

Turfgrass Maintenance Essential Elements

Tom Samples, Professor and John Sorochan, Associate Professor, Plant Sciences and Hugh Savoy, Associate Professor Biosystems Engineering and Soil Science

Actively growing turfgrasses usually contain more than 75 percent water. Their “dry” matter holds 16 nutrient elements considered essential for survival, flowering and/or seed production. Turfgrasses receive three of these, **carbon (C)**, **hydrogen (H)** and **oxygen (O)**, from carbon dioxide in the air and from water. The remaining essential elements are minerals, most often supplied by the soil. Healthy turfgrass roots are ideally suited for their uptake from moist soils. Root systems are usually fibrous, extensive and have a very large surface area. Once inside the roots, many of the mineral elements are transported through a

vascular system, the xylem, to other areas of the plant.



Essential mineral elements in turfgrass nutrition.

| | Element | Symbol | Mobility in Plants / Comments |
|---|------------|--------|-------------------------------|
| MACRONUTRIENTS Classification / Quantity Required ^a | | | |
| Primary / Largest | Nitrogen | N | Mobile |
| | Phosphorus | P | Mobile |
| | Potassium | K | Mobile |
| Secondary / Medium | Calcium | Ca | Immobile |
| | Magnesium | Mg | Mobile |
| | Sulfur | S | Mobile |

| MICRONUTRIENTS Classification / Quantity Required ^a | | | |
|---|------------|----|---|
| Trace (Minor) / Smallest ^b | Boron | B | Immobile |
| | Chlorine | Cl | Probably does not become a structural part of organic molecules in turfgrasses |
| | Copper | Cu | Content highest in actively growing tissue |
| | Iron | Fe | Immobile |
| | Manganese | Mn | Immobile |
| | Molybdenum | Mo | Concentration highest in the leaf blade; tends to accumulate as plants reach maturity |
| | Zinc | Zn | Immobile |

^a Each of the 16 essential elements is categorized as a macronutrient (primary or secondary) or a micronutrient, based on the amount required by turfgrasses. The concentration of a macronutrient in turfgrass dry matter must be \geq 1,000 parts per million. Nitrogen, P, K, Ca, Mg and S, in addition to C, H and O, are macronutrients. The concentration of each micronutrient in dry turfgrass tissue does not exceed 100 ppm.

^b Nickel and cobalt, in addition to the seven minor nutrients listed here, have also been recognized as being essential.

Primary Nutrients

Nitrogen (N), phosphorus (P) and potassium (K) are classified as primary nutrients based on the large amounts of each required by turfgrasses.

Although no more or less important than the others, these are

the essential nutrients most commonly applied as turf is fertilized.

Turfgrasses require more N than P and K and more K than P.

Although the movement of N, P and K varies in soils, all three are mobile once inside the plant.



Nitrogen. Turfgrasses usually contain from 2.5 to 4 percent N on a dry-weight basis, except where deficiencies exist. Although the atmosphere is about 78 percent nitrogen gas (N₂), turfgrasses cannot capture it. Once absorbed from soil, N usually moves from roots to leaves within a few hours.

Nitrogen, often associated with turfgrass growth and color, is found in amino acids, chlorophyll, enzymes,

proteins and vitamins. Turfs low in N are most often weak, weedy and lack vigor. Plants deficient in N are often stunted, with very short leaves and few tillers. Older leaves may first turn pale green, then yellow, as deficiency symptoms progress toward the base of the leaf blade.

Phosphorus. Phosphorus is critically important in the transfer and storage of energy in turfgrasses. Compounds containing P also affect the transfer of genetic information.

Phosphorus is found in plant cell membranes and DNA. The role of P in turfgrass rooting is well-documented. Phosphorus is relatively immobile in most soils and is less likely to move into soil solution

and leach than N-containing nitrate. Seedling plants, with limited root systems, need immediate access to P. As plants mature and develop more and deeper roots, they become very efficient in obtaining this nutrient from the soil.



The P content in dry turfgrass tissue is expected to range from about 1/5 to 1/2 percent. Leaves of turfgrasses deficient in P often become narrow and have a tendency to curl. They may darken and develop a purple or red pigmentation. Phosphorus deficiencies are most often observed as plants develop from seed.

Potassium. Potassium activates enzymes, is involved in photosynthesis and is very important in the regulation of small openings (stomates) on the exterior tissue of turfgrasses that are responsible for water release from the plant into the air.

The level of K in dry turfgrass tissue normally ranges from 2 to 3 percent. Leaves of turfgrasses deficient in K often droop and yellow from the outer edges toward the center. Plants do not grow well and are not very tolerant of traffic, high and low temperature stresses or drought. They may also be very prone to diseases, including dollar spot, Fusarium patch, red thread and Rhizoctonia blight.



Secondary Nutrients

The required amount of each of the secondary nutrients, **calcium (Ca)**, **magnesium (Mg)** and **sulfur (S)**, is between that of the primary and minor nutrients.

Calcium. Calcium is found in plant cell walls and is required for cells to divide and flowers to form. This nutrient maintains internal "balance" among other essential nutrients including K and Mg.

A Ca level from 1/5 to 2/5 percent in dry turfgrass tissue is considered normal. The Ca content in old leaves may approach 1 percent, while new leaves may contain only about 0.1 percent Ca. This secondary nutrient is immobile in turfgrasses and, as a result, new plant parts deficient in Ca often curl and appear stunted. The margins of young leaves may first turn pale green, and then reddish brown as Ca availability drops.

Magnesium. Magnesium is necessary for the formation of proteins and is found at the center of the chlorophyll molecule. It also improves P uptake

from soil and is involved in many internal reactions that are regulated by a variety of enzymes.

A Mg content in dry turfgrass tissue ranging from about 1/10 to 7/10 percent is considered normal. Magnesium is relatively mobile inside plants. Lower, older leaves of turfgrasses deficient in Mg may first appear blotched and red before yellowing.

Sulfur. Low levels of S in soil limit the formation of proteins and the growth of turfgrasses. Several vitamins and the amino acids cystine and methionine contain S. Turfgrasses deficient in S cannot use N and most often have pale, yellow-green leaves. The margins of leaves of sulfur-deficient turfgrasses often appear scorched.

A 15:1 N:S ratio is considered normal in dry tissue of turfgrasses receiving adequate amounts of both essential mineral elements. Normal amounts of S in dry tissue range from about 1/10 to 3/5 percent.

Minor Nutrients. Minor nutrients, often referred to as trace elements or micronutrients, serve as catalysts in reactions regulated by enzymes in turfgrasses. Because they are required in such small amounts, the indiscriminate application of minor nutrients without benefit of soil or tissue test may result in toxic accumulations in plant tissue, causing severe turf injury. Deficiencies are more likely to occur in turfs maintained in organic soils or in soils amended with large amounts of sand. Heavily irrigated turf and turfgrasses maintained in compacted soils may also be deficient in one or more of the minor nutrients. In native soils in Tennessee, low levels of iron, the minor nutrient most often deficient in turf, may be the result of an insolubility problem rather than an absence from the soil.

Boron (B). Turfgrasses low in B most often grow very slowly and do not complete their life cycle. Boron affects the development of plant cell walls and is believed to be necessary for the transport of sugars inside turfgrass plants. The growing points of plants deficient in B may develop yellow streaks and leaves are often stunted.

The B level in dry turfgrass tissue is expected to range from 3 to 20 parts per million (ppm).

Chlorine (Cl). One of the last elements accepted as "essential," Cl is found in chlorides inside turfgrasses. This minor nutrient stimulates photosynthesis and is believed to be involved in nutrient balance in plant cells.

A Cl deficiency is uncommon in turfgrasses.

Copper (Cu). Copper is associated with several plant enzyme systems and the formation of a number of growth-promoting compounds. Tips of the youngest leaves of turfgrasses deficient in Cu may appear blue-green and some axillary buds may die.

A level of 5 to 40 ppm Cu in dry turfgrass tissue is considered normal.

Iron (Fe). Iron is associated with turfgrass color. It may also improve frost resistance and reduce the dehydration of some turfgrasses during winter. Although this minor element is not part of the chlorophyll molecule, it is needed for its production. Iron is found in several enzymes that enable turfgrasses to absorb oxygen and release carbon dioxide. The tissue between veins of new leaves may yellow as Fe becomes more and more limited.

Turfgrasses growing in soils with less than 2 1/2 ppm extractable Fe may respond to an application of the essential minor nutrient.

Manganese (Mn). Manganese, like Fe, is required for the formation of chlorophyll. Although it is not a part of the chlorophyll molecule, Mn influences photosynthesis and the rate of growth of turfgrasses. It is also involved in several plant enzyme systems. Highest concentrations of this minor nutrient are usually found in actively growing tissue, such as new leaves. An extremely high level of Fe in turfgrass tissue can result in a Mn deficiency.

Manganese is immobile in turfgrasses. Leaves of manganese-deficient plants often bend, yellow between veins and become spotted as tissue dies in distinct spots. Although the tip above the affected tissue may remain green for some time, the entire leaf eventually withers or rolls. Turfgrasses deficient in Mn may feel soft to the touch.

The concentration of Mn in dry tissue normally ranges from 22 to 240 ppm.

References:

1. Carrow, R. N. 2001. Turfgrass soil fertility and chemical problems: assessment and management. ix, 400 pp. Chelsea, MI: Ann Arbor Press.
2. Daniel, W. H. 1979. Turf manager's handbook. 423 pp. Cleveland, OH: Business Publications Division of Harvest Pub. Co.
3. Landschoot, P. J. 2003. Turfgrass fertilization: A basic guide for professional turfgrass managers. Pennsylvania State University. University Park, PA. Cooperative Extension CAT UC184 5M11/O3CP4609.
4. Mills H. A. and J. B. Jones, Jr. 1996. Plant analysis handbook II: a practical sampling, preparation, analysis, and interpretation guide. Athens (GA): Micro-Macro Publishing.
5. Plank C. O. 1989. Plant analysis handbook for Georgia. Athens (GA): University of Georgia Cooperative Extension Service. p 21-8.

Visit the UT Extension Web site at
<http://www.utextension.utk.edu/>

W161D-3/08

Copyright 2008 The University of Tennessee. All rights reserved. This document may be reproduced and distributed for nonprofit educational purposes providing that credit is given to University of Tennessee Extension.

Programs in agriculture and natural resources, 4-H youth development, family and consumer sciences, and resource development. University of Tennessee Institute of Agriculture, U.S. Department of Agriculture and county governments cooperating.
UT Extension provides equal opportunities in programs and employment.