



## Soil Testing and Interpretation for Florida Turfgrasses<sup>1</sup>

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Most people agree that a healthy, well-maintained turfgrass is a thing of beauty. However, many of these same people envision a beautiful turfgrass as a lot of trouble, hard work and possibly demanding expertise which they do not possess. This is not necessarily true, but a few basic facts concerning the nutritional requirements of turfgrasses and the properties of fertilizer and liming materials are essential. Water and pest infestation influence turfgrass growth, but more often lawns suffer from nutritional deficiencies.

Florida soils are predominately sandy and have a low capacity for nutrient retention. Thus, fertilizer nutrients must be supplied on a regular and continuing basis to satisfy the nutritional needs of turfgrass. Except for the calcareous soils of South Florida, our soils are also predominately acidic. A liming material must be applied in many cases to neutralize a portion of this acidity to obtain optimum growth and color of turfgrasses. Nutritional requirements of turfgrasses and suggested soil test levels for the various nutrients are presented in the following sections.

### Soil Test Philosophy

Soil testing is an applied science and can be used as one of the tools in the maintenance of a healthy

turfgrass. Soil testing should be used in conjunction with tissue testing to arrive at the optimum fertility maintenance program for your turfgrass. Many things influence the level of nutrient extracted from the soil sample, the quantity taken up by the plant and the observed response. The soil test and resulting recommendations represent the turfgrass production area only as well as the sample itself. Therefore, it is imperative that the soil sample be taken and handled properly. The quantity of a target nutrient extracted depends on several mostly uncontrollable soil factors, but the nutrient recommendations are based on plant growth responses which have been correlated with the levels of nutrients extracted in a soil test. The levels of extracted P, K and Mg are divided into five categories: very low, low, medium, high and very high. Recommendations are based on statistical probability of response to an application at the various levels of nutrient extracted as follows: a very low level of nutrient implies that there is a 75% or less probability that a response will be observed if that nutrient is applied, a low level implies 50% or less probability, a medium level implies a 25% or less probability, and a high level implies that a response is not anticipated. Thus, one can see that a response to the application of a recommended nutrient is not guaranteed. The anticipated response is based on a probability calculated on a large number of soils and

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conditions which may or may not be representative of your soil situation. This discussion is not meant to diminish your faith in using soil testing as management tool for the health of your turfgrass and environmental stewardship, but is to strengthen your understanding of soil testing and subsequent recommendations.

## Soil Analysis and Interpretation

One of the first steps in producing and maintaining beautiful turfgrass is to obtain an analysis of a representative soil sample from the turfgrass production area. The sample should be obtained by taking 15 to 20 small plugs at random over the entire area, avoiding any areas with an unusual and/or identifying appearance. Ideally, one should sample the areas with special characteristics separately. Most turfgrass roots are located in the top 4 inches of soil; therefore, limit sampling depth to 4 inches.

Place the 15 to 20 plugs in a plastic container, mix them thoroughly, and send approximately one pint of the mixed sample to the UF/IFAS Extension Soil Testing Laboratory (ESTL) for chemical analysis. The county Cooperative Extension Service can also supply additional information on the proper technique of sampling and submitting a soil sample. The office address and phone number are listed in your local telephone directory, or you can contact the ESTL on the internet at [soilslab.ifas.ufl.edu](http://soilslab.ifas.ufl.edu) or by email at [soilslab@mail.ifas.ufl.edu](mailto:soilslab@mail.ifas.ufl.edu).

A soil analysis supplies a wealth of information concerning the nutritional status of a soil and can detect potential problems that limit turfgrass growth. A routine soil analysis supplies information relative to soil acidity and the Mehlich-I (the chemical extractant currently used by the ESTL) extractable phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) status of the soil. A lime requirement determination is included in the routine analysis if the soil pH is below 6.0. Nitrogen (N) is not determined because, in most soils, N is highly mobile so its soil status varies greatly with rainfall and irrigation events. Nitrogen recommendations are based on the nutritional requirements of the turfgrass being grown and the quality of turfgrass desired.

You will note from Table 1 that there is no interpretation made for soil test Ca or Fe. No interpretation is made for Mehlich-I extractable Ca levels because the extractant dissolves calcium compounds in the soil which are not readily plant available. Thus, an erroneous interpretation of the plant available Ca could be made. In most cases, Ca levels are adequate for turfgrass growth because Florida soils are inherently high in Ca, have a history of Ca fertilization, or receive Ca regularly through irrigation with high Ca water. The soil test level for Mehlich-I extractable Ca is used only to determine the type of limestone needed when lime is recommended. For most soils and crops, liming to insure an adequate soil pH for proper growth will insure more-than-adequate Ca. Research has shown no crop response to added Ca, from either liming materials or gypsum, when the Mehlich-I extractable Ca level is above 250 ppm.

The following levels of Mehlich-I extractable nutrients are considered adequate for optimum turfgrass growth.

The ESTL does not analyze for extractable Fe because definitive interpretation data are lacking. Significant correlation of soil test Fe levels and plant tissue levels is lacking and testing procedures tend to produce highly variable results. Most soils, except ones having a pH of greater than 7.0, generally contain adequate levels of Fe for optimum growth. Turfgrasses grown on soils with  $\text{pH} \geq 6.5$  exhibit a greening response to Fe applied as a foliar spray. Unfortunately, reapplication may be required to sustain the desirable color.

Liming recommendations are based on the Adams-Evans lime requirement test. This test is included in the routine soil analysis, but the test is only run if the soil pH is 6.0 or less. The quantity of lime recommended is based on the type of turfgrass being grown and the target pH desired.

## Soil Acidity

Turfgrasses differ in their adaptability to soil acidity. For example, Centipedegrass and Bahiagrass grow better in an acid environment (pH 5.0 to 6.0) than St. Augustinegrass or Zoysiagrass, which grow best in near neutral or alkaline soils (pH 6.5 to 7.5) (Table 2).

## Adjusting the Soil Reaction (pH)

Soil reaction, or pH, is important because it influences several soil factors that affect plant growth. Soil bacteria that transform and release N from organic matter function best in the pH range of 5.5 to 7.0; certain fertilizer materials also supply nutrients more efficiently in this range. Plant nutrients, particularly P, K, Ca, Mg, B, Cu, Fe, Mn and Zn, are generally more available to plants in the pH range of 5.5 to 6.5. These plant nutrients leach more rapidly at pH values below 5.0 than in soils with reactions between 5.0 and 7.5. In certain soils, when the pH drops below 5.0 aluminum may become toxic to plant growth.

Normally, liming materials are used to increase soil pH and supply the essential nutrients Ca and Mg. The two most commonly available liming materials are calcic and dolomitic limes (Table 3). In instances where the soil tests low in Mg (less than 20 ppm Mehlich I extractable Mg), dolomitic lime should be used. Generally, about 6 months' reaction time is required for calcic and dolomitic lime to have their maximum effect on soil acidity. If more immediate results are desired, hydrated lime can be used. Hydrated lime is not recommended for use by the non-professional, however, because this material can severely damage the turfgrass if improperly used. Lime recommendations are typically made on a calcic limestone basis. If another liming material is used, adjust the application rate according to the calcium carbonate equivalents given in Table 3. Basic slag is a slow-reacting product which also contains large amounts of phosphorus, but cost and availability limit its use.

The amount of lime necessary to properly adjust the soil pH depends on the soil type. The greater the amount of organic matter or clay content of the soil and the lower the pH, the more lime required to increase the soil pH to a desired level. Soil lime requirement cannot be determined by soil pH alone. If the soil pH is less than 6.0, a lime requirement test will be run on the soil sample to determine how much lime is required to increase the soil pH to 6.5. The lime requirement test is included in the routine standard analysis of a soil sample.

## Soil Alkalinity

If a soil is too alkaline, i.e., has a pH of greater than 7.5, one must determine whether the excess alkalinity is due to an inherent soil characteristic or previous excessive application of liming materials. Soils having a pH of greater than 8.3 are not alkaline due to the presence of calcium carbonate materials, because calcium carbonate has an equilibrium pH of 8.3 in water. Thus, excessively high soil pH is mostly likely due to the presence of elevated levels of sodium. It is difficult and uneconomical to change the pH of naturally occurring alkaline soils such as those found in coastal areas or "fill" soil containing marl, shell, or limestone. If a high pH is due to applied lime or other alkaline additives, on the other hand, then acid-forming materials such as sulfur and ammonium sulfate can effectively reduce soil pH when applied at the proper rate and frequency.

Granular, super-fine dust, or wettable sulfur can be used to decrease soil pH. Granular sulfur is preferred for turfgrass production systems due to the ease of application (with cyclone fertilizer spreaders) and the reduced possibility of foliar burn from the granules. Thoroughly water-in sulfur after application, taking care to wash off all above ground turf parts. It takes approximately 1/3 the amount of sulfur to decrease the soil pH 1 unit as it does calcic lime to increase the soil pH 1 unit. Do not apply more than 10 pounds of sulfur per 1000 square feet per application. Repeat applications of sulfur should not be made more often than once every 3 months. Remember that sulfur oxidizes in the soil and reacts with water to form a strong acid (sulfuric acid) that can severely damage plant roots, so it must be used cautiously.

## General Fertilizer Recommendations

A soil analysis furnishes information about the P, K, Ca and Mg status of the soil. Adjustments should be made in the fertilization and liming program to take advantage of the information derived from the soil test. A routine soil analysis does not include nitrogen (N), sulfur (S) or micronutrient analysis.

## Nitrogen

Nitrogen is used in larger quantities than any of the other applied nutrients and needs to be applied on a regular basis. The Florida Extension Soil Testing Laboratory does not analyze for soil N. Nitrogen is so mobile in Florida's sandy soils that correlations cannot be established between analytical soil N and turfgrass response; therefore N recommendations are based on the turfgrass N requirement. The actual quantity of N required depends on a number of factors: type of turfgrass being grown, turfgrass quality desired, type of soil and quantity of water the turfgrass receives, either through irrigation or natural rainfall. Detailed N fertilizer recommendations for turfgrasses are available in Soil & Water Science Department Fact Sheet SL-21, "General Recommendations for Fertilization of Turfgrasses on Florida Soils".

## Phosphorus

Phosphorus is used by turfgrasses in much smaller quantities than N, so much less P should be applied. Due to their marine origin, Florida soils often test high in soil -extractable P. Additionally, many of our soils have received abundant fertilizer P in the past, and have high soil test levels of P. Thus, many of our turfgrass soils do not require P for adequate turfgrass growth and survival. Nevertheless, the best way to know the P status of the soil is to test it.

Most mixed fertilizers contain a source of P because P materials are good conditioners and are added to blended fertilizers to enhance handling properties. Thus, it is difficult to find a turfgrass fertilizer at your local garden supply store that contains no P. If your soil test calls for no P, your only alternative is to choose a blended fertilizer containing minimal available P (choose the blend in which the middle number on the fertilizer tag is the smallest).

As a general rule, P does not induce growth and color responses in turfgrass similar to N. In fact, research has shown that established turfgrasses respond very little to P application in most cases. Newly planted turfgrass areas are much more likely to respond to P application through enhanced rooting

characteristics. A color response is almost never observed, except in extreme deficiency situations where the soil is composed of uncoated (i.e., clean, white) sands which retain very little P. If your soil is an uncoated sand (pure white sand with no iron staining), P should be applied with caution because P tends to leach through these soils freely and can contaminate surface water bodies. A very low level of P (0.05 ppm) can cause eutrophication of surface waters.

## Potassium

Potassium is used in quantities by turfgrasses second only to N. As with P, however, most turfgrasses do not exhibit growth and visible responses to K application. Only when soil test levels are very low is there a noticeable response to K application. Levels of K application are often tied to the rate of N application. Maintaining a high quality turfgrass through high N fertilization requires more K for optimum growth and root production. One of the primary influences K has on turfgrass growth is enhancement of rooting and tolerance to water, heat and cold stress.

Most Florida sandy soils will contain low-to-very low levels of Mehlich I extractable K. Medium-to-high levels of soil K are difficult to maintain in Florida's sandy soils, so most turfgrass soils require K fertilization at some time during the year. The level and frequency of K application depends on the turfgrass being grown, the location in the State, the soil test level of K and the level of N being applied. Commonly the K fertilization rate is tied to N fertilization rate. Thus, many turfgrass managers apply K at 50% to 100% of the N application rate. For additional insights to the K fertilization requirements of turfgrasses refer to Soil & Water Science Department Fact Sheet SL-21 "General Recommendations for Fertilization of Turfgrasses on Florida Soils".

Potassium is not considered a pollutant as are N and P, and precision in turfgrass K fertilization is not as demanding as in the case of P. Nevertheless, economics and attempts to avoid the accumulation of excess salinity dictate soil testing for K and carefully following fertilizing recommendations.

## Micronutrients

Essential nutrients required in very small quantities for turfgrass growth are referred to as 'micronutrients' i.e., iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), chlorine (Cl) and molybdenum (Mo). Most low maintenance turfgrasses do not require the addition of micronutrients but, if a micronutrient deficiency is suspected, the Extension Soil Testing Laboratory offers a soil test for Mn, Cu and Zn. Interpretation of Mehlich-I extractable Mn, Cu and Zn depends on the soil pH. The critical soil levels for these nutrients (i.e., the likelihood of a response to one or more of them) increase with soil pH for turfgrasses grown on acid sandy soils in Florida. The Mehlich-I extractant is not recommended for alkaline soils; micronutrient availability in the alkaline pH range is better evaluated with a plant tissue test or with a soil test extractant developed especially for alkaline soils.

### Manganese

In most cases, a turfgrass response (greening) to applied Mn is likely if the soil pH is greater than pH 6.5. Soil tests and tissue analyses for Mn are more reliable in predicting a response than for Zn and Cu. Thus, if soil pH is high and turfgrass is not responding to macronutrient fertilization, a micronutrient soil test may be warranted. If the soil tests low or tissue analysis indicates a Mn deficiency, application of 0.75 pounds Mn per 1000 sq ft as manganese sulfate or manganous oxide is recommended. Turfgrasses growing on acidic soils, pH of 6.0 or less, do not generally respond to a Mn application.

### Zinc

A turfgrass response to applied Zn has not been observed in Florida. Most responses to Zn application have occurred in tree crops, such as citrus and pecans. Bermudagrasses did not respond positively to Zn application on soils testing low in Zn, nor did they respond negatively in soils testing high in Zn. This suggests that the apparent critical level for Zn is very low and that the toxicity level is very high. There appears to be very little reason to analyze for, or apply, Zn to turfgrasses grown on Florida soils.

## Copper

In Florida, Cu deficiencies are generally confined to soils high in organic matter and to "new ground" just coming into cultivation in the flatwoods areas. It seems that there is no research in Florida demonstrating a response to Cu applications on acid mineral soils. Turfgrasses produced for sod on organic soils often require an initial application of Cu, but a single application of Cu can suffice for several years. The application should not be repeated until soil or tissue tests indicate a need for Cu. Copper added to a soil is fixed and remains in the soil for a long time, and should not be added until a need is clearly identified. If Cu is required, application of 0.1 pounds of elemental Cu per 1000 sq ft, as either copper sulfate or finely ground copper oxide, should supply the turfgrass needs for Cu for several years.

## Iron

A strong relationship between extractable soil Fe, tissue levels of Fe and predictable responses to applied Fe does not exist, so the Extension Soil Testing Laboratory does not analyze for extractable Fe. However, there are certain soil conditions warranting consideration of an Fe application. In most Florida soils with a pH of 7.0 or greater, turfgrass greens in response to the application of Fe. Centipedegrass and Bahiagrass are particularly sensitive to Fe deficiencies and typically respond to Fe application when grown on soils with an alkaline pH. St. Augustinegrass and Bermudagrass growing on high pH soils will also respond to Fe application by greening. An Fe application is often used during the hot summer months to green the grass rather than applying additional N. Turfgrass Fe needs can be met variously. If the Fe deficiency occurs on acid soils, use one pound of iron sulfate per 1000 square feet. If the deficiency occurs on neutral or alkaline soils, use the container label recommended rate of iron chelate. If you wish to foliar apply the Fe, spray on 2 ounces of iron sulfate in 3 to 5 gallons per 1000 square feet. Responses to foliar applications are usually temporary, and frequent application may be required.

**Table 1.** Suggested Ranges for Mehlich-I Extractable Soil Nutrient Levels for Florida Turfgrasses.

Macronutrients*			Micronutrients**		
P	K	Mg	Mn	Zn	Cu
----- ppm -----					
16-30	36-60	20-30	3-9	0.5-3	0.1-0.5

\* Shown are defined as being the medium ranges of Mehlich-I extractable P, K, and Mg in which cases a response to applied fertilization would be expected in 25% of the time or less.

\*\* Soils testing below these levels of micronutrients are expected to respond to applied micronutrients. Interpretation of soil test micronutrient levels is based on soil pH. The smaller number is for soils with a pH of less than 6.0 and the larger number is for soils with a pH of 7.0 or greater. Mehlich-I extractable micronutrient levels are only determined when requested and require an additional charge.

**Table 2.** Desirable pH ranges for turfgrasses.

pH			
< 5.5	5.5 - 6.4	6.5 - 7.4	> 7.4
Bermudagrass	Bermudagrass	Bermudagrass	Bermudagrass
Carpetgrass	Carpetgrass	Fescuegrass	St. Augustinegrass
Centipedegrass	Centipedegrass	Italian Ryegrass	Zoysiagrass
Bahiagrass	Bahiagrass	St. Augustinegrass	
	Italian Ryegrass		

**Table 3.** Chemical Composition and Calcium Carbonate Equivalents of Liming Materials.

Materials	Chemical Composition	CCE*
Burned Lime	CaO	56
Hydrated Lime	Ca(OH) <sub>2</sub>	74
Dolomitic Limestone	CaCO <sub>3</sub> • MgCO <sub>3</sub>	92
Calcic Limestone	CaCO <sub>3</sub>	100
Basic Slag	CaSiO <sub>3</sub>	135

\* The number of pounds of the material required to give the same neutralizing value as pure calcium carbonate.