SOIL TESTING FOR NUTRIENT EVALUATION AND CHEMICAL PROBLEMS*

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One of the basic turf management practices that often gets overlooked as we become more attracted to what might be called the "WOW" of science is routine soil testing. As a friend of mine said, "I told the crew to lime all the fields, but later this spring one field would not respond like the others. We tried extra applications of nitrogen and micronutrients so after two months I decided to test the soil and found the pH to be 4.9." It can be difficult to grow grass under those conditions.

The first step to determining the soil fertility and planning a sound fertilizer program is a soil test. Soil tests are used for identifying nutrient deficiencies, evaluating potential excesses or imbalances of essential nutrients, heavy metals, or salts, and assessing other important soil chemical aspects (organic matter content, cation exchange capacity, etc.) that may influence turfgrass growth.

One of the most important and probably one of the weakest steps in a soil testing program is soil sampling. Soil types at a facility may vary significantly from one field to another or even from one end of a field to the other. This commonly occurs when there is significant soil movement during construction or when soil is brought in to the site. Thus, if samples are not taken properly, the test results are of little value or even misleading. Remember, that one pint of soil in the bag must represent the entire field. Therefore, extreme care should be taken during sample collection because soil test results are no better than the sample submitted to the laboratory. Below are some guidelines to aid in collecting a representative soil sample.

- Collect samples using clean sampling tools and a plastic bucket. Use of metal containers for collecting and mixing samples may result in contaminating the sample with some micronutrients, e.g. manganese (Mn) and zinc (Zn), invalidating these tests.
- Collect subsamples from defined areas in a random pattern. Sample similar areas together with at least 15 subsamples or soil cores from an area to make a composite sample. Sample each field separately unless you know fields can be consolidated because they have the exact same soil type and have been fertilized, irrigated, and cultivated the same.
- Sampling depths will vary depending on soil conditions and whether the area is being sampled for establishment, maintenance, or troubleshooting purposes. It is important to follow the sampling guidelines of the laboratory performing the analyses. Some suggested guidelines for sampling depths include sampling the top six inches for establishment but sampling only the top three to four inches for established turf areas.
- Carefully mix the subsamples and obtain a representative sample that contains sufficient soil for analyses. Usually one to two cups of soil is sufficient. Some laboratories now provide "fill lines" on the sample container to insure adequate sample volume.
- Keep good records of where samples were obtained and the particular code used to identify a sample.

Although samples can be obtained at any time of the year it is suggested that samples be collected before the most stressful part of the year. Also, samples should not be collected within two weeks of phosphorus (P), potassium (K), or magnesium (Mg) fertilization. If results are being compared from one sampling period to another, samples should be taken at the same time each year. This is because there can be some seasonal variation in results for some analyses. For example, soil pH values will generally be lower in July or August as compared to January or February.

Highly managed areas and fields where one is trying to alter some soil chemical aspect such as pH, P levels, salinity, etc. should be sampled annually. Routine sampling every 2 to 3 years is usually adequate for medium to fine textured soils once an annual sampling history is established.

Air dry the soil in an area free of fertilizer dust and include all information requested by the laboratory. The laboratory will grind the sample to break up any aggregates and screen it to uniform size (<2mm, or 10 mesh).

It is important to note that once a sampling strategy (sampling depth, sampling time, etc.) has been developed one should maintain that strategy. This is particularly important to compare results over several years to determine trends in fertility levels. For example, have the P and K management practices used resulted in an increase or decrease in the soil nutrient levels? If one does not follow consistent sampling strategies each year, such comparisons cannot be made.

Nitrogen Recommendations

Nitrogen recommendations are developed in a slightly different manner than other nutrient recommendations. Whereas, Phosphorus (P), Potassium (K), Calcium (Ca), and Magnesium (Mg) recommendations are based on the amount of each nutrient extracted from a soil, N recommendations are not. Because of the many factors that influence the amount of N present in a soil at

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any given time, laboratories do not test samples for N for the purpose of making recommendations. Nitrogen recommendations are developed through a series of field experiments that are conducted over several years in which variable rates of nitrogen are evaluated relative to selected turf properties. Some laboratories will then modify the recommendation based on the amount of organic matter in the soil. Therefore, N recommendations for turf can vary considerably depending upon how it is to be used, the rate of growth and color desired, and the geographical region in which it is being grown.

Phosphorus (P) Recommendations

Phosphorus recommendations for turf are based on soil test P levels, the intended use and management practices that will be used. For most turf, phosphorus applications are recommended for very low, low and medium testing soils. Several laboratories recommend phosphorus applications on high testing P soils for turf establishment. This is due in part to the critical role that P plays in promoting early root and vegetative development during the initial phases of turf establishment.

Except for sandy, acid soils, P does not leach like N or K. However, in fine-textured soils P becomes bound to different soil components and with continued indiscriminate applications can build up to excessively high levels. In some cases it may become a potential environmental hazard leading, for example, to water pollution. As developments encroach upon tributaries and other environmentally sensitive areas, turf managers will need to rely much more on soil testing in the future to guide fertilization practices than they have in the past.

Potassium (K) Recommendations

Potassium recommendations are based on K soil test levels and turf management practices. Potassium is generally recommended on very low, low, medium, and high testing soils. However, very few laboratories recommend potassium fertilization on very high testing soils. In some cases recommendations are modified for sandy soils to allow for the higher rate of leaching compared to finer textured soils. Thus, it is generally recommended that the annual rate of K be divided into split applications to help prevent K from leaching below the root zone and preventing potential K deficiencies. The K applications can be made in combination with the N applications not to exceed 1.5 lb. K_2O per 1000 ft^2 per application.

Maintaining adequate K in the root zone for turfgrasses is very important. Potassium contributes cell turgidity. Potassium-deficient turfgrass tends to lose stomatal control and transpirational loss of water is high, turgidity decreases, and wilt is more prevalent. However, when K levels in the soil become excessive, high soil salinity limits plant water uptake, induces wilt, and reduces wear tolerance. Saline conditions can easily build up in sandy soils if high levels of salts are added (via fertilization, irrigation) and leaching is limited.

Calcium (Ca) and Magnesium (Mg) Recommendations

Few laboratories have specific recommendations for these nutrients if they are found to be low. Generally, low levels of these nutrients are associated with low soil pH and are corrected by the application of dolomitic limestone to increase pH.

While Ca deficiency is very rare, Mg deficiency can occur on very acidic and on low cation exchange capacity (CEC) soils such as sandy soils that are subject to frequent leaching. Also, Mg deficiency may be induced by large applications of calcitic limestone or

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large applications of K. To help prevent this problem from occurring use dolomitic limestone as the liming source. If a Mg deficiency is suspected, a plant or tissue analysis will aid in confirming the diagnosis. An alternative method is to apply a foliar application of 1 lb. magnesium sulfate (i.e. 0.1 lb. Mg) per 1000 ft^2 in 2 to 3 gallons of water. If Mg is deficient, the turf will start to green up in generally less than five days. In severe cases, higher rates need to be applied. Another alternative is to apply Mg in the regular fertilizer program.

Sulfur (S-SO_4) Recommendations

Although procedures are available to determine sulfate-sulfur (SO4-S) levels in the soil, because of its mobility, particularly on coarse-textured soils, few soil test laboratories do this on a routine basis. Instead some laboratories make a routine recommendation.

Micronutrient Recommendations

Until recently, few research studies have been conducted relating turfgrass performance to micronutrient deficiencies. Consequently, with the exception of Fe and Mn, extractants used for assessing the availability of micronutrients have not been evaluated extensively on turf. Although extractants for Fe and Mn are best correlated, they are not very reliable for predicting maintenance or corrective treatments. This may be due in part to the fact that most turfgrasses are very efficient in utilizing micronutrients in the soil.

Iron (Fe) deficiencies are readily apparent from plant symptoms - chlorotic turf with yellowing being most apparent on the new leaves; spindly, thin leaves; chlorosis often occurs in irregular patches rather than uniformly across the turf. Application of foliar Fe at 1 lb Fe/acre will result in rapid greening of the turf. Grasses often respond to foliar Fe even when there isn't a Fe deficiency; thus, a true deficiency is present only if real Fe-deficiency visual symptoms are present.

Manganese deficiencies are most prevalent on near neutral to alkaline pH soils. The solubility of Mn in soils is strongly influenced by soil pH and deficiencies are rarely encountered in turfgrass growing on soils with a pH less than 6.5. Therefore, for a Mn soil test to be meaningful, soil pH must be included in the interpretations. If soil pH is not taken into account with the extractable soil Mn level, the soil test may indicate a low soil level, even though the level is sufficient for good growth. If a Mn deficiency is suspected it can generally be confirmed by plant analysis. Another method for confirming a suspected Mn deficiency is to apply a foliar application of Mn, using 1 lb. of Mn/A in sufficient water to thoroughly wet the foliage. If Mn is deficient, a greening response will occur in a few days. The following table lists some examples of spray rates that can be used to spot check for micronutrient deficiencies. ***STM***

McCarty, et al., 1993)

Element	Fertilizer source	Product oz. per gal	Lb. element per 1000 ft.²	Lb. element per acre
Fe	Iron sulfate	0.75	0.025	1.1
Mn	Manganese sulfate	0.50	0.025	1.1
Zn	Zinc sulfate	0.50	0.010	0.44
Cu	Copper sulfate	0.50	0.003	0.13
B	Sodium borate	0.05	0.001	0.04
Mo	Sodium molybdate	0.01	0.001	0.04

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