Plant Nutrients for Citrus Trees[1]

Mongi Zekri and Thomas A. Obreza[2]

Introduction

This publication targets agricultural and horticultural producers, homeowners, Extension agents, industry or governmental staff, land managers, other professionals, youth and interested citizens.

Seventeen elements are considered necessary for the growth of green plants: carbon (C), hydrogen (H), oxygen (O), nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe), zinc (Zn), manganese (Mn), boron (B), copper (Cu), molybdenum (Mo), chlorine (Cl), and nickel (Ni). These elements are commonly referred to as essential plant nutrients. An element is considered essential if a plant cannot complete its life cycle without it, and if the problem that develops in its absence is curable only by its addition. Plants obtain C, H, and O from carbon dioxide and water. The remaining elements, called the "mineral nutrients," are obtained from the soil.

Mineral nutrients are classified as *macronutrients* and *micronutrients*. The term "macronutrients" refers to those elements that plants require in large amounts (N, P, K, Ca, Mg, S). The term "micronutrients" applies to plant nutrients that are essential to plants but are needed only in small amounts (Fe, Zn, Mn, B, Cu, Mo, Ni, Cl). The use of the terms "minor element" or "trace element" for some of the nutrients can be misleading. For example, the role of Fe in plant metabolism should not be considered less important than the role of K. Iron deficiency can result in total crop loss, so its role is not a "minor" one, and it is not of minor importance. The difference between Fe and K is in the amount required by plants, so the use of the terms "micronutrients" and "macronutrients" is more appropriate.

Macronutrient Functions in Plants

Nitrogen (N)

Nitrogen is of special importance because plants need it in large amounts. It is also easily lost from soil and fairly expensive to supply. A major factor in successful farming is the grower's ability to manage N efficiently. Nitrogen has numerous functions in plants, and essentially all life processes depend on it. Nitrogen occurs chiefly in amino acids, proteins, and sugars. The most active nitrogenous compounds occur largely in the protoplasm and nuclei of plant cells. Among them are the enzymes that speed up biological processes.

An abundant supply of essential N compounds is required in each plant cell for normal cell division, growth, and respiration. Even the green leaf pigment chlorophyll, which enables plants to use the energy of sunlight to form sugars from carbon dioxide and water, is a nitrogenous compound. A high concentration of N is found in young, tender parts of plant tissues like tips of shoots, buds, and new leaves. The N, present mostly as protein, is constantly moving and undergoing chemical changes. As new cells form, much of the protein moves from older cells to newer ones, especially when the total N content of the plant is low.

1. This document is SL 200, one of a series of the Soil and Water Science Department, UF/IFAS Extension. Original publication date December 2002. Revised February 2009. Reviewed February 2021. Visit the EDIS website at https://edis.ifas.ufl.edu.

2. Mongi Zekri, multi-county citrus agent, Hendry County; and Thomas A. Obreza, professor, Soil and Water Science Department, UF/IFAS Extension, Gainesville, FL 32611.

The proper functioning of N in plant nutrition requires that the other essential elements, particularly P, K, Ca, and Mg, be present in adequate supply. If the supply of one or more of them is inadequate, the addition of N to most common crops may not produce optimum growth. Such plants often are susceptible to disease, mature late, and produce poor-quality fruit. However, if the nutrient balance and total supply are adequate, significant growth of dark green foliage will occur. Nitrogen is the mineral element used most by citrus trees to produce leaves, flowers, and fruit, although Ca and K are also used in great amounts.

Nitrogen is the key component in mineral fertilizers applied to citrus groves; it has more influence on tree growth, appearance, and fruit production/quality than any other element. Nitrogen affects the absorption and distribution of practically all other elements and appears to be particularly important to the tree during flowering and fruit set.

For more information on N deficiency, see SL 201, Macronutrient Deficiencies in Citrus: Nitrogen, Phosporus, and Potassium.

Phosphorus (P)

Phosphorus is present in all living tissue. It is particularly concentrated in the younger parts of the plant, in the flowers, and in the seeds. Phosphorus is necessary for many life processes such as photosynthesis, synthesis and breakdown of carbohydrates, and the transfer of energy within the plant. It helps plants store and use energy from photosynthesis to form seeds, develop roots, speed maturity, and resist stresses. Phosphorus is involved in nutrient uptake and translocation. It is a major part of the cytoplasm and the nucleus of cells, where it is involved in the organization of cells and the transfer of heredity characteristics. Phosphorus is also important for cell division and enlargement, thus plant growth is reduced when the supply of P is too low.

For more information on P deficiency, see SL 201, Macronutrient Deficiencies in Citrus: Nitrogen, Phosporus, and Potassium.

Potassium (K)

Citrus fruits remove large amounts of K compared with other nutrients. Potassium moves from leaves to fruit and seeds as they develop. Potassium is necessary for several basic physiological functions like the formation of sugars and starch, synthesis of proteins, normal cell division and growth, and neutralization of organic acids. Potassium is important in fruit formation and enhances fruit size, flavor, and color. It helps reduce the influence of adverse weather conditions like drought, cold, and flooding.

Potassium is known to influence many enzymatic reactions and is associated with almost every major plant function. Potassium helps regulate the carbon dioxide supply to plants by controlling stomata opening and closing. It improves the efficiency of plant water and sugar use for maintenance and normal growth functions. It moves sugars from the site of photosynthesis to other storage sites. Potassium works with P to stimulate and maintain rapid root growth of plants. It stimulates the synthesis of protein from amino acids. Potassium improves plant health and resistance to disease and tolerance to nematodes and insects.

The rate of photosynthesis drops sharply when plants are K deficient. Too much N with too little K can result in a back-up of the protein building blocks, set the stage for disease problems, reduce production of carbohydrates, reduce fruiting, and increase fruit creasing, plugging and drop. A shortage of K can result in lost crop yield and quality. Moderately low plant K concentrations will cause a general reduction in growth without visual deficiency symptoms. The onset of visual deficiency symptoms means that production has already been seriously impaired.

For more information on K deficiency, see SL 201, Macronutrient Deficiencies in Citrus: Nitrogen, Phosporus, and Potassium.

Calcium (Ca)

Calcium resides mainly in plant leaves. Calcium is an important element for root development and functioning and is an important constituent of cell walls. It is required for chromosome stability and cell division. Calcium activates several enzyme systems and neutralizes organic acids in plants. Plant growth and fruit yield can be reduced by inadequate Ca supply long before deficiency symptoms become evident.

For more information on Ca deficiency, see SL 202, Macronutrient Deficiencies in Citrus: Calcium, Magnesium, and Sulfur.

Magnesium (Mg)

Magnesium is the center of the chlorophyll molecule. It is involved in photosynthesis and plays an important role as an activator of several enzymes. It is also involved in carbohydrate metabolism and synthesis of nucleic acids. Magnesium influences the movement of carbohydrates from the leaves to other parts of the tree and also stimulates P uptake and transport.

For more information on Mg deficiency, see SL 202, Macronutrient Deficiencies in Citrus: Calcium, Magnesium, and Sulfur.

Sulfur (S)

Many plants use about as much S as they do P. Sulfur is an essential constituent of many proteins. Sulfur is important for the production of amino acids, proteins, and chlorophyll, and is a constituent of vitamins and some plant hormones. Protein synthesis is retarded in S-deficient plants. Sulfur enhances the development of nodules and N fixation by legumes. It improves root growth and promotes vigor and hardiness. Sulfur also affects carbohydrate metabolism.

For more information on S deficiency, see SL 202, Macronutrient Deficiencies in Citrus: Calcium, Magnesium, and Sulfur.

Micronutrient Functions in Plants

Functions of iron (Fe)

- Catalyzes the production of chlorophyll.
- Involved in some respiratory and photosynthetic enzyme systems.
- Involved in the reduction of nitrates and sulfates.

For more information on Fe deficiency, see See SL 204, Micronutrient Deficiencies in Citrus: Iron, Zinc, and Manganese.

Functions of zinc (Zn)

- Involved in plant carbon metabolism.
- A necessary component of several enzyme systems that regulate various metabolic activities within plants.
- Part of an enzyme that regulates the equilibrium among carbon dioxide, water, and carbonic acid.
- Part of two enzymes that play a role in protein metabolism.
- Essential for the formation of chlorophyll and function of normal photosynthesis.
- Needed to form auxins, which are growth-promoting substances in plants.
- Associated with water relations in plants and improves water uptake.

For more information on Zn deficiency, see See SL 204, Micronutrient Deficiencies in Citrus: Iron, Zinc, and Manganese.

Functions of manganese (Mn)

- Involved in the production of amino acids and proteins.
- An activator of several enzymes.
- Plays an essential role in respiration and N metabolism.
- Necessary for the reduction of nitrates and helps make them usable by plants.
- Plays a role in photosynthesis and in the formation of chlorophyll.

For more information on Mn deficiency, see See SL 204, Micronutrient Deficiencies in Citrus: Iron, Zinc, and Manganese.

Functions of boron (B)

- Important in sugar translocation and carbohydrate metabolism.
- Particularly needed at the location of active cell division.
- Plays an important role in flowering, pollen-tube growth, fruiting processes, N metabolism, and hormone activity.
- Maintains Ca in a soluble form, thus insuring its proper utilization.
- Deficiencies may be aggravated by severe drought conditions, heavy lime applications, or irrigation with alkaline water.

For more information on B deficiency, see See SL 203, Micronutrient Deficiencies in Citrus: Boron, Copper, and Molybdenum.

Functions of copper (Cu)

- Part of several enzyme systems.
- Has a role in photosynthesis and chlorophyll formation.
- May have an important function in root metabolism. (Cu appears to be concentrated more in the rootlets of plants than in leaves or other tissues. Cu in citrus fibrous roots may be 5 to 10 times greater than in leaves.)
- Regulates several biochemical processes within the plant.
- Important in the utilization of proteins in the growth processes of plants. (The photosynthesis rate of Cu-deficient plants is abnormally low.)
- May also be involved in oxidation-reduction reactions in plants.

- Heavy fertilization with N tends to increase the severity of Cu deficiency.

For more information on Cu deficiency, see See SL 203, Micronutrient Deficiencies in Citrus: Boron, Copper, and Molybdenum.

Functions of molybdenum (Mo)

- Assists in the formation of plant proteins.
- Helps starch, amino acid, and vitamin formation.
- Considered a catalyst that aids the conversion of gaseous N to usable forms by nitrogen-fixing microorganisms.
- A constituent of the plant enzyme that converts nitrate to ammonia.

For more information on Mo deficiency, see See SL 203, Micronutrient Deficiencies in Citrus: Boron, Copper, and Molybdenum.

Functions of chlorine (Cl)

Although the essentiality of Cl has been established for most higher plants, its need for fruit crops has not yet been demonstrated. The plant requirement for Cl is quite high as compared with other micronutrients, but its exact role in plant metabolism is still obscure. Chlorine is:

- Associated with turgor in the guard cells through the osmotic pressure exerted by imported K ions.
- Involved with oxygen production in photosynthesis.
- Involved in chlorophyll and photosynthesis because its deficiency causes chlorosis, necrosis, unusual bronze discoloration of foliage, and reduction in growth.

Functions of nickel (Ni)

Within the last decade, Ni has been established as an essential element in higher plants. Although well-defined enzymatic functions are known to be associated with Ni in legumes, apparently the need for Ni exists in other plants as well. No one has ever seen a Ni deficiency in soil-grown plants.

Summary

Nutrient availability directly affects how well plants grow and produce. A sufficient supply of all nutrients is critical to nutrient management and sustainability. If a single essential element is below the critical level for availability, crop growth and yield will fall even if the other elements are in sufficient supply.

Concern for nutrient sufficiency is often confined to N, P, and K because they are needed in relatively large amounts by crops and are most often the limiting factors in crop production. However, nutrient insufficiency can go beyond N, P, and K. A balance of a sufficient supply of nutrients is a key component to profitability. Plant nutrients interact positively when properly balanced. For example, in the case of N fertilization, a shortage of another nutrient could decrease N uptake, reduce N use efficiency and returns on investment, and increase the potential for N loss.

Balanced nutrition of plants should be a high priority management objective for every citrus grower. Plants require a balanced nutrition program formulated to provide specific needs for maintenance and for expected production performance. Properly nourished fruit trees or plants grow stronger, produce more consistently, have better disease resistance, and are more tolerant to stresses.

For most macronutrients, soil application is still recommended because of the large quantities required. However, fertilizer applications to the soil are subject to various fates including leaching, runoff, and fixation to forms not available to plants. Therefore, foliar application should be considered as a possible supplement to soil application for some nutrients. Foliar application of N, K, Mg, Zn, Mn, and B has several positive attributes. It is of significant importance when the root system is unable to keep up with crop demand or when the soil has a history of problems that inhibit normal growth. It is proven to be useful under prolonged spells of wet or dry soil conditions, calcareous soil, or cold weather, which decrease the plant's ability to take up nutrients when there is a demand. Foliar application can reduce overall fertilizer application rates and energy use, and can improve the uptake efficiency of micronutrients because they are directly absorbed into the leaves. Foliar application is the quickest method of getting nutrients into plants over the short term when a nutritional deficiency is diagnosed, but should not be relied upon for long-term tree nutrition. Foliar feeding may also become a best management practice that can help reduce groundwater contamination concerns.

It should be kept in mind that foliar feeding is not intended to completely replace soil-applied macronutrient fertilization. Furthermore, there is a perception that foliar spray of macronutrients is more expensive because several applications are required to satisfy plant needs and maintain high yield. On the other hand, foliar applications of micronutrients are more effective than soil applications with the exception of Fe. Foliar micronutrient (Zn, Mn, Cu, B) sprays provide a more rapid response and are easier to apply, but the effect does not last as long as that of soil application. Soil applications of Fe chelates still offer the most effective means of correcting Fe deficiency.

Fertilization represents a relatively small percentage of the total cost of citrus production, but it has a large effect on potential profitability. Visual evaluation of nutritional status, soil and plant analysis, field history, production experience and economics are all important guidelines to use when making fertilizer rate and source decisions.