

Understanding a Soil Analysis

Soil pH

Soil pH is a measurement of the hydrogen ion concentration. Its presence or absence 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 acid conditions being most productive. However, different grass species differ 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
Bermudagrass	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, it's value can be variable from one season to the next. This variability makes it difficult to predict the amount of lime necessary to increase pH to an optimum value.

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 affect on availability of plant nutrients, particularly with manganese, iron, zinc, and phosphorus. As it increases, so does nutrient fixation rates. Excess carbonate can be neutralized with acid materials (elemental sulfur); however, the quantity required can be so large that it may become toxic to turf grasses.

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.

Generalized table of limestone applications for buffer pH values.

Buffer pH	Lbs. Limestone Lbs/1000 sf
7.3	0 Lbs
7.2	20 Lbs
7.1	20 Lbs
7.0	25 Lbs
6.9	30 Lbs
6.8	35 Lbs
6.7	60 Lbs
6.6	75 Lbs
6.5	95 Lbs

Note: Above limestone is assuming 100% CaCO₃, with an incorporation. On established turf, do not apply more than 50 pounds in any one application.

Soluble Salt

Soluble Salt is a measure of the soil's ability to conduct electricity. 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 which have poor drainage conditions. Salt accumulates at the soil surface rather 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 water ratio.

Interpretation table.

Test/unit mmhos/cm	Optimum range	Warning range
Soluble salt	< 0.60	> 1.0

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 CEC, are often deficient in these trace elements.

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 from this soil analysis: (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.

Table representing the optimum percentage of the five major soil cations.

Cation	CEC Range				
	3-7	8-15	16-25	26-36	>36
	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 relating to reclaiming saline and/or alkaline soils. When its base saturation exceeds 5%, 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 (CaSO₄), epsom salts (MgSO₄) 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% OM. In golf course construction it is common to have this topsoil either being buried or stripped away. These areas lose a valuable nutrient source. In addition, sand-based greens may contain zero or less than 0.5% OM. As a result, greens have high leach rate, low water holding ability or 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.

Soil nutrients (Potassium, Magnesium, Calcium, Phosphorus)

These four cations are extracted with ammonium acetate and reported in parts per million (ppm).

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. Applications can be as epsom salts, dolomitic limestone, or other soluble forms of Mg.

Calcium: (Ca)

Calcium is rarely deficient as a plant nutrient and is usually applied as a soil amendment. Limestone is to increase soil pH; gypsum is to exchange with sodium.

	Optimum range			
	Soil Cation Exchange Capacity (CEC)			
	5	10	15	20
	Parts per million (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 < 7.2 Bray I; if soil pH > 7.1, Olsen P. In the plant, phosphorus stimulates early growth and root formation. Its primary usage is in 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 (Zn)

On new construction and with 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)

Organic matter nutrient release is the primary source of manganese; therefore, sand-based greens are usually deficient in Mn. In addition, Mn is highly reactive with soil pH. On pHs greater than 8.0, Mn applications plant response can be highly variable do 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 with in 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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