Understanding a Soil Analysis

TURF **TIPS**

Soil pH

Soil pH is a measurement of the concentration of hydrogen ions. The level of concentration determines whether the soil is acidic or alkaline. Acid soils require limestone to raise the pH, whereas alkaline soils may need acid applications (elemental sulfur) to reduce soil pH. Most soils have a pH range from 4.0 to 8.5, with slightly acidic conditions being most productive. However, different grass species vary in their ability to tolerate pH conditions.

Grass Species	Minimum pH	Maximum pH
Fescue	5.0	8.5
Bentgrass	5.0	7.5
Creeping bentgrass	5.0	7.5
Bluegrass	5.0	8.4
Bermuda grass	5.0	8.0
Perennial ryegrass	5.2	7.5
St. Augustine grass	6.5	7.5
Salt grass	6.4	10.5

Because soil pH measures the active hydrogen, its value can be variable from one season to the next. This variability makes it difficult to predict the amount of lime needed to increase pH to an optimum value.

Buffer pH (or Buffer Index)

This index was developed to measure the total hydrogen (acid) in the soil, which needs to be neutralized by limestone applications. As this index decreases, the percentage of hydrogen increases.

As a result, greater amounts of limestone are required. Because buffer pH is only used to predict the quantity of lime, it is only analyzed when the soil pH is less than 6.5.

A generalized table of limestone applications for buffer pH values is listed below.

Buffer pH	**Limestone** (lbs./1,000 sq. ft.)
7.3	0
7.2	20
7.1	20
7.0	25
6.9	30
6.8	35
6.7	60
6.6	75
6.5	95

Limestone guidelines are assuming 100% $CaCO_3$, with a 6" incorporation. On established turf, do not apply more than 50 pounds in any one application.

Excess Carbonate

This quick test measures the amount of free limestone in the soil. It is reported as very low, low, medium, high or very high. As this rating increases, so does the amount of free carbonate. This quantity has a direct effect on availability of plant nutrients, particularly with manganese, iron, zinc, and phosphorus. As it increases, so do nutrient fixation rates. Excess carbonate can be neutralized with acid materials (elemental sulfur); however, the quantity required can be so large, it may become toxic to turf grasses.

Soluble Salt

Soluble Salt is a measure of the soil's ability to conduct electricity, expressed in millimhos per centimeter (mmhos/cm). The more electricity conducted, the higher the salt content in the soil. These salts are mobile in the soil solution and will move up and down with the soil water. Generally, high salt levels are associated with soils that have poor drainage conditions, as salt accumulates at the soil surface rather

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than leaching down through the soil profile. Irrigation water can also contribute to this problem. On this report, soluble salt is analyzed as a 1:1 soil to water ratio.

Test Unit: mmhos/cm	Optimum Range	Warning Range
Soluble salt	<0.60	>1.0

Cation Exchange Capacity (CEC)

CEC establishes the rate at which nutrients (cations) will be stored and released. It is an estimated value, based on the extracted cations: calcium Ca++, magnesium Mg++, potassium K+, sodium Na+ and hydrogen H+. Since the clay and organic sites in the soil have a negative charge, the positively charged cations bond with these sites. Therefore, CEC can be closely related to soil texture.

CEC Value	Estimated Texture
1-8	Sand
9-12	Loamy Sand
13-20	Sandy or Silty Loam
21-28	Loam
29-40	Clay or Clay Loam

Percent of Base Saturation

The base saturation is expressed as a percentage and is calculated by dividing each individual cation (Ca, Mg, Na, K, H) by the total CEC.

Below is a table representing the optimum percentage of the five major soil cations.

	CEC Range				
	3-7	8-15	16-25	26-36	>36
Cation	Optimum Percent Base Saturation				
Hydrogen	<30	<30	<20	<20	<20
Sodium	<10	<8	<5	<5	<5
Magnesium	10-20	10-20	10-20	10-20	10-20
Calcium	50-75	50-75	60-75	60-75	60-75
Potassium	3.3-7.7	1.5-4.3	1.0-2.2	0.7-1.3	0.5-1.3

Sodium (Na)

Sodium provides information related to reclaiming saline and/or alkaline soils. When its base saturation exceeds five percent, water infiltration rates can be reduced. This may not be the case with sand-based greens, where sand size (not soil structure) promotes infiltration. When correcting soils with high sodium, check and rate drainage conditions. This salt load can only be reduced by leaching it below the rooting zone. If appropriate, select one of these soil amendments: gypsum ($CaSO_4 \cdot 2H_2O$), epsom salts ($MgSO_4$) or elemental sulfur (S).

Organic Matter (OM)

Soil organic matter is the result of the decay process of organic residues. The result of this process is a stable humus compound that has active cation-holding sites. These sites serve as a storehouse for plant nutrients and also improve soil structure in heavy soils. Undecomposed organic residue (thatch build-up) is not organic matter.

In most productive soils, the topsoil contains between 1.0 to 10.0 percent OM. In golf course construction, the top soil is commonly buried or stripped away, causing the loss of a valuable nutrient source. In addition, sand-based greens may contain 0 to less than 0.5 percent OM, resulting in high leach rates, low water holding abilities and low nutrient content.

Nitrate-Nitrogen

Nitrate-nitrogen is a measure of the available nitrogen present in the soil at the time the soil sample was taken. Due to solubility, it can leach rapidly out of the root zone, particularly on sand greens. This mobility makes it difficult to predict how much nitrogen will be present throughout the growing season.

Potassium (K)

The potassium extracted by ammonium acetate is readily available for plant uptake. Potassium is contained in the plant cells and tissues; therefore, it is removed in large quantities when vegetative growth is removed (removal of clippings).

The following table provides a generalized interpretation. As noted, soil texture influences availability. Sandy textures do not have enough holding sites, resulting in high leaching rates. Heavier textures will hold onto increasing amounts of K. As a result, high application rates are not advisable on sand-based greens, but can be successful on heavier-textured fairways.

Magnesium (Mg)

Magnesium can be deficient in sandy soils with low organic matter. Amendments can include: epsom salts, dolomitic limestone, and other soluble forms of Mg.

Calcium (Ca)

Calcium is rarely deficient as a plant nutrient and is usually applied as a soil amendment. Limestone ($CaCO_3$) is used to increase soil pH, gypsum ($CaSO_4{\cdot}2H_2O$) is used to dislodge sodium from soil particles; this releases calcium, but does not affect pH.

Soil Cation Exchange Capacity (CEC)

	5	10	15	20
	Optimum Range (ppm)			
Potassium	91-120	121-160	151-200	181-240
Magnesium	60-119	120-239	180-359	240-479
Calcium	600-1199	1200-2399	1800-3599	2400-4799

Phosphorus (P)

Two types of phosphorus extractions are used in this report: if soil pH ≤ 7.1 Bray I; if soil pH ≥ 7.2, Olsen P. In the plant, phosphorus stimulates early growth and root formation. Its primary usage is storage and transfer of energy throughout the plant.

Rating	pH ≤7.1 Bray P ppm	pH ≥7.2 Olsen P ppm
Low	<15	<9
Adequate	16-25	10-15
Optimum	26-40	16-24
High	>40	>24

Zinc-Manganese-Copper-Iron

These four micronutrients are extracted from the soil with DTPA solution. As a general rule, soils which are high in pH, low in organic matter, and have a low Cation Exchange Capacity (CEC), are often deficient in these trace elements.

Zinc (Zn)

On areas with new construction and/or extensive dirt work, zinc levels can start out as deficient. But over time, areas with high management (golf greens) can achieve a build-up to very high levels. In turf grass, toxic levels have not been reported; however, monitoring is advisable.

Manganese (Mn)

Nutrient release from organic matter is the primary source of manganese; therefore, sand-based greens are usually deficient in Mn. In addition, Mn is highly reactive with soil pH. In soils with a pH greater than 8.0, plant response to Mn applications can be highly variable due to the very high fixation rates.

Copper (Cu)

Copper is similar to Zn in that it can start out as low in new construction, and be built to very high levels within several years. Monitoring is important; if a build-up occurs, check for a Cu source. Some soil-applied fungicides contain high concentrations of Cu. Toxicities have not been established in turf grasses; however, levels greater than 10 ppm would be a concern.

Iron (Fe)

Iron is similar to Mn in that it is highly reactive with pH. Soils with a pH greater than 8.0 can be sensitive to Fe deficiencies. In these soils, iron fertilizer fixation rates can be high, so multiple applications will be necessary each season.

Nutrient	Optimum Range (ppm)	Very High Range (ppm)
Zinc	1.5-5.0	>10.0
Manganese	5.0-15.0	>30.0
Copper	0.5-2.0	>5.0
Iron	5.0-30.0	>90.0

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