Reading and Interpreting a Soil Test

Soil testing is used to assess what soil nutrients are present or may be needed for optimum plant growth and yield potential. Due to variability in soil, lab analysis, and reporting, guidelines specific to your region may exist. A local agronomist or extension specialist can provide information specific to your area. The results from a soil test list the concentration of each measured nutrient, an interpretation value (low, optimum, and high), and recommendations for amendments or nutrient application.

// Soil Lab Testing and Results

Soil sampling must be conducted properly to obtain quality soil test results. Each sample should be representative of the entire field or specified sampling unit. Comparing soil tests over time is the best method of evaluating nutrient management decisions. Samples must be taken at the proper depth during the same time frame each year that sampling is conducted. Sample depths can vary by test type, but it is usually 6-12 inches.

Soil test results list the type of test conducted, the result, and may include interpretation or recommendations. When reviewing lab results, it is important to know what extraction method was used and how the results were reported. Labs may report results in parts per million (ppm) or lb/acre.

To convert ppm to lb/acre, multiply ppm by 2 (lb/acre = ppm x 2).

To convert lb/acre to ppm, divide lb/acre by 2 (ppm = lb/acre ÷ 2).

// Soil Parameters in a Soil Lab Test

Soil test results include the amount of macronutrients nitrogen (N), phosphorus (P), and potassium (K); secondary macronutrients sulfur (S), calcium (Ca), and magnesium (Mg); and micronutrients copper (Cu), iron (Fe), manganese (Mn), zinc (Zn), boron (B), chloride (Cl), nickel (Ni), and molybdenum (Mo) in the soil. Other soil characteristics that may be included in soil test results are organic matter (OM) content, soil pH, soluble salts (salinity), and cation exchange capacity (CEC).

Nitrogen - An adequate supply of N is associated with high photosynthetic activity, vigorous growth, and dark-green plant vegetation. There are two forms of plant available N: nitrate (NO_3^-) and ammonium (NH_4^+). Nitrate is measured most often in soil tests. Soil test results report nitrate-N in lb/acre. It is important to remember that nitrate levels on a soil test reflect what is immediately available and not what will be available in the future from mineralization of organic matter or lost from leaching or denitrification. The Late Spring Nitrate Test, also known as the Pre-sidedress Nitrate Test (PSNT), may be used in-season when corn plants are 6-12 inches tall to determine how much N should be sidedressed. Since nitrate soil test thresholds are regional, consult the nitrate soil test thresholds specific to your geography.

Table 1. Phosphorus recommendations for corn production utilizing various extraction methods.

	PPM				
	Very Low	Low	Optimum*	High	Very High
Bray P and Mehlich-3 P	0-8	9-15	16-20	21-30	31+
Olsen P	0-5	6-9	10-13	14-18	19+
	P_2O_5 (lb/acre) to apply to corn				
	100	75	58	0	0

(Table extracted from Mallarino and Sawyer, 2013)

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Phosphorus - Phosphorus is needed by the plant to store energy created from photosynthesis and carbohydrate metabolism to be used for plant growth and reproductive processes. Phosphorus is not as naturally abundant in the soil as other macronutrients and is relatively immobile. The amount of plant available P in the soil solution is related to soil pH. Different P extraction methods are used depending on the soil pH: Bray P (acidic soils), Mehlich-3 P (acidic soils), and Olsen P (neutral to alkaline soils). Test results may vary based on the extraction method or test used for measuring P. Table 1 provides recommendations for corn production based on soil test results from each of the three methods.

Potassium - Potassium helps plants activate enzymes, draw water into roots, produce phosphate molecules and CO_2, translocate sugars, and uptake and assimilate N. Most soils contain K in large quantities, although it is not always available. Soil testing in the fall or spring are acceptable for determining K concentrations as long as there is consistency as to when samples are taken. Soil test K recommendations for corn production are listed in Table 2.

Sulfur - Sulfur has many important functions in plant growth and metabolism. Only a small fraction of the total soil S is readily available to plants and that form is sulfate (SO_4^{2-}). Sulfur can be mobile or immobile in soil depending on microbial activity and the quantity of carbon (C), N, and P. S-deficient soils have soluble SO_4^{2-} concentrations less than 5-10 ppm.

Calcium and Magnesium - Calcium enhances nitrate-N uptake and also regulates the uptake of cations, such as K^+ and sodium (Na^+). High Ca concentrations typically result in low concentrations of undesirable cations, but a low Ca content can contribute to soil acidity. Magnesium is needed for photosynthesis and in many other physiological and biochemical functions within the plant. Both Mg and Ca ions can easily be exchanged or removed from negative soil colloids. Concentrations of Mg^{2+} in the soil are commonly 5-50 ppm in temperate soils but can be much higher.

Micronutrients - Although many of the micronutrients are reported on soil test reports, their levels do not currently affect fertilizer recommendations, with the exception of Zn. Soil test Zn recommendations for corn are shown in Table 3.

Table 2. Potassium recommendations for corn production using the ammonium acetate and Melich-3 Extractable K method.

Ammonium Acetate and Mehlich-3 Extractable K (PPM)					
	Very Low	Low	Optimum*	High	Very High
Dry	0-120	121-160	161-200	201-240	240+
Field-moist and Slurry	0-50	51-85	86-120	121-155	156+
K_2O to apply (lb/acre)					
Fine Textured	130	90	40	0	0
Sandy Textured	110	70	40	0	0

(Table extracted from Mallarino and Sawyer, 2013)

Table 3. Zinc recommendations for corn production utilizing the DTPA Extractable Zn extraction method.

	Zn Soil Test	Zn Application (lb/acre)	
	PPM	Broadcast	Band
Low	0.0-0.04	10	2
Marginal	0.5-0.8	5	1
Adequate	0.9+	0	0

(Table extracted from Mallarino and Sawyer, 2013)

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Organic Matter - Organic matter affects many soil biological, chemical, and physical properties that influence nutrient availability. A general guideline is to reduce N recommendations by 20 lb/acre for soils with >3% OM and increase N recommendations for soils with <1% OM. Consult your regional guidelines for a more precise influence of OM on nutrient availability.

Soil pH - Soil pH is an indicator of the level of acidity or alkalinity of the soil, ranging from 0-14. A reading of 7 is neutral; crops typically grow best when pH is between 6 (slightly acidic) and 7.5 (slightly alkaline). Results of soil pH are reported on a logarithmic scale; a soil with a pH of 6 is 10 times more acidic than a soil with a pH of 7, and a pH of 5 is 100 times more acidic than a pH of 7. Nutrient availability may be hindered if soil pH is not within the optimum range. A buffer pH (BpH) test is used to determine lime rate requirements. The amount of lime needed to increase soil pH to a desirable level can be estimated by mixing a buffer solution (with a known pH) to soil and then measuring the change in pH. If the change in pH is large after the buffer is added, the soil pH is easily changed and a low lime rate will be recommended, but if the change is small it means the soil pH is difficult to change requiring a larger rate of lime.

Soluble Salts - High soluble salt content (or salinity) can cause water stress, nutrient imbalances in plants, and affect nutrient uptake. Seedlings are more sensitive to higher than normal soluble salts compared to older plants. High soluble salt levels above 4 mmhos/cm (or dS/m) can potentially damage plants. Salinity levels in soil can change rapidly due to leaching; therefore, sampling should take place periodically within the growing season.

Cation Exchange Capacity (CEC) - The CEC is not always part of a soil analysis. If it is included on a lab result, a CEC above 10 milliequivalents per 100 grams (10 meq/100 g) is considered adequate. A high CEC is sought because it indicates a high capacity for the soil to hold cations (positively charged particles) such as K^+, NH_4^+, Cu^{2+}, Fe^{2+}, and Mn^{2+}.

References

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