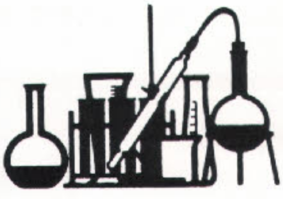

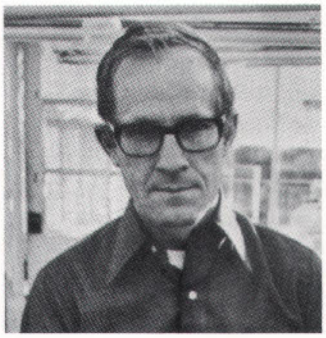

Soil Testing and Plant Analysis

By Dr. Emmett E. Schulte

The only reliable way of knowing how much lime and fertilizer are needed for turf is to have the soil tested. Soil tests can also determine whether too much lime or fertilizer has been applied. Excessive lime or fertilizer is not only wasteful, but may also result in reduced turf vigor.

Plant analysis is useful in diagnosing soil fertility problems. Analysis of plant tissue tells what nutrients the plant found to be available in the soil. It integrates the combined effects of soil fertility, soil permeability, root distribution, climatic conditions and other factors influencing nutrient uptake by turfgrass. A combination of soil and plant analysis gives more information than either one alone.

What Do Soil Tests Measure?

Soils contain large amounts of most plant nutrients, but only a small fraction is available to plants during the course of a growing season. The objective of soil testing is to extract an amount of the nutrient that is proportional to what the plant finds to be available in the soil. A typical soil, for example, may contain 2.5% potassium or the equivalent of 50,000 lbs. of potassium per acre to the depth of tillage (six to seven inches), but the same soil will contain only about 200 pounds per acre of "available" potassium.

The first step in developing a soil test is to find an extracting solution that extracts the "available" form(s) of the nutrient to be tested. This is usually done by a combination of greenhouse and laboratory research. Assay plants are grown in a number of different kinds of soil under controlled greenhouse conditions. Nutrients other than the one being studied are supplied as needed. Uptake of the element in question by the plant is measured to determine the amount found to be available to the plant in each soil. Samples of the uncropped soils are extracted with various extractants, and the amounts to the element extracted are "correlated" with the amount taken up by the assay crop. The best extractant is studied further to determine the optimum extraction time and other soil testing conditions.

Once a suitable extracting method has been developed for the element being studied, the soil test must be calibrated under field conditions. Until that is done, the results of the new soil tests are simply numbers with little relevance. Field calibration involves a determination of the yield or growth increase that is obtained at different soil test values when the nutrient studied is added to the soil. Other field experiments determine how much of the nutrient must be supplied for optimum growth or quality and methods of fertilizer placement for maximum eficiency. It is important that soil tests be calibrated for the soils of the area for which recommendations are made.

History of Soil Testing

Early soil chemists measured the total amounts of nutrients present in the soil. Unfortunately, there was very little correlation between total nutrients and plant available nutrients. This was the situation in 1840 when Justus von Liebig, father of soil chemistry, was prominent. In 1850, Thomas Way in England measured "exchangeable" cations, and modifications of his test are in use today. Later (1894), Dyer extracted phosphorus and potassium with citric acid as soil chemists attempted to duplicate the dissolving power of plant roots.

Modern soil testing began with the work of Bray (Ill., 1929), Truog (Wis., 1930), Morgan (Conn., 1935) and Spurway (Mich., 1938) who used extracting solutions designed to reproduce the solvent action of root exudates. Refinements in these early methods, notably by Bray and Kurtz, (1945), Mehlich (1953) and Olsen (1954) have led to many of the methods still in use today.

Current research in soil testing methodology involves attempts to measure both the actively available forms of nutrients and the reserve supplies that become available more slowly. Some research is being conducted to find extractants that can measure available forms of several nutrients simultaneously.

Advances in instrumentation have led to improvement in soil testing accuracy. Prior to the 1960's, soil test kits were in vogue. Almost every county in the state, many vocational agriculture in-

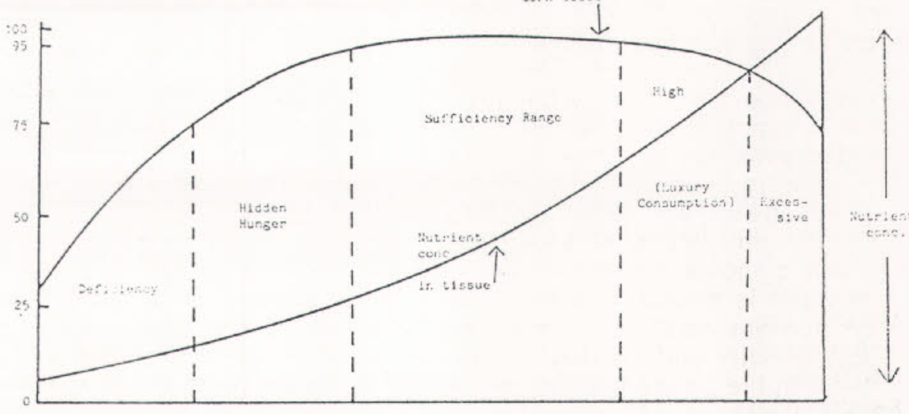

Fig. 1. Relationship between nutrient supply, plant growth and nutrient concentration in ear leaf tissue. (Adapted from Brown, 1970).

structors and fertilizer dealers all were testing soil with these kits. Soil testing with kits was reliable only when performed by an experienced technician. The soil test kit was replaced with electronic instruments in the 60's.

Computer processing of soil test results was pioneered at the University of Wisconsin by L.M. Walsh, currently Dean of the College of Agricultural and Life Sciences. In 1964, electronic reporting was made available to commercial soil testing labs through Agricultural Records Cooperative (now known as Wis. Dairy Herd Improvement Coop). Approximately 200,000 samples are processed by WDHIC annually in Wisconsin. The results are stored on magnetic tape and summarized by county every four years.

The routine soil test for turfgrass is pH or acidity, buffer pH, organic matter, phosphorus, potassium and soluble salts. The buffer pH is used to calculate the lime requirement of acid soils. The soluble salt test is used to indicate problems due to over-fertilization. Other tests available upon request in Wisconsin are calcium, magnesium, sulfur, boron, zinc, manganese and particle size distribution (percent sand, silt, clay).

Plant Analysis

Plant analysis is the quantitative analysis of the elements in plant tissue. Carbon, hydrogen, and oxygen come from air or water and are not analyzed routinely because they seldom limit plant growth. Chlorine and molybdenum are normally sufficient. Thus, most plant analysis labs analyze plant tissue for nitrogen, phosphorus potassium, calcium, magnesium, sulfur, boron, zinc, copper, manganese and iron. Aluminum and sodium are sometimes included even though they are not essential to plants.

The general relationship between nutrient level and plant growth is shown in Figure 1. When a nutrient is deficient, addition of that nutrient results in increased plant growth and usually an increase in the concentration of the element in the plant. As the level of the deficient nutrient increases, plant growth increases until some other factor limits growth. Further additions of the element will cause the concentration of that element in the plant to rise more rapidly because it is not being diluted by additional dry matter. Eventually, toxicity of that element may occur.

Plant analysis has proven useful in confirming nutrient deficiencies, toxicities or imbalances, identifying "hidden hunger," evaluating fertilizer programs, determining the availability of elements not tested for by other methods, and to study interactions among nutrients.

For most field crops, the portion of the plant sampled and the stage of maturity influence the nutrient composition. These factors are less critical for turfgrass that is mowed regularly. If allowed to grow to maturity or senscence, however, the analyses are difficult to interpret. Unfortunately, there is not much research being conducted on the optimum nutrient composition of different species of turfgrass.

Plant analysis complements soil testing. Sometimes adequate nutrient levels may be present in the soil but, because of other problems such as insect feeding, root damage, too much or too little moisture, or compaction, inadequate amounts of nutrient get into the plant. Plant analysis, along with soil tests, can help pinpoint the problem.

Editor's Note: Dr. Emmett Schulte is a Professor of Soil Science at the University of Wisconsin — Madison. He has a B.S. degree in Chemistry, a M.S. and a Ph.D. in Soil Science and has been a UW—Madison staff member since 1964. His responsibilities include instruction, research and extension work in soil fertility and he currently is also the Director of UWEX Diagnostic Labs. He also spent a number of years overseas as a member of the USAID-University of Wisconsin team at the University of Ife, Nigeria.

GOLFERS BID FOND FAREWELL TO STRUM'S SAND GREENS!

Golfers had their final chance on the weekend of June 8 to play the sand greens of Strum's Viking Skyline Recreation Area golf course, a remnant of yesteryear.

A brand new par-36, nine-hole course with big grass greens has been built around the old golf course. A sand green is the putting surface of a golf hole in which smooth sand takes the place of the closely mowed grass. Sand greens were common in all sections of America in years past. The club held a tournament that began on the nine-hole sand-green course and ended on the grass green course. Over one hundred players participated. The tournament, however, was not the highlight of the weekend celebration. The "drags," pieces of carpet with handles attached to them for smoothing the sand each time they putted, were burned in a ceremony on Saturday night! The golf course originally opened in 1965 and made the switch to grass this year because members were simply tired of the sand. The course is part of a 300 acre recreation area and started with sand greens because of the lower expense associated with maintaining them. However, in recent times the golf course was losing business because of them and faced closing if changing to grass was delayed or avoided.

Sand greens are rapidly disappearing around the country. Except for the novelty of it, playing sand is little fun. The sand is left black and hard by the twice-a-year oiling, and it leaves golfers with a oily residue on hands and shoes.