RESEARCH LABORATORY TECHNICAL REPORT

BARTLETT TREE EXPERTS
SCIENTIFIC TREE CARE SINCE 1907

Role of Nutrients

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Plants are one of the few organisms that produce their own food. They do this by converting carbon dioxide and water into carbohydrates in the presence of sunlight through the photosynthetic process. In addition to water and carbon dioxide, there are 14 more essential elements required for photosynthesis, growth, defense, and reproduction. Each one of these nutrients is therefore critical in the physiology of the plant. Justus von Liebig's "Law of the Minimum" states that the lack of any single nutrient can limit the growth and productivity of the plant when its concentration is insufficient, regardless of the abundance of other nutrients.

The elements essential for plant health aredivided into three categories: macronutrients, secondary and micronutrients (See Table 1). These categories are based upon the amount required within a plant. Often in landscapes, these nutrients are in low supply in the soil or are unavailable due to a high or low soil pH. A deficiency in one or more nutrients can have a severe impact on plant growth, aesthetics, and susceptibility to pests. Plants are efficient in their use of nutrients, and as such visual symptoms often do not appear until deficiencies are severe.

Table 1:	
Macronutrient	
Nitrogen (N)	Structure of amino acids, proteins and enzymes Constituent of DNA and chlorophyll
Phosphorus (P)	Energy transfer within the plant as adenosine triphosphate (ATP) Buffers cellular pH Enzyme activity regulation Structure of lipid membranes, DNA and RNA
Potassium (K)	Regulates opening and closing of stomata, which regulates water loss and photosynthetic activity Transport of carbohydrates Strengthens cell walls through cellulose synthesis
Secondary nutrient	
Sulfur (S)	Protein structural integrity Enzyme activity
Magnesium (Mg)	Center of chlorophyll molecule Key enzyme in photosynthetic process
Calcium (Ca)	Strengthens cell walls Involved in cell elongation at growing tips

Micronutrient	
Boron (B)	Meristematic growth : cell differentiation, maturation, division and elongation
Chlorine (Cl)	Required for water splitting during photosynthesis Electron transfer during photosynthesis
Copper (Cu)	Enzyme component that influences carbohydrate production Electron transfer during photosynthesis
Iron (Fe)	Required for oxidation-reduction reactions and energy transfer reactions Essential component of proteins and pigments for defense in some plants
Manganese (Mn)	Oxidation-reduction reactions Cofactor for many enzymes Neutralizes free radicals from water splitting reaction
Molybdenum (Mo)	Essential to enzymes responsible for converting nitrogen within the plant
Zinc (Zn)	Required for several enzyme systems
Nickel (Ni)	Component of enzymes involved in N metabolism

Soil samples are often recommended in order to identify levels of nutrients, cation exchange capacity (the ability of the soil to retain nutrients, also referred to as Nutrient Retention Capacity), organic matter, and soil pH. Prescription fertilization is based on the idea that only the nutrients that are lacking or will improve plant performance should be added to the soil.

In addition to low nutrient levels and extremes in soil pH, nutrient uptake can be reduced when the soil is very wet or dry, or where other factors such as soil compaction limit root development. All of these factors can be tested, quantified and treated, if necessary.

In mature trees, many nutrients are stored within the tree and some nutrients in the soil cannot be readily absorbed or transported to the leaves. When nutrient deficiencies are suspected but the cause is not revealed in a soil analysis, a foliar nutrient analysis can be conducted. Identified deficiencies can then be treated with soil or foliar applied nutrients.

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