Turf Nutrient Needs

Determining a soil's nutrient deficiencies is the first step in assuring healthy turfgrass.

by R.P. Freeborg and W.H. Daniel

Good turf maintenance requires the addition of nutrients which will force new growth as well as counteract wear, disease damage, and aging of turf.

This procedure helps to override weed competition and replace nutrients that are lost through leaching, fixation, volatilization, and clipping removal.

Both plant tissue and soil tests have been developed to assay the available nutrients in the soil, to predict plant utilization, and to provide a basis for determining nutrient needs. Before applying nutrients it is important that the soil be tested. This is especially important if lime is to be applied.

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Turfgrass with *phosphorus deficiency symptoms.*

Determining deficiency

Determination of nutrient deficiency is based on the least fertile soil within the project area. Maximum fertilizer should be used initially in order to produce a good turfgrass or plant growth cover and to correct existing soil deficiencies.

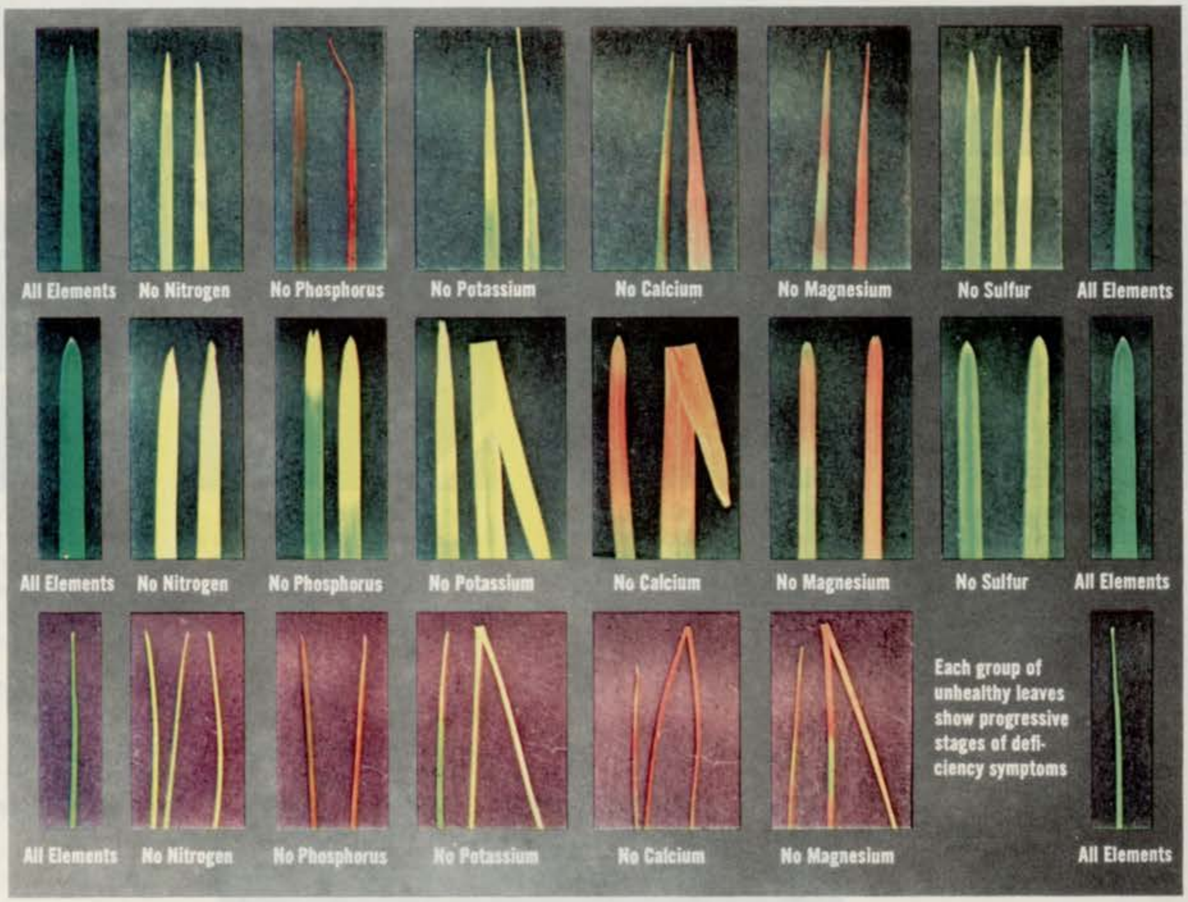
All soils need supplemental nitrogen to maintain fast, vigorous growth of turfgrasses and other ornamental plants. Some soils need additional phosphorus, in the upper soil for turf or in the active rootzone for other plants, to assure an adequate supply.

TABLE 1.

SEASIDE CREEPING BENTGRASS

MERION KENTUCKY BLUEGRASS

PENNLAWN RED FESCUE



Foliar symptoms of six essential nutrient deficiencies in three cool-season turfgrasses. (Photos courtesy of O. J. Noer Research Foundation, Milwaukee, Wis.)

To produce healthy plants, most soils need potassium to balance the available nitrogen. Phosphorus, if needed, should be mixed into the rootzone prior to planting.

A standard, basic recommendation for initial rootzone preparation is the application of 100 lbs./A each of nitrogen, phosphorus, and potash. Each plant has an optimum nutrient range plus a minimum nutrient level. Below this nutrient level, plants begin to exhibit signs of deficiency such as yellowing, firing, or die-back.

Above the deficiency level, most plants have a range of element content tolerance which allows normal growth. Excessive uptake by plant roots, or unbalanced nutrients in the rootzone can cause toxicity.

In the application of plant nutrients we must attempt to avoid deficiency, assure and maintain adequate nutrition, and yet prevent toxicity. Foliar symptoms of six essential nutrient deficiencies in three cool season grasses are illustrated in Table 1.

Nutrient sources

Certain elements are essential to plant growth. Although each one is credited with specific functions, it is important to understand the intricate balance and interrelation of the entire plant growth process.

The major elements are:

Nitrogen (N) is the key element in the production of plant growth, especially turfgrass.

A proper balance and adequate suppply of other nutrients is important and is generally maintained, but the amount of nitrogen should be adjusted for the desired growth response. Variation in the available nitrogen determines the greenness of the leaves, ability to recover from damage or stress, and the quantity of clippings that grass produces.

In the application of plant nutrients we must attempt to avoid deficiency, assure and maintain adequate nutrition and yet prevent toxicity.

Nitrogen affects the grass color, root and shoot growth (density), resistance to disease, cold and heat, and tolerance to drought.

Nitrogen is a mobile element. When it is deficient the proteins of older leaves are converted to nitrogen and transported to the younger leaves. Older leaves become light green, then yellow, and finally, before necrosis (dying) a copper yellow.

When turfgrass tissue tests are made the new leaves are used to determine nutrient content. The most sensitive and accurate measure of available nitrogen in the plant is obtained by tissue test. For turf, the quantity of clippings is the second most accurate measure.

Changes in leaf color and density of turfgrass are less accurate indicators of nitrogen supply.

Phosphorus (P) has been labeled as the workhorse of the nutrition team.

It is taken into plants from a very dilute solution by ion exchange at the root surface. Phosphorus is present in every plant cell. It provides the plant with a mechanism for using and transforming energy. A phosphorus deficiency is reflected in new plant parts.

The phosphorus content in dry turfgrass ranges from .15 to .55 percent P, with 0.3 to 0.4 percent as an average. Adequate levels of phosphorus promote rooting and improved root branching.

Deficiency causes a reduction in tillering and moisture retention. Leaves become more narrow and have a tendency to curl. Leaves become darker green, with some purple pigment evident and they develop a decidedly wilted appearance.

Potassium (K) is used by the plant in relatively large quantities.

It is not a fixed constituent of living cells, but is essential to the growth and development processes. Potassium furthers the development (thickness) of cell walls, thus making the plant more resistant to heat, cold, and frost. It also increases wear tolerance in turfgrass and encourages rooting.

High potassium levels tend to reduce damage caused by dollar spot, fusarium blight, brown patch, and red thread diseases of turfgrass.

Potassium's role is that of a regulator of plant processes. It influences at least 46 enzymes, and controls the uptake of some nutrients. Low oxygen supply in the rootzone reduces the effectiveness of potassium because roots must have oxygen to utilize the elements.

Dry turfgrass tissue may have a range of 0.9 to 4.0 percent potassium, but 2-3 percent is normal. Potassium deficiencies are first indicated by drooping leaves, which feel soft to the touch.

Necrosis of the leaf tip is preceeded by a reduction in foliage density. The leaves develop green and yellow blotches. As potassium moves readily into the plant, deficiencies can be corrected in a relatively short period of time following application of fertilizer.

Secondary elements

Calcium (Ca) is a structural element that accumulates calcium pectate in the middle lamella of cell walls.

It regulates the balance of other cations. Calcium is necessary for cell division in apical meristems and in formation of flowers.

Adequate levels of calcium have been shown to improve the growth of root hairs. Calcium is fixed at high levels in leaf tissue and is immobile in plants.

Phosphorus is present in every plant cell. It provides the plant with a mechanism for using and transforming energy.

Sulfur (S)

There have been indications of disease reduction in plants due to an interaction of sulfur with phosphorus (Washington State study).

In sulfur deficient soils, applications of a nitrogen-sulfur ratio of 7 to 1 is recommended. Earlier, sulfur was obtained through industrial fall-out and as a component of many pesticides and some low grade fertilizers. Since these have been greatly reduced, the deficiencies are becoming increasingly evident.

As a consequence, applications of sulfur may be needed.

Micronutrients include seven elements known for their essential contribution to plant growth. Special tests help estimate the soil supply of micronutrients and determine if additions are needed.

Tissue tests are usually more accurate indicators of the available nutrient supply. If micronutrients are needed, either solid forms as mixed fertilizer or liquid as in dilute foliage sprays may be used at critical states of plant growth.

The soil's nutrient requirements may vary according to soil type, pH, organic matter content, moisture, or stress created by excesses of other nutrients.

Iron (Fe) functions in certain respiratory enzyme systems. Its presence is essential for the formation, but it is not a constituent, of chlorophyl.

It serves as a catalyst in the reduction of nitrates. As iron is immobile in the plant, new tissues will tend to develop interveinal yellowing (chlorosis) when deficient.

The blades tend to lose color, (almost white), but necrosis is minimal. Wet or cold soils are conducive to iron deficiency. The solubility of iron decreases as the pH becomes more alkaline.

Iron content in turfgrass clippings is normally 5 ppm, but has great variability. In soils the normal ratio of available iron to manganese is 2 to 1.

A standard foliage spray for correcting iron deficiency in turfgrass is 2-3 pounds of iron sulfate per acre or 1 ounce per 1,000 square feet. An application of a 3 percent solution at seven to 14 day intervals is recommended during stress periods.

Potassium deficiencies are first indicated by drooping leaves, which feel soft to the touch.

Grasses are considered tolerant to low iron availability.

Manganese (Mn) is necessary for absorption of CO and for transforming carbohydrates.

Like iron, it is not a constituent of chlorophyl, but activates its synthesis. Manganese is more abundant in leaves than in other plant parts, but is immobile.

The manganese level in soils is usually adequate but anaerobic soil conditions (limited oxygen) can create an increase in Mn availability and concurrently favor iron deficiency. Alkaline conditions or intense leaching favor manganese deficiency.

Yellowing or striping between veins, along with stunting, curling or spotted turfgrass leaves may indicate a deficiency.

Deficient tissue has a very soft feel and the leaves tend to bend, giving them a very limp appearance.

The expected range of Mn in dry plant tissue is 22 to 140 ppm. A recommended spray to correct manganese deficiency is 1 to 2 pounds of manganese sulfate per acre. One or two applications may carry through a growing season.

Zinc (Zn) improves reproduction capabilities and is vital to oxydization processes within the plant. The plant requires only minute quantities of zinc.

It is not a component of chlorophyl, but like iron and manganese, it is required for chlorophyl synthesis. Zinc is immobile in the plant.

Dark, thin, desiccating leaves, which turn white in advanced stages, along with yellowing and bronzing of stunted leaves, witches broom, and reduced growth are symptoms of zinc deficiency.

Compaction, excess irrigation, and alkaline conditions reduce the availability of zinc to plants. Because zinc is readily fixed (made unavailable) in the soil, the surface soil accumulates a higher concentration of zinc than the lower soil levels.

Excess phosphates in soil precipitate insoluble zinc conditions. A range of 8 to 60 ppm of zinc in dry tissue is normal. To correct zinc deficiency an application of 0.4 to 0.8 pounds per acre of zinc sulfate is recommended.

Copper (Cu) is an activator of some enzyme systems and certain growth promoting substances. The copper content in a plant is highest in actively growing tissue. Copper is toxic except in dilute proportions. Water from copper downspouts can cause areas of turfgrass to be stunted.

Organic soils tend to be deficient because substances released as organic matter decay and tend to limit the availability of copper.

Boron (B) is necessary for plant reproduction and is related to calcium and phosphorus metabolism and protein synthesis. It affects the development of the plant cell wall, and is thought to be active in sugar transfer. It also aids in maintaining correct water balance in plants.

The new leaf tip has the highest concentration of boron within the plant. Because the leaf tips are removed by mowing, for limited periods turfgrass can tolerate higher boron concentrations than other plants.

Availability is reduced under alkaline conditions. Deficiencies of boron are evident in the growing points as chlorotic streaks. Also, the leaves are stubby and rosette-like in appearance.

Some plant stems become brittle and leaves become mottled.

The normal range of boron in dry plant tissue is 3 to 20 ppm. The normal boron concentration in the soil is 2 to 1,000 ppm, with an average of 30 ppm.

A corrective application of boron requires 0.1 to 0.3 pounds per acre. Where a deficiency exists, the maximum amount required for any boron sensitive crop is only 1 to 4 pounds per acre.

Molybdenum (Mo) is believed to be necessary as an activator for the enzyme regulating nitrate reduction. It is essential in the process of nitrogen fixation. Wilting, stunting, and cupping of leaves are possible symptoms of molybdenum deficiency.

Concentration of molybdenum is highest in the leaf blade and tends to accumulate in plants as they mature. Molybdenum, like zinc, tends to accumulate near the soil surface as a result of plant decay and subsequent release of this micronutrient.

Leaf tissue to be used for testing should be dried before any deterioration occurs.

It is less available under acid soil conditions. Applications of lime to acid soils can improve availability.

The expected range of molybdenum in dry tissue is 2 to 8 parts per million, but plants with tissue contents of 11 to 15 ppm were produced on soils high in molybdenum.

Corrective treatment of soils lacking Mo is 0.1 pounds per acre.

Preparation for Testing

Leaf tissue to be used for testing should be dried before any deterioration occurs.

The clippings of leaf tissue may be dried by spreading them in a thin layer on a clean surface in the open air and sunshine. Stirring the leaves occasionally helps them to dry uniformly.

They may also be dried in a warm (not hot) oven for a limited time. It is suggested that approximately one pound of fresh leaf tissue be dried out though only a few grams of tissue are actually needed for the laboratory test.

The sample container should be clearly labeled. Information and questions concerning the sample can be helpful in securing more complete interpretation of the data.

The following Table 1 (from page 26) Turf Managers Handbook, Daniel & Freeborg, is an example of tissue analysis showing the range of elements within a plant. Such an analysis can serve as a basis for interpretation and correctvie action. Soil testing laboratories will supply additional information on processing tissues for testing. **WT&T**