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Don't Guess, Soil Test

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Although poor performing turf can indicate underlying soil problems, one cannot identify soil pH, nutrient, and/or plant parasitic nematode problems by site. Soil analysis is needed to determine if these factors are limiting turfgrass rooting and nutrient uptake. If so, lime and fertilizer are recommended to rectify pH and nutrient levels and nematicides are suggested for nematode control. Here are some guidelines for proper soil testing.

Take a Good Soil Sample

A sample that adequately represents the soil area of interest is key. Soil pH and nutrient levels can be extremely variable naturally due to non-uniform applications of lime, fertilizer, and water. For example, we have seen soil pH vary from 4.0 to 8.0 within a single fairway due to differences in soil type. Unfortunately, this was evident because the ryegrass overseeding had died in the pH 4.0 soil. Soil pH was not a suspect in the turf death initially, because a composite soil sample of the entire fairway had a pH of 6.8. Although the areas with pH 4.0 were limed to adequate levels during construction, 6.0 to 6.5, their pH had declined to detrimental levels over time. Periodic liming of these areas will continue to be necessary. The soil with a pH of 8.0 was formed in high calcium carbonate deposits and will have excessively high pH for a long time. A good map defining areas of like soil properties and fertilization and liming histories is helpful for future sampling.

Plant parasitic nematodes are also variable in their occurrence. In turf, nematode problems are most likely in sandy or sandy loam soils. Thinning turf with yellowed leaves, unusual disease outbreaks, and difficult to control weed infestations are characteristic symptoms of nematode problems. Bermudagrass may be infected with leaf spot diseases when stressed by nematodes. Likewise, weeds such as prostrate spurge, Florida pusley, and Virginia buttonweed commonly colonize turf that is less vigorous due to nematodes. Since the symptoms of nematode damage are very general, soil sampling is needed to confirm or rule out their role in turf decline.

Sampling Techniques

Obtain 15 to 20 soil cores randomly from throughout each sampling area using a 0.5 to 1.0" soil probe. Samples for pH and nutrients should be taken 6 to 8" deep prior to turf establishment, but only 3 to 4" deep thereafter. Remove the thatch and turf layer and thoroughly mix the soil cores in a clean plastic bucket. Fill a 1 pint sample container with soil and discard the excess. Annual soil sampling is recommended for native soil fairways, but more frequent sampling may be prudent on sand-based greens and tees. Soil pH and nutrient levels can change rapidly on greens and tees, particularly when recently constructed. Seasonal variation in soil pH occurs so standardizing the time of sampling is a benefit to tracking changes from year to year. Soil samples do not have to be dry to be mailed to the laboratory, but excessively wet samples should be air dried to moist conditions prior to shipping.

There are two basic types of nematode samples that one can take. A 'diagnostic' sample is taken in obviously weak turf areas to determine the level of nematodes. In this situation, soil cores are taken along the margins of the weak turf where nematodes are likely to be highest. It is a good idea to compare the 'suspect' sample with a 'good' sample from adjacent healthy turf. The species and numbers of nematodes found in both 'bad' and 'good' samples can be compared to help determine their role in causing turf decline. Diagnostic samples can be taken in spring, summer, or fall.

The other type of sample could be described as a 'routine' sample. Routine samples are taken periodically from areas to provide general monitoring for nematode buildup. Also they are used to to determine if nematode counts are above damage thresholds prior to applying a nematicide or to judge the effectiveness of a nematicide application. In these cases, soil is taken from throughout the turf area regardless of symptoms. We suggest taking soil samples in a zig-zag pattern across the turfgrass area to obtain the best estimate of nematode species and levels. A good time to take routine samples in bermudagrass or bentgrass turf is mid to late spring or early fall, because the weather is good for both turf growth and nematode reproduction. These are also good times to apply a nematicide if needed., although late spring applications are preferred for optimum nematode suppression and turf enhancement.

Nematode samples should be taken to the approximate depth of the majority of roots, usually 3 to 5" deep. Using a 1" diameter standard soil probe, collect about 20 to 25 soil cores and combine in a bucket. Gently break apart the soil cores (sand abrasion will kill nematodes) and place about one quart of soil in a plastic bag and seal tightly. Label the sample bags with a permanent marker and make sure your labels correspond with the submission forms. Keep the samples below 80 ^{o}F and treat them gently to avoid nematode mortality (do not freeze or refrigerate). Send them to the laboratory as soon as possible and avoid sending samples over weekends or extended holidays.

Recommendations from nematode analysis

Recommendations for nematode control depend on the species and level of nematode and their capacity to damage specific turfgrasses. Most states publish recommendations based on 'damage thresholds' that are a general guideline to assist in judging the relative importance of nematodes in turf damage. The most damaging nematode in the Carolinas is the sting nematode. The threshold for bentgrass published by Clemson University is 20 or more nematodes/100 cubic centimeters (cc) of soil and 18 nematodes/100 cc or above for bermudagrass. Damage thresholds for most nematodes are much higher than those for sting nematode. The threshold for ring nematodes in bentgrass is 500 or more/100 cc of soil and 1000 or more/100 cc for bermudagrass. Many times a sample will contain more than one type of nematode, but none above threshold levels. If this is the case, treatment may still be beneficial if the total number of nematodes approaches high levels. Turf that is managed to compensate for the root damage caused by nematodes can withstand higher numbers without nematicide treatment. Turf that is stressed by other factors, such as temperature and moisture, may be damaged at levels below the published thresholds.

Soil Analysis Procedures

The level of available nutrients in soil can be determined by several suitable extracting agents. Three common extractants are Mehlich I, Mehlich 3, and Bray. Although each of these is appropriate for the acid, low cation exchange capacity soils that are predominant in the Carolinas they will extract different amounts of nutrients from the soil, particularly phosphorus. This is not usually a problem because the laboratories make fertilizer recommendations specific to the extracting agent they utilize. However, in order to compare results from different laboratories you must know that they use the same extracting agent. Even analysis of the same sample by the same laboratory will show some variation in results so do not expect identical numbers from the two laboratories even when they employ the same procedures.

Methods for measuring soil pH differ little among soil test laboratories, but methods used to determine lime requirement (represented by buffer pH on some soil reports) do vary. Even so, lime recommendations will not differ substantially among laboratories as long as the target pH (the expected pH after liming) is the same. Recommended soil pH levels are dependent on grass type and may be as low as 5.5 for centipede to as high as 6.5 for most other grasses.

Fertilizer Recommendations from Soil Analysis

Most soil testing laboratories make fertilizer recommendations for the major nutrients, phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg), and these recommendations are made based on the 'sufficiency level' approach. This philosophy acknowledges that as the soil test level of the nutrient increases the chance of getting a response to adding that nutrient decreases and the magnitude of the response, if it occurs, is diminished. At a low soil test nutrient level a response to adding the nutrient is expected most of the time and the response should be relatively large. Adding the nutrient to soil with a medium level of the nutrient should garner a growth response about half the time, but the enhancement will be less than at low soil test levels. Little or no response to adding the nutrient will be realized on high soil test levels. Maintaining soil test levels in the upper part of the medium category or the lower part of the high category is a safe and efficient way to manage P, K, Ca, and Mg. Most laboratories will recommend nutrient additions to turfgrass even at high soil test levels, in part based on anticipating the replacement of nutrients removed in clippings. Building high soil test levels of P and K will be difficult in sand-based greens and tees especially when recently constructed, because the ability to retain these nutrients is very limited. Hence, the spoon-feeding approach usually adopted on greens, where P and K applications are tied to nitrogen fertilization rates (for example in a 5-1-5 ratio of N-P-K).

Another approach used to make nutrient recommendations is the basic cation saturation percentage method. This approach is based on the notion that there is an 'ideal' cation composition of the cation exchange capacity -- 65% calcium, 10% magnesium, 5% potassium, and 20% hydrogen. This idea was advanced in 1945 and subsequent research, as early as 1949, demonstrated it was not a valid method for making fertilizer recommendations in most situations. Although managing calcium, potassium, and hydrogen by this method is not recommended it is important to keep magnesium above 10% of the cation exchange capacity at low to medium soil test levels (see the March/April 2003 Carolinas Green for more details on managing magnesium).

Soil testing procedures can identify insufficient soil supplies of manganese (Mn) and copper (Cu), as well as excessive levels of Cu. Soil pH has such a dramatic effect on Mn availability that it must be used in combination with the soil test Mn level to make a fertilizer recommendation. For example, at a soil pH of 7 soil test Mn must exceed 17 lb/acre or 9 ppm to be sufficient (using the Mehlich I extract). However, at a pH of 6.0 only 8 lb/acre or 4 ppm is needed. Copper deficiencies in turfgrasses are extremely rare, to our knowledge only occurring on organic soils. We diagnosed deficiency in tall fescue on a sod farm where soil test Cu levels were below 2 lb/acre or 1 ppm (using the Mehlich III extract). We have also seen copper toxicity in bentgrass at soil test levels above 10 lb/acre or 5 ppm (using the Mehlich I extract).

Soil testing is not widely utilized to make fertilizer recommendations for the other essential nutrients derived from the soil, namely nitrogen (N), sulfur (S), boron (B), chlorine (Cl), molybdenum (Mo), zinc (Zn), and iron (Fe), even though values for levels of these nutrients may be provided on soil reports.

Maintaining soil reports and reviewing them from year to year is a great tool for determining the effectiveness of a lime, fertilizer, and nematode control program. Details of the soil testing and nematode assay services offered by the Clemson Extension Agricultural Service Laboratory are available at: http://virtual.clemson.edu/groups/agsrvlb/#Home If we can help, please do not hesitate to call.

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