

## Soil Testing

Soil testing is the beginning of precise nutrient management programs for all nutrients other than nitrogen as it can be used to determine nutrient levels, make fertilizer recommendations, and in some cases diagnose the cause of poor performing turf. Assessing the existing reservoir of available nutrients in the soil can minimize the need for supplemental applications of fertilizer, which saves money while protecting the environment.

Soil nutrient analysis aids in determining if nutrient deficiencies exist, as many soils have various levels of nutrient holding capacity, often referred to as cation exchange capacity (CEC). For example, sand-based systems, which have only a limited amount of stored minerals, may demand more mineral additions. Determining supplemental nitrogen needs are typically not based on soil tests as the method of extracting N and the subsequent calibration with plant growth have not been established.

Soil tests are required by the NYS Dishwasher Detergent and Fertilizer Law to confirm a need for phosphorus fertilization prior to its application. Research at Cornell University, however, concluded that no correlation exists between soil test phosphorus levels and runoff until phosphorus levels are 50 fold greater than the sufficiency level. A survey of soil test submissions to the Cornell University Nutrient Analysis Lab found that less than 3% of all submitted samples over a 5 year period had phosphorus values at these levels.

## Soil Sampling

General guidelines for soil sampling are as follows:

- Sample when soils are biologically active. Fall sampling is most common and allows time to review results and apply lime and nutrients in advance of spring growth and to develop a season-long plan.
- Do not sample within the two months following heavy fertilizing or liming; sampling around frequent, light applications (spoon feeding) is acceptable.
- Test soils at the same time of year to allow for comparison of results from year to year.
- Because soils exhibit significant spatial variability, take a number of samples, combine, and then subsample. As a rule, a minimum of ten sample locations should be sampled per acre.
- Sample areas with different soils and drainage separately, for instance, sample sand-based greens and tees separately from fairways and roughs.
- Take the sample from the root zone (typically 4-6 inches deep) typically by removing the grass mat from the top of the sample.

## Laboratory Analysis

Soil test methods vary in a number of respects:

- the type of chemical extractant used to measure the nutrient that can be released or dissolved into solution
- the ratio of soil to solution

- laboratory methods

Some methods are more suitable for one type of soil than another; therefore different labs use different tests. For example, soil labs at universities in the northeast use the Morgan or Modified Morgan test, which is appropriate for the acidic soils found in this region. Other test methods, such as the Bray-1, the Olsen, and the Mehlich-3 tests, use very different extracting solutions, different soil to solution ratios, and processes and are more appropriate for other types of soils. The Olsen test is specifically designed for calcareous soils (soils that contain calcium carbonate). The Mehlich-3 provides reliable results across a wider spectrum of soil pH. Results vary depending on the test method and even when using the same method, can vary widely from one lab to another due to variations in lab procedures. Consistently use the same laboratory to perform soil test in order to compare results over time.

On sand-based areas of golf courses with low CEC (<6 cmol/kg), soil testing has limited utility. Test results in these areas are often low due to the soil's low nutrient holding capacity. On such sites, test only for pH, CEC, soluble salts, organic matter, phosphorus (to adhere to regulatory requirements); if the pH is above 7.5, also test for calcium and magnesium.

## Interpreting Test Results

Soil nutrient analysis provides information on the levels of macronutrients (phosphorus, potassium, calcium, and magnesium) and typical micronutrients (iron, zinc, copper, and boron) present in the soil, as well as the soil pH. In addition to standard pH and nutrient information, additional soil test data, such as CEC, soil organic matter content, and total soluble salts, can be requested and may prove valuable in the management of putting green soils in particular. Soil test results may include N levels, however because nitrogen constantly fluctuates between plant available and unavailable forms, it is unclear whether this information is useful.

Laboratories report results for nutrients as either parts per million (ppm), pounds per acre (lbs/A), or as a predictive index (lbs/A can be converted to ppm by dividing the lbs/A reported by two and ppm can be converted to lbs/A by multiplying by two). Most laboratories report a rating indicating the relative status for each nutrient, such as Very Low, Low, Medium, High, or Very High. Test results provide recommended nutrient (including nitrogen) and lime application levels and frequency of application. Soil test results form the basis for nutrient management planning for selection of nutrient sources, rates of application, and appropriate timing to meet site specific needs for greens, tees, fairways, and roughs.

## Supplemental Plant Tissue Analysis

Plant tissue analysis is a useful diagnostic tool when samples are collected over a season in which levels can be correlated with environmental, biological, and fertilizer events. Occasionally sampling provides little information regarding nutrient management when tissue levels are not properly correlated with fertilizer need. Therefore, tissue testing is not considered a reliable means of establishing a nutrient management program on its own. Used in conjunction with soil tests, analyzing plant tissues over time can be used to observe trends that can be correlated to environmental and management factors. Tissue testing may be best used on sand-based areas and when the majority of nutrients are going to be applied in fertigation (the application of nutrients through the irrigation system) or in small amounts (spoon feeding).