SOIL TESTING: Techniques and Application

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Soil testing is probably the most misused and misunderstood tool of modern agricultural technology. Soil tests were originally developed to predict yield responses of specific agronomic crops to elements applied on a specific soil type. That is all they were ever intended to do and from a fertility standpoint that is all they are capable of doing. Unless the results from a particular soil extraction technique are correlated experimentally with field responses of a particular crop being grown on a specific soil series the results are just numbers and nothing more. To predict crop responses to applied fertilizer using soil tests results when these relationships have not been established is guessing, pure and simple. In otherwords soil tests have to be calibrated for each crop on each soil type. Recommending specific quantities of elements based on soil testing for a soil and crop which have not been calibrated to that particular soil testing procedure is a very common misuse of soil testing. This is not calibrated to a given situation. It can still yield valuable information and can be used to make some inferences about how a soil should be managed and fertilized.

There are 3 basic parts to any soil test, the sample, laboratory analysis, and interpretation of the lab data. Optimum results from a management program based on soil testing depends on all three steps. The soil sample must be representative. The lab analysis must be consistent and minimize errors. The interpretation must be done by someone with experience who is aware of the inherent limitations of soil testing.

Most good turf managers know how to take a representative soil sample but since this is probably the single largest source of error in most situations the procedure bears repeating. Keep in mind that the lab is going to use from about 1/4 ounce to 8 ounces of soil depending on the procedure being done and you intend to make inferences from that sample for a soil that weighs about 2 million pounds per acre furrow slice. This size is equivalent to about 10 to 230 parts per billion of the total soil mass per acre. You can see why the sample had better be a representative one. To obtain a representative soil sample you must take samples at random all over the area of interest and from the root zone of the crop being grown. For turf the effective rooting depth is usually considered to be 6". Soil samples should be taken from a depth of 2 to 5 inches below the soil line. Areas that are not representative of the general status of the soil, such as localized wet spots or soil near building foundations or road beds, should be avoided. A different sample should be submitted for every area with a different soil type or different management scheme. For golf courses a separate sample should be done for each green, tee, and fairway even if soil types are similar. Never sample immediately after applying fertilizer, wait at least one week. Once a composite sample for an area is obtained all thatch should be removed and the sample should be screened to remove roots, rocks and other large particles. A piece of ordinary fiberglass house screen will do the trick. The sample should then be thoroughly mixed. Samples should be air dried unless they can be analyzed immediately.

The second step in a soil test is the lab analysis. Soil pH is usually determined using a 1:1 by weight soil water mix. The mixture is stirred, allowed to settle and the pH of the supernatant liquid is determined with a pH meter. This procedure is reliable and the results are fairly easy to interpret. Determination of "available" nutrients usually consist of adding a liquid "extractant" to a given volume of soil. The extractant is a chemical solution containing a relatively large concentration of a given cation,typically ammonium or hydrogen. The cation in the extractant drives other exchangeable cations off the soil colloid and into the surrounding solution. The solution is then separated from the soil by filtration and is analyzed to determine the quantity of calcium, magnesium, potassium, and sodium it contains. Phosphorus is determined in a similar manner. From the results of the extraction procedure the lab attempts to predict what will be available to the crop over the course of a growing season or year. The lab procedures for any given extractant are standardized and give reasonably consistent, reproducible results if the procedure is done correctly. However, this is obviously a very artificial system which only

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vaguely resembles what actually happens in the soil over time. Furthermore numbers obtained from one extractant will be different from results using a different extractant. Thus the need arises for calibrating the numbers obtained in the lab with actual field responses.

The research correlating response of turfgrass and many other ornamentals with soil test results has not been done for most situations. A half dozen subsamples of the same soil sample sent to six different soil testing labs typically will, result in six different recommendations. These recommendations may be 5 to 10 times higher from smallest to largest. The reason for the discrepancies is not poor lab analysis in most cases but rather a difference in interpretation of what the results mean. Labs which use the same extractant usually report similar results but very often make different recommendation. Who is right and who is wrong is anybody's guess. Very often soil test labs will report results with quantities of individual elements rated from very low to very high. A rating in the low range implies the crop will respond to applications of that element. A medium rating means the element is probably present in adequate amounts while a rating in the high range means that more than ample quantities are present and the crop should not respond to applications of that element. However, this is not always the case. Reasearch at the University of Florida on St. Augustinegrass showed no differences in rooting, yield, and turf quality for potassium rates ranging from ½ pound to 2 pounds per 1000 sq. ft. per month on plots which tested low in potassium. Studies at Texas A&M using 2, 4, 6 and 8 pounds of potassium per acre, year demonstrated increased wear tolerance of bentgrass with increasing amounts of potassium on a soil which tested high in potassium.

Differences in recommendations often occur even for crops and soils which have been calibrated to soil test results. One study on corn grown in Nebraska on four different soil types followed recommendations from 5 different soil testing labs. They found no difference in yield between the lowest recommendation, for nitrogen and potassium only, and the highest recommendation for large applications of virtually every fertilizer element. Again the reason is differences in interpretation. Many labs interpret their data using concepts, such as cation saturation ratios, which aren't valid.

I've spent a lot of ink telling you what a soil test cannot do. By now if you are still reading you are probably wondering what a soil test can do for you. A soil test can give some valuable information such as soil pH which is very important and may need to be adjusted for optimum crop performance. It can be used to monitor changes in soluble salt levels in the soil when saline irrigation is being used. Soil test results can be used in conjunction with visible deficiency symptoms and tissue analysis when trying to diagnose problems. Soil texture, C.E.C., and percent organic matter are also reported by most soil testing labs. This informatioan can be used when deciding how much, and how often, fertilizer and water should be applied. Course textured soils with low CEC's should be applied. Course textured soils with low CEC's should be fertilized with light frequent applications while finer textured soils with higher CEC's can hold more fertilizer and can be fertilized less frequently.

Some general inferences can also be made in terms of watering. Course textured soils such as sands hold less available water and must be watered more freuently. Medium textured soils such as loams hold most available water and require less frequent watering while fine textured soils such as clays have available water contents similar to sands. Soil C.E.C. and water holding capacity will also increase with increasing organic matter content.

As far as recommending specific quantities of elements based on soil test results, the research simply has not been done for turfgrass on Florida soils. The first and most important rule is to fertilize, and use the proper ratio of N-P-K. For turf this ration should be 3-1-2- or 4-1-2. Changing ratios or deleting one or more of these elements based on soil test results could be a dubious practice. Elements other than N, P, and K, particularly iron and sulfur, can be limiting factors to turfgrass growth in Florida. Probably the best way to determine need for other elements is simply to apply them individually to a small area and look for a response. Keep in mind that things other than yield, such as stress tolerance and turf quality, are important parameters.

To put it simply, soil testing is no panacea but rather a small piece of the puzzle. Even well calibrated soil test results must be evaluated in conjunction with other environmental conditions. Light, temperature, diseases,insects, soil moisture, soil oxygen, and numerous other factors will influence responses in specific instances. The best test is still the discerning eye of an experienced agronomist and the best fertilizer for any plant is the grower's shadow.

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