

**M**any golf course maintenance practices are based on feel, while others require scientific test results to make proper decisions. A common scientific test is a chemical soil test, which measures the content of elements in the soil.

The common elements are macronutrients – nitrogen, phosphorus, potassium, calcium, magnesium and sulfur – and micronutrients – iron, copper, manganese, zinc, boron, molybdenum and chlorine. A soil test – along with pH; conductivity; the calculated distribution of calcium, potassium, sodium, and magnesium (base saturation); and cation exchange capacity – provide the basis for fertilizer and amendment applications to soil. Chemical soil testing is standard operating procedure, and many superintendents spend money on such tests.

Most chemical soil tests address about 13 of the 16 to 20 essential elements for plant survival. Other important elements that aren't normally

tested for are carbon, hydrogen and oxygen. Some estimates of carbon content in soil come from organic matter testing. Hydrogen is related to pH levels, but you don't think of applying hydrogen to soils as an essential element. Elemental hydrogen rarely occurs in nature. Rather, hydrogen occurs as organic compounds with carbon, and there are no specific deficiency symptoms for hydrogen. Chemical soil tests don't address oxygen levels in the soil. From a nutrient standpoint, oxygen is a major component of organic compounds. It's the oxygen content in soil that drives most chemical reactions that are necessary for life functions. Without oxygen, nothing happens.

#### THE PROPER BALANCE

So how is oxygen in soil measured? Soil is a three-phase system consisting of solids, water and gas (oxygen and carbon dioxide). The measurement of these components is done through physical soil testing. The formation of soil and its

characteristics depends on the combined effect of physical, chemical and biological processes. Theoretically, a healthy soil consists of a balance of these three phases. When out of balance, turfgrass plants suffer.

The understanding of the proper balance between solid, water and gas is reflected by the recommendations for putting green construction in which the demand for healthy grass is required even under the most extreme environmental conditions. The accepted method for building a new root zone was introduced about 50 years ago, specifying volume of 50 percent solid and 50 percent pore space. Pore space is equally occupied by water and air. Generally, this is accomplished by using a specific particle-sized sand with the addition of a specific amount of organic matter or other amendment. This is a good starting point for the optimum soil root zone, but over time, the percentage of each phase changes. It's beneficial to know how to measure the change and how to

# DIGGING IN THE DIRT

