requirements of young citrus trees depend on the N-supplying capacity of the soil. The lower limit of the ranges in the table is adequate for soils with a soil organic matter content of 2% or more and soils previously used for pasture or vegetable production.

For the foothills, Cindy Fake recommended treating trees from the fourth year on as mature trees, thus applying 1 to 1.5 lbs N/tree per year. A study carried out in Arizona on a fine sandy loam found that the optimal annual N rate for years four to six was between 0.25 and 0.33 lbs/tree.



## Nitrogen Fertilization PRE-BLOOM to SPRING FLUSH

Nitrogen uptake is low during dormancy and increases during flowering. During spring flush and flowering, N reserves from older tissues are mobilized and used for new leaves and flowers. A study carried out in Tulare County found that even though yield did not differ significantly between treatments, nitrate leaching below the root zone was greatly reduced with two annual applications in late winter and late May, compared to a single application in late May. Applying N with every irrigation from late winter through fall also resulted in higher leaching rates than split treatment with two applications.

Granular fertilizers are best applied in the herbicide strip along the tree rows and not broadcast over the entire area. Fertilizer applied between the rows is less efficiently used due to competition with weeds or cover crops and lowers tree root density.

The optimal time for pre-bloom foliar applications in southern California is from December 15 to February 15. Winter foliar application of 0.35 lbs N/tree in the form of low-biuret urea significantly increased yield of mature navel orange trees in Riverside. The foliar application was in addition to 1.1 lbs N/tree of soil-applied urea. In a Florida study, prebloom foliar applications of urea (25-28 lbs/ac) to mature Valencia trees increased yield and soluble solids in juice compared to the control. In a study carried out with 'Nules' Clementine mandarins in a Fresno orchard, a January prebloom application of low-biuret urea (23 lbs N/acre) tended to increase total yield and significantly increased the number of large fruits.



## Nitrogen Fertilization FRUIT SET and DEVELOPMENT

N uptake is highest during fruit set. For optimal growth and production of citrus, about 2/3 of the annual N requirement should be supplied between early spring flush and fruit set. N fertilizer applications should be completed by early fall to avoid stimulation of late growth which may be susceptible to cold damage or impacts on fruit quality.

Frequent N applications through the drip system (fertigation) is an efficient way for applying N. The fertilizer should be injected into the irrigation system in the middle third of the irrigation set.

Applying some of the N with foliar sprays and the rest by fertigation has been found to be a very effective N fertilizer program, which ensures high yield and fruit quality, while reducing the risk of nitrate leaching. Foliar fertilizers can correct nutrient deficiencies more rapidly than soil applied fertilizers and can be properly timed to key developmental stages. However, the amount of foliar fertilizers that can be supplied with one application is limited to prevent leaf damage.

Summer foliar urea should be applied before the end of the cell division stage, characterized by maximum peel thickness, which is between early June and late July in California. Low-biuret urea is applied at the rate of 50 lbs in 200 gallons of water per acre (0.35 lbs/tree; 23 lbs N/acre). In Valencia oranges, urea applications close to harvest can result in regreening.

Foliar fertilizers are best applied early in the morning when the plant's stomata are open.

For more information and references about N management in citrus, access the crop fertilization guidelines at:

[www.cdfa.ca.gov/go/FREPGuide](http://www.cdfa.ca.gov/go/FREPGuide)

