Profile Technical Document

Soil Testing and Interpretation

Introduction

Soil testing, interpretation of the test results, and incorporating prescriptive remedies to improve soils should be a fundamental part of any reclamation or revegetation project. Without a proper understanding of soils or substrates considered for use as growing media to establish vegetation, it is difficult to predict potential project success.

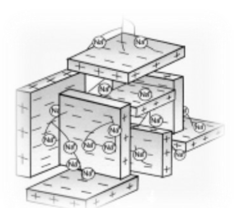
Prior to conducting and interpreting soil tests, it is important to understand test methods that are relevant for reclamation and/or vegetation establishment projects. There are various ways to extract measurable soil characteristics and analyze samples, but rarely do varying soil testing methods produce identical results. Further, it is important to properly collect and label soil samples prior to sending them to a reputable lab. Profile Products provides detailed instructions in its PS^3 software program with three instructive videos that can be accessed at www.profileevs.com/resources/article/soil-foundation-success-part-1-3. In addition, Profile has a laboratory dedicated to properly testing soils for erosion control projects at no cost to the client. Please go to www.profileps3.com and create your own account for more details.

Whether you are utilizing the Profile Products soil testing laboratory or another facility, please refer to the methodologies listed below to insure you are employing relevant testing protocol for erosion control projects that require vegetative establishment.

Testing Methodology

- Texture/Particle Size Analysis - Hydrometer Method
- Soil pH and Soluble Salts - 1:1 Soil/Water Slurry and Saturated Paste Extraction
- Buffer pH - Sikora Method
- Cations (Ca, K, Mg, Na) - Ammonium Acetate Extraction
- Phosphorus - Bray 1 Extraction or Olson Extraction
- Trace Elements (Zn, Mn, Cu, Fe) - DTPA Extraction
- Sulfur - Phosphate Extraction
- Boron - DTPA/Sorbitol
- Nitrate Nitrogen - Cadmium Reduction
- Salinity Evaluation - Saturated Paste Extraction
- All Soluble Nutrients - Saturated Paste Extraction

Consistency in testing methods allows for simplified and more rapid evaluations of the results. **Table 1 on Page 4 of this document provides optimal ranges for various soil parameters and values where deficiencies or excesses may compromise or limit vegetative establishment - using the test methods identified above.** If your soils were tested with different methods or you need assistance in reviewing soil test results from our lab, please contact Profile Products Technical Services Department at (847) 215-3464 or tech@profileproducts.com.



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Soil Testing Characteristics

Organic Matter

Organic Matter is a byproduct of decayed or decaying (decomposing) Organic Material which improves soil structure and is where plants obtain most of their nutrients. Organic Matter should not be confused with Organic Material. Organic Material is any material which was once living, and when decomposed turns into stable Organic Matter compounds like humus. Humus is a form of Organic Matter that has been converted by microorganisms to a stable state where it resists further decomposition and may persist for many years. Under normal conditions, only 10% of Organic Material is converted to Organic Matter over time. By adding growth enhancers, biological/bacterial treatments and Organic Material to the soil, vegetation is established faster, sustained and Organic Matter is added to the site more quickly. **Profile Remedies: BioPrime™, JumpStart™, JumpStart™ 5, ProGanics™ Biotic Soil Media™ (BSM™)**

Texture/Particle Size Analysis

Soil texture is a qualitative classification that describes soils based on their percentage of sand, silt, and clay by completing a Particle Size Analysis. A soil's composition of sand, silt, and clay can be used to determine soil texture using a soil textural calculator and triangle such as provided by USDA NRCS. Soil texture can be used as an indicator for a soil's Cation Exchange Capacity, Buffer pH, and Moisture Retention.

pH

Soil pH is the second most important soil characteristic (moisture being the most important), affecting nutrient uptake and resulting vegetation establishment. pH is a measure of acidity and alkalinity - pH values less than 7 are acidic, greater than 7 are alkaline, and 7 is neutral. The pH scale is logarithmic so each whole number is ten times more acidic or alkaline than the next number. For example, a soil with a pH of 5 is 10 times more acidic than a soil with a pH 6 and a pH of 4 is 100 times more acidic than a soil with a pH 6. **Vegetation typically thrives when pH is between 6.3 - 7.3**. Essential plant nutrients are most soluble and readily available to plants within this pH range. **Profile Remedies: Aqua-pHix™ Hydro, Aqua-pHix™ Granular, NeutraLime™ Dry, NeutraLime™ Liquid**

Buffer pH

Buffer pH is the acidity of the tested soil solution after being treated with a Calcium Carbonate solution and is only applicable with acidic soils. Some soils are more resistant to changes of pH than others and a buffer pH analysis helps to determine how easily soil pH may be modified. Typically, soils with high clay content buffer or are more resistant to changes in pH while sandy soils are more susceptible to changes in pH. This value, when used in conjunction with pH, is helpful in determining recommended liming rates.

Excess Carbonate

Excess Carbonate is a measure of the "Free Limestone" in the soil sample. Soils derived from a limestone parent material typically have higher levels of Calcium Carbonate. Soils with Excess Carbonate are typically alkaline and more difficult to permanently lower the pH. Aqua-pHix™ is an acidifier which immediately begins to lower pH of the soil solution. Elemental Sulfur and Iron Sulfate are examples of slower reacting amendments that will lower soil pH for an extended period of time. **Profile Remedies: Aqua-pHix™ Hydro, Aqua-pHix™ Granular**

Electrical Conductivity (EC) and Total Dissolved Solids (TDS)

Excess salts can be measured in a soil solution once they are dissolved in water. Water with elevated dissolved solids/salt content is a better conductor of electricity than pure distilled water. EC is typically measured in deciSiemens per meter (dS/m) or millimhos per centimeter (mmho/cm), which are equivalent units. To convert from EC to TDS simply use the following equation: TDS (in ppm or mg/L) = EC (in dS/m) × 640. **Profile Remedies: BioPrime™, JumpStart™, JumpStart™ 5**

Sodium Adsorption Ratio (SAR)

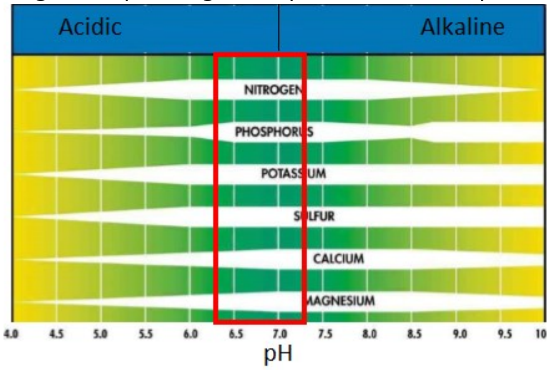
Sodium Adsorption Ratio (SAR) is the calculated ratio of cation charges contributed to a soil sample by Sodium, to the cation charges contributed by Calcium and Magnesium. Soils with elevated SARs typically experience drainage and soil structure issues. **Profile Remedies: Aqua-pHix™ Hydro, Aqua-pHix™ Granular, BioPrime™, JumpStart™, Sodium-pHix™**

Plant Mineral Macronutrients

Affects of pH

As seen in Figure 1, pH plays a large role in the availability of both Macro- and Micro-nutrients. When pH strays further to the acidic or alkaline side, nutrient imbalances are more likely to occur. Maintaining a soil pH between 6.3 and 7.3 will lead to increased nutrient availability for greater success in establishing and sustaining vegetation.

Figure 1 - pH Range for Optimal Nutrient Uptake



Primary Macronutrients

Nitrogen (N)

Nitrogen is available to plants as both Nitrate (NO_3^-) and Ammonium (NH_4^+). Nitrogen, in general, is easily removed from soils through leaching, denitrification, and volatilization. Since Nitrogen is easily lost from soils, its content in soil can be variable. For this reason, it is sometimes difficult to make accurate Nitrogen fertilization recommendations based on a single soil test report. This is why Nitrogen fixing bacteria, fungi, and legumes are recommended to help keep soil Nitrogen content at sufficient levels. Nitrogen is needed by plants for producing proteins, nucleic acids, and chlorophyll. Deficiencies result in chlorosis (lighter green to yellow leaves), stunted and slower growth.

Phosphorus (P)

Phosphorus is used in the development of Adenosine Triphosphate (ATP) for plant energy, sugars, and nucleic acids. It promotes early root formation and growth. Phosphorus deficiencies are most common when pH is not in the optimum range. This is because even if Phosphorus is prominent in the soil, it may form insoluble compounds with Aluminum and/or Iron in acidic soils and Calcium in alkaline soils. Deficiencies are more noticeable in younger plants. Plant leaves and stems turn dark green or occasionally develop a purple hue.

Potassium (K)

Potassium is a cation that forms bonds with soil colloids and rarely leaches out of soils. Potassium is utilized in the activation of enzymes and co-enzymes, photosynthesis, protein formation, and sugar transport. Potassium is very important in plant reproduction, flowering and the development of seeds. Deficiencies result in initial growth rate reduction, chlorosis, and possibly necrosis (death of plant tissue) occurring in later stages.

Secondary Macronutrients

Calcium (Ca)

Calcium is a major component of plant cell walls and regulates cell wall construction. Deficiencies cause young leaves to distort and turn a dark green and are most prevalent in acidic soils.

Sulfur (S)

Sulfur is an essential constituent of certain amino acids. Deficiencies result in inhibition of protein and chlorophyll synthesis. Deficiencies resemble Nitrogen or Molybdenum deficiencies (chlorosis), and occur in younger leaves.

Magnesium (Mg)

Magnesium is the central molecule in chlorophyll and an important co-factor for ATP production. Deficiency symptoms include interveinal chlorosis and leaf margins becoming yellow while leaf midrib remains green.

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General Soil Test Interpretation

Soil Characteristic Tested	Unit	Low Value (Deficiency*)	Optimal Range (Sufficiency*)	High Value (Toxicity*)
Texture	Physical Description	N/A	N/A	N/A
OM (Organic Matter)	OM mass/sample mass	<3%	3%-5%	> 10%
pH	0-14	< 6.3	6.3 - 7.3	> 7.3
$HC0_3$ (Bicarbonate)	ppm	N/A	< 50	$\geq$ 50
Electrical Conductivity (EC)	mmhos/cm = dS/m	N/A	< 0.75	> 7.0
Total Dissolved Solids (TDS)	ppm	N/A	< 480	> 4480
Sodium Adsorption Ratio (SAR)		N/A	< 2.0	> 7.0
N (Nitrogen)	ppm	< 10	10 - 30	> 30
Bray 1 P (Phosphorus) pH<7.2	ppm	< 20	20 - 40	> 40
Olsen P (Phosphorus) pH>7.2	ppm	< 10	10 - 25	> 25
K (Potassium)	ppm	< 150	150 - 250	> 250
Mg (Magnesium)	ppm	< 60	60 - 300	> 300
Ca (Calcium)	ppm	< 400	$\geq$ 400	N/A
S (Sulfur)	ppm	< 5	5 - 20	> 20
Zn (Zinc)	ppm	< 1.0	1.3 - 3.0	> 5.0
Mn (Manganese)	ppm	< 2.5	4.1 - 12.0	> 50
Cu (Copper)	ppm	< 1.0	1.0 - 2.0	> 2.0
Fe (Iron)	ppm	< 4.5	7.1 - 20.0	> 70
B (Boron)	ppm	< 0.5	1.0 - 1.5	> 2.0
K (Potassium)	CEC %		3 - 7%	
Mg (Magnesium)	CEC %		15 - 20%	
Ca (Calcium)	CEC %		65 - 75%	
Na (Sodium)	CEC %		0 - 4%	> 15%
H (Hydrogen)	CEC %		0 - 5%	
Cation Exchange Capacity (CEC)		< 5	10 - 30	> 50
Cl (Chloride)	ppm	< 10	10 - 20	> 800

*All values listed in the above table are generalizations from a variety of sources and based on "ideal" soils. Optimal ranges may vary depending on intended site goals, vegetative species, geographic location, and climate. Values outside of optimal ranges do not necessarily imply plant toxicity. Please consult Profile Technical Services for additional details on specific out of range values.

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