Understanding Soil Tests

Taking a Soil Sample

Soil testing laboratories recommend soil be tested every 3 years on most native soils high in silt and clay and once a year on modified sand-based systems. Your county Cooperative Extension office or soil testing lab can be contacted for the materials and information necessary for taking soil samples.

To get the most accurate results, it is important to be consistent when taking soil samples.

1. Depth of the sample should be about 4-7 inches depending on the length of your root system. Make sure all the samples are a consistent depth.
2. About 10-20 samples should be taken from an area. Ideally the area should be no smaller than 10,000 square feet and no larger than 20,000 square feet.
3. After removing the thatch and live plant material, combine the samples in a clean plastic container to make one composite sample of approximately ½ pint in volume.
4. Do not mix samples from multiple sampling areas and/or fields.
5. Do not mix cores from soil of different texture and color, areas differing sharply in elevation, disturbed with undisturbed soils, or healthy with troublesome areas.
6. Air dry the samples before sending them to the lab.

Interpreting Soil Test Results

Keep in mind that different laboratories use different test methods, which may influence results. General recommendations should be fairly consistent between reputable laboratories. Sufficiency ranges vary depending on the test used to determine the amount of each nutrient in the soil. Acceptable levels of a nutrient can vary with geographic location, species and cultivars within a species. Specific ranges have not been developed for most turfgrass species and cultivars.

Soil pH

Soil pH is the measure of acidity and alkalinity of a soil. pH influences nutrient availability, activity of specific microbial populations, quantity of lime or Sulfur to change pH, and overall turfgrass health.

pH < 6.0	pH 6.0 – 7.5	pH > 7.5
Acidic Soil	Neutral Soil	Alkaline Soil

Certain grass species tolerate soil pH extremes better than others.

Grass species tolerant to acid soils: bentgrasses, bermudagrasses, carpetgrass, centipedegrass, fescues, seashore paspalum, and zoysiagrasses.

Grass species tolerant to alkaline soils: bermudagrasses, blue grama, buffalograss, perennial ryegrass, seashore paspalum, St. Augustinegrass.

Liming

If a soil is acidic, a Lime Requirement Test will be performed and the soil test results will make a lime recommendation to increase the pH. Do not apply lime unless it is recommended. The amount of lime needed to adjust soil pH depends on the soil type. Lime is very slow acting, so immediate change in pH will not be seen.

Proper liming is as important as fertilization. Liming adjusts soil acidity, keeps other nutrients available to the plant, reduces toxicity problems, and creates an environment that supports helpful soil microorganisms. Common liming materials are calcitic limestone and dolomitic limestone. These materials displace exchangeable acidity (hydrogen and aluminum) on soil particles with calcium and magnesium. The carbonate then neutralizes the displaced protons (hydrogen and aluminum), which leads to an increase in soil pH.

Improving Alkaline Soils

Alkaline soils can be characterized by high levels of sodium or high amounts of free calcium carbonate. It is very difficult to change the pH of naturally occurring alkaline soils. The most common way to reduce soil pH is by applying elemental sulfur. Do not apply sulfur unless it is recommended. Elemental sulfur reduces pH by replacing calcium and other cations in the soil with hydrogen. Other ways to reduce pH is by applying sulfuric acid through irrigation, fertilizing only with ammonium sulfate or applying phosphoric acid through irrigation. As with lime, the pH change is very slow to take place.

Gypsum

Salt damaged and sodic soils are characterized by high levels of sodium (Na) occupying the cation exchange sites on soil particles. When a soil is high in sodium, it adversely affects the soil structure. Gypsum is effective in treating salt damaged and sodic soils to improve soil structure. With the application of gypsum, calcium displaces sodium on the exchange site. The sodium then reacts with the sulfate in gypsum to form a water soluble material that is easily leached.

Another advantage of using gypsum is that it provides calcium and sulfate to turfgrass plants without raising the pH.

Nitrogen (N)

There is no reliable test for nitrogen because it is in many different forms in the soil. This makes it difficult to predict availability to the plant. Most soil tests will provide nitrogen recommendations depending on the turfgrass species and the environment in which it is being grown. Soil and tissue tests only provide the amount of nitrogen available at the time the sample was taken.

Phosphorus (P)

Soil test results represent the amount of phosphorus available to the plants from the soil. Phosphorus sufficiency levels vary depending on the test used to measure it in the soil.

Potassium (K)

Soil test results represent the amount of potassium available to the plant from the soil.

Potassium sufficiency levels vary depending on the test used to measure it in the soil.

Calcium (Ca)

Soil test results represent the amount of calcium available to the plant from the soil.

Magnesium (Mg)

Soil test results represent the amount of magnesium available to the plant from the soil.

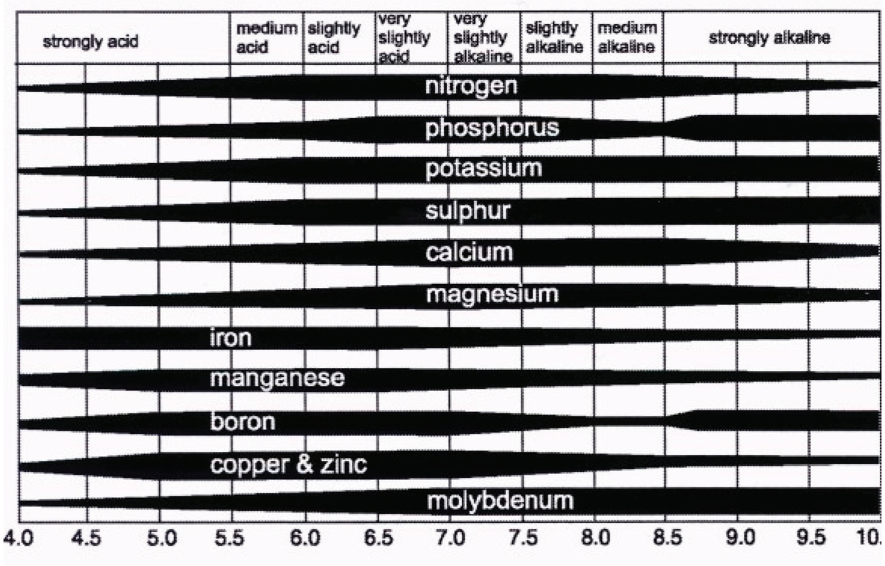
Sulfur (S)

Sulfur is difficult to measure in the soil because it is highly mobile. Therefore, sulfur is not commonly reported on soil or tissue tests.

Micronutrients

Iron (Fe), manganese (Mn), copper (Cu), boron (B), zinc (Zn), nickel (Ni), chlorine (Cl) and molybdenum (Mo) may also be listed on a soil test report. The most effective and reliable way to test for micronutrients is tissue testing. Remember, tissue tests only provide the nutrient content of the turfgrass at the time the sample was taken. Micronutrients rarely need to be added to the soil because they are normally already present in adequate amounts. Toxicity from one of these elements is more common than deficiencies.

Influence of Soil pH on Nutrient Availability



Cation Exchange Capacity (CEC)

Cation Exchange Capacity is the measure of the amount of cations that a soil can hold which are potentially exchangeable for plant uptake. Cations are positively charged ions adsorbed onto negatively charged exchange sites on soil particles and organic matter. Adsorbed cations can be replaced by other cations depending on the adsorption strength to the exchange site proportional to the charge of the cation and by the amount of the cation present in the soil. The cations most readily available for turfgrass plants are those in the soil solution and on exchange sites on the soil particle.

The principle cations necessary for turfgrass health include aluminum, hydrogen, calcium, magnesium, sodium, potassium and ammonium.

More exchange sites mean a higher CEC. Therefore, because of higher surface area, soils with high clay or organic matter content tend to have high CEC and sandy soils tend to have a low CEC. Acceptable CEC is based on your soil texture, type of clay, percent organic matter and pH.

Soils with low CEC have increased potential for nutrient deficiencies and leaching, build up of total soluble salts, accumulation of Na, pH alteration, nutrient balance changes, and difficulty to establish turfgrass.

Base Saturation

Base saturation is a percentage of the total CEC that is occupied by cations other than hydrogen and aluminum. There are 4 base cations: calcium, magnesium, potassium, and sodium. If all of the cation exchange sites are occupied by these 4 base cations, the base saturation is 100%. If not all the sites are occupied, the base saturation will be less than 100%. Each present cation is expressed as a percent. Soils with a low base saturation are generally acidic.

Calcium to Magnesium Ratio

Ideal ratio: 6-10 : 1 (calcium to magnesium respectively)

This is the basis of percentage saturation of the soil by CEC by each element. This ratio is needed when lime is being added to the soil.

Magnesium to Potassium Ratio

Ideal ratio: Greater than 2:1 (magnesium to potassium respectively)

The percent base saturation of Mg should be at least two times the percent base saturation of K. Therefore the ratio should be greater than 2:1. High potassium can reduce the uptake of magnesium in a plant.

Salt Affected Soils

There are three types of salt affected soils: saline, sodic and saline-sodic. The following table shows characteristics associated with these three soils:

Soil Type	ECe (Total Soluble Salts)	pH	ESP (Sodium Percentage)
Saline	> 4 dS/m	< 8.5	< 15%
Sodic	< 4 dS/m	> 8.5	> 15%
Saline-Sodic	> 4dS/m	> 8.5	> 15%

Table taken from Turfgrass Soil Fertility and Chemical Problems Assessment and Management by R.N. Carrow, D.V. Waddington, and P.E. Rieke

Saline soils are high in soluble salts and usually have high sodium (Na) levels. Soluble salt concentration is measured by the Electrical Conductivity (ECe) of a saturated paste soil extract. A soil is considered saline if the ECe is greater than 4 dS/m.

The exchangeable sodium percentage (ESP) measures the percentage of total exchangeable cations that are sodium. In other words, ESP is the percent of cation exchange sites occupied by sodium. ESP greater than 15 percent indicates high levels of sodium.

Helpful Conversions

To convert column 1 into column 2, divide by	Column 1	Column 2	To convert column 2 into column 1, multiply by
390	ppm K	meq K/100 g soil	390
200	ppm Ca	meq Ca/100 g soil	200
121	ppm Mg	meq Mg/100 g soil	121
230	ppm Na	meq Na/ 100 g soil	230
1	meq/ 100 g soil	cmol/kg soil	1
2*	lb/acre (7 inch depth)	ppm	2*
3.65	lb/acre (1 foot depth)	ppm	3.65*
43.56	lb/acre	lb/1000 sq ft	43.56
43,560	square feet	acres	43,560
2.471	acres	hectares	2.471

*These values vary with soil bulk density.

Table taken from Oregon State University's Soil Test Interpretation Guide

References:

Turfgrass Soil Fertility and Chemical Problems Assessment and Management by R.N. Carrow, D.V. Waddington, and P.E. Rieke

Ohio State University: Interpreting a Soil Test for Lawns http://ohioline.osu.edu/hyg-fact/4000/4028.html

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Texas Cooperative Extension: Turfgrass Rootzones http://aggie-horticulture.tamu.edu/plantanswers/turf/publications/rootzone.html

Iowa State University: Applying Gypsum in Iowa – when is it really needed? http://www.hort.iastate.edu/turfgrass/extension/gypsum.pdf