

# Soil Test Interpretation

## Terms and Definitions

By Dr. Richard Large

Revised by: Dr. Oscar F. Ruiz Jr.

### REPORT TERMS

#### ppm (lbs/acre)

Results may be listed in ppm (parts per million) or pounds per acre. To convert from ppm to pounds multiply by 2 and to convert from pounds per acre to ppm divide by 2.

#### DECISIEMENS/METER (dS/m)

Electrical conductivity measurements are often used to measure the amount of soluble salts in the soil. The conductivity increases with increasing soluble salts, and the soil is considered saline when the conductivity reading reaches 2 to 3 dS/m.

(1 dS/m = 1 millimhos/cm)

#### RATINGS

Most soil test readings on the report are given a rating of very low, low, medium, optimum, or very high. The rating bars are color coded to the rating scale across the top.

The purpose of these ratings is to provide a general guideline for determining the optimum nutrient levels. However, the actual value that is best depends on many factors such as crop, yield potential, and soil type.

| Rating       | Probability of crop response |
|--------------|------------------------------|
| Very low     | Close to 100%                |
| Low          | About 75%                    |
| Medium       | 50%                          |
| Optimum/High | 0-25%                        |
| Very High    | 0-10%                        |

Monitor very high levels for excessive nutrient levels that may impede uptake of other nutrients.

### SOIL ANALYSIS TERMS AND APPLICATIONS

#### SOIL pH

The soil pH measures active soil acidity or alkalinity. A pH of 7.0 is neutral. Values lower than 7.0 are acid; values higher are alkaline. Usually the most desirable pH range for mineral soils is 6.0 to 7.0 and for organic soils 5.0 to 5.5. The soil pH is the value that should be maintained in the pH range most desirable for the crop to be grown.

#### BUFFER pH

This is an index value used for determining the amount of lime to apply on acid soils to bring the pH to the desired pH for the crop to be grown. The lower the buffer pH reading, the higher the lime requirement.



## PHOSPHORUS

The phosphorus test measures that phosphorus that should be available to the plant. The optimum level will vary with crop, yield and soil conditions, but for most field crops a medium to optimum rating is adequate. The Mehlich 3 extraction is useful for a wide range of alkaline to acid soil pHs. Soil Bray P1 is an older extraction used on acid soils. Olsen sodium bicarbonate extraction is another older extraction for P traditionally used on alkaline soils with pHs above 7.3 but has been used reliably down to pHs of 6.0. Excessive P levels caused by over application can decrease micronutrient availability of Zn, Mn, Fe, or Cu.

## POTASSIUM

This test measures available potassium. The optimum level will vary with crop, yield, soil type, soil physical condition, and other soil related factors. Generally higher levels of potassium are needed on soils high in clay and organic matter versus soils, which are sandy and low in organic matter. Higher clay content and/or organic matter increases the cation exchange capacity (CEC) of the soil. Sandy soils typically have low CECs therefore potassium can be lost through leaching in sandy, low CEC soils. It is recommended to split applications on low CEC soils to reduce loss. On finer textured soils, potassium loss can occur through fixation.

For Mehlich 3 extractions, optimum levels are generally the following:

**CEC 0-4.9: 95 to 115 ppm**

**CEC 5-9.9: 130 to 155 ppm**

**CEC 10-14.9: 155 to 190 ppm**

**CEC 15+: 175 to 215 ppm**

## CALCIUM

Primarily soil type, drainage, liming and cropping practices affect the levels of calcium found in the soil. Calcium is closely related to soil pH. Calcium deficiencies are rare when soil pH is adequate. The level for calcium will vary with soil type, but optimum ranges are normally in the 65% to 75% cation saturation range. Calcium saturations above 85% may indicate a calcareous or gypsiferous soil

## MAGNESIUM

The same factors, which affect calcium levels in the soil, also influence magnesium levels except magnesium deficiencies are more common. Adequate magnesium levels can be greater than or equal to 64 ppm (128 lbs/ac). The cation saturation for magnesium should be 10 to 15%. Magnesium saturations above 20% can adversely affect soil structure, water-infiltration, soil drainage and aeration.

## SULFUR

The soil test measures sulfate-sulfur. This is a readily available form preferred by most plants. Soil test levels should be maintained in the optimum range. It's important that other soil factors, including organic matter content, soil texture and drainage be taken into consideration when interpreting sulfur soil test and predicting crop response. Soil tests resulting in low sulfur levels should be addressed with sulfate fertilizer applications. Elemental sulfur does not provide readily available sulfur.

## BORON

The readily soluble boron is extracted from the soil. Boron will most likely be deficient in sandy soils, low in organic matter with



adequate rainfall. Soil pH, organic matter level and texture should be considered in interpreting the boron test, as well as the crop to be grown.

### **COPPER**

Copper is most likely to be deficient on either low organic matter sandy soils, or highly organic/muck soils. The crop to be grown, soil texture, and organic matter should be considered when interpreting copper tests. A rating of medium to optimum should be maintained.

### **IRON**

Soil pH is a very important factor in interpreting iron tests. In addition, crops vary a great deal in sensitivity to iron deficiency. Normally a medium level would be adequate for most soils. If iron is needed it would be best applied foliar. When applying to high pH soils, it should be applied only as a chelated form.

### **MANGANESE**

Soil pH is especially important in interpreting manganese test levels. In addition, soil organic matter, crop and yield levels must be considered. Manganese will work best if applied foliar or banded in the soil. Chelated forms are utilized on high pH soils.

### **ZINC**

Other factors, which should be considered in interpreting the zinc test, include available phosphorus, pH, and crop and yield level. For crops that have a good response to zinc, the soil test level should be optimum and should be administered in the same fashion as manganese and iron.

### **SODIUM**

Sodium is not an essential plant nutrient but is usually considered in light of its effect on the physical condition of the soil. Soils high in exchangeable sodium may cause adverse physical and chemical conditions to develop in the soil. Increasing sodium levels in soils that contain a significant amount of silt and/or clay can impair water infiltration and drainage. Very high levels will damage soil structure and can be potentially toxic to sensitive plants. Fine textured soils (silt/clay loams) should preferably have a Sodium percent saturation less than 1%. Reclamation of these soils involves the replacement of the exchangeable sodium by calcium and the removal by leaching.

### **SOLUBLE SALTS**

Excessive concentration of various salts may develop in soils. This may be a natural occurrence or it may result from irrigation, excessive fertilization or contamination from various chemicals or industrial wastes. One effect of high soil salt concentration is to produce water stress in a crop to where plants may wilt or even die. The effect of salinity is negligible if the reading is less than 1.0 dS/m. Readings greater than 1.0 dS/m may affect salt sensitive plants and readings greater than 2.0 dS/m may require the planting of salt tolerant plants.

### **ORGANIC MATTER AND ESTIMATED NITROGEN RELEASE (ENR)**

Percent organic matter is a measurement of the amount of plant and animal residue in the soil. The color of the soil is usually closely related to its organic matter content, with darker soils being higher in organic



matter. The organic matter serves as a reserve for many essential nutrients, especially nitrogen. During the growing season, a part of this reserve nitrogen is made available to the plant through bacterial activity. The ENR is an estimate of the amount of nitrogen (lbs/acre) that will be released over the season. In addition to organic matter level, this figure may be influenced by seasonal variation in weather conditions as well as soil physical conditions.

### **NITRATE NITROGEN NO<sub>3</sub>-N**

Nitrate nitrogen is a measure of the nitrogen available to the plant in nitrate form. In high rainfall areas, sandy soil types and areas with warm winters, this measurement may be of limited value except at planting or side dress time. In the areas with lower rainfall, the nitrate test may be very beneficial.

A general guide to determine NO<sub>3</sub>-N levels:

**Very low: 0-5 ppm**

**Low: 6-10 ppm**

**Medium: 11-20 ppm**

**High: 21-35 ppm**

**Very high: 36 ppm and above**

### **CATION EXCHANGE CAPACITY CEC**

CEC measures the soil's ability to hold nutrients such as calcium, magnesium, and potassium, as well as other positively charged ions such as sodium and hydrogen. The CEC of a soil is dependent upon the amounts and types of clay minerals and organic matter present. The common expression for CEC is in terms of milliequivalents per 100 grams (meq/100g) of soil. The CEC of soil can range from less than 5 to 35 meq/100g for agricultural type

soils. Soils with high CEC will generally have higher levels of clay and organic matter. For example, one would expect soil with a silty clay loam texture to have a considerably higher CEC than a sandy loam soil. Although high CEC soils can hold more nutrients, it doesn't necessarily mean that they are more productive. Much depends on good soil management.

An accurate CEC of calcareous, saline or sodic soils should only be performed with cation replacement. A calculated CEC will typically be inflated with these soil types.

### **CATION SATURATION**

Cation saturation refers to the proportion of the CEC occupied by a given cation (an ion with a positive charge such as calcium, magnesium or potassium).

The percentage saturation for each of the base cations are commonly within the following ranges:

**Calcium 40 to 80%**

**Magnesium 10 to 40%**

**Potassium 1 to 5%**

Many consider idealized base saturation ranges to be:

**Calcium 65 to 80%**

**Magnesium 10 to 20%**

**Potassium 2 to 7%**

**Sodium less than 1%**

### **RATIOS**

K/Mg and Ca/Mg ratios compare the milliequivalents or percent saturations to each other. These are not ratios based on the comparison of ppm or lb/acre extracted. For example, a K percent saturation of 2.5% and a Mg of 12% produces a ratio of 0.2.



K and Mg are nutrients that can compete for uptake in various crops. In soils where ratios are greater than 0.33, crops should be monitored for low or deficient magnesium. Crops, especially forages, that are fertilized with high amounts of potassium fertilizer should be monitored for magnesium deficiency.

Ca and Mg are essential macronutrients whose levels can provide insight into the soil's chemical and physical condition. Soils with significant silt and clay content can have their structure adversely affected if magnesium levels are disproportionate to the levels of calcium. An idealized Ca/Mg ratio is typically near 6.5.

### **REPORT NUMBER**

All samples are filed by report number. When contacting Waypoint Analytical Inc. concerning a certain report, be sure to refer to this number.

### **SAMPLE NUMBER**

The customer's identification number on the information sheet for each sample is listed on the report.

### **LABORATORY NUMBER**

The identification number, which was assigned by the laboratory to each individual soil sample, is shown. There may be more than one laboratory number or sample per report.

### **SOIL FERTILITY GUIDELINES**

The crop to be grown will be listed and the recommendation units (lbs/acre or lbs/1000 sq ft) will be listed on the same line. The fertility guidelines are based on a season long application and suggested splits are normally listed in the comments.

The lime application is reported in pounds of 100% effective calcium carbonate limestone per acre. Contact the laboratory if you have any questions on how the lime value is reported. If you want a lower pH, reduce the lime application; for a higher soil pH, increase the lime application.

The recommendations for N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O- etc. are in lbs of the actual nutrient. For example, 100 lbs of N would require 294 lbs of ammonium nitrate (34-0-0) per acre fertilizer to be applied at sidedress. In the long-term, timely analyses can be used to adjust the amount of nitrogen fertilizer applied according to a field's inherent fertility and average yield. Growers whose fields often test high due to manure applications, organic matter mineralization, or nutrient retention can reduce nitrogen applications by 10-15% of the recommended nitrogen rate. Growers whose fields often test low should consider split applications instead of a total application at-plant. Sidedressing will reduce the possibility of losing nitrogen fertilizer by heavy rainfall and consequently assure that the majority of nitrogen applied is present during the corn's highest period of demand (V4+).

Prepared by: Dr. Richard Large June 12, 2003  
Revised by: Dr. Oscar F. Ruiz Jr. May 16, 2023