Channel Seedsmanship At Work

Agronomy ADVICE | Tips from the Channel® Field Check Up Series

How to Use Soil Sample Results

Key Points

- Regular soil testing can help maintain soil fertility levels and sustain crop productivity.
- Interpreting and implementing soil fertility based on soil test recommendations may help reduce fertilizer costs and optimize crop inputs.
- Soil lab results can be used to recommend optimum application rates of both macro and micronutrients.

Soil Testing and Lab Results

The value of your soil samples depends on three main steps: (1) collecting consistent soil samples, (2) proper analysis and implementation of lab results, and (3) following through on lab recommendations. Samples should be taken at the proper depth, usually 0 to 6 inches or 6 to 12 inches, during the same time frame every time you sample. Each sample should represent an entire field or a specific area of a field. You should sample the same areas each sampling cycle. For more information on soil sampling best management practices, refer to the Agronomy ADVICE - Keys to Reliable Soil Test Information.

As you study soil test results, it is important to know which extraction method was used (Tables 1 and 2). 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 lbs/acre by 2 (ppm = lb/acre ÷ 2).

Macronutrients and Micronutrients

Actively growing plants need macronutrients, nitrogen (N), phosphorus (P), potassium (K), sulfur (S), calcium (Ca), and magnesium (Mg), in large amounts. Micronutrients, copper (Cu), iron (Fe), manganese (Mn), zinc (Zn), boron (B), chloride (Cl), nickel (Ni), and molybdenum (Mo), are needed in only trace amounts. Your lab results may also show organic matter (OM), soil pH, soluble salts (salinity), and cation exchange capacity (CEC). Each of these nutrients and soil characteristics plays an important role in plant growth and reproduction.

Nitrogen is necessary for photosynthesis, vigorous growth, and dark green plants. There are two forms of plant-available N: nitrate (NO_3^-) and ammonium (NH_4^+). Most soil tests measure nitrate N in lbs/acre. Remember nitrate levels on a soil test show what is immediately available and not what will be available in the future from mineralization of organic matter. You may also use a Late Spring Nitrate Test, or Pre-sidedress Nitrate Test (PSNT), when corn plants are 6 to 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.

Phosphorus helps plants store energy they create through photosynthesis and carbohydrate metabolism. Plants use this stored energy for growth and reproduction. Since the amount of plant-available P in the soil solution is related to soil pH, labs may use different P extraction methods, depending on the soil pH; Bray P for acidic soils, Mehlich-3 P for acidic soils, and Olsen P for neutral to alkaline soils. When you interpret soil test results, it is important to know which extraction method and test were used, and how the results were reported. Table 1 shows recommendations for corn and soybean production based on soil test results from each of the three soil extraction methods.[2]

Potassium helps plants activate enzymes, draw water into roots, produce phosphate molecules and CO_2, move sugars throughout the plant, and take up and use N. Although most soils contain large quantities of K, it is not always available. Changing environmental conditions can cause K concentrations to fluctuate over the seasons. Comparing soil test results over time is the best way to make K management decisions. Soil testing in the fall or spring can give a good indication of K soil concentrations, as long as you always take samples at the same time. Table 2 shows soil test K recommendations for corn and soybean production.[2]

Sulfur is also important for plant growth and metabolism. Deficiency symptoms (yellowing) are similar to N deficiency symptoms; however, S deficiency is usually found in young tissue and N deficiency can be found in both old and young plant parts. Only the sulfate (SO_4^{2}) form of the total soil S is readily available to plants. Sulfur deficient soils have soluble SO_4^{2} concentrations of less than 5 to 10 ppm.[5]

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Calcium helps plants take up nitrate nitrogen and regulates the uptake of cations such as K^+ and sodium (Na^+). A low Ca level can contribute to soil acidity, while high Ca concentrations typically result in low concentrations of undesirable cations.

Magnesium is necessary for photosynthesis and many other plant functions. Deficiencies of Mg are not widespread, but can occur.

Micronutrients (Cu, Fe, Mn, Zn, B, Cl, Ni, and Mo) are required in trace amounts for normal plant functions. Although many of the micronutrients are shown on soil test reports, fertilizer recommendations are typically made only for Zn.

Organic matter affects many soil biological, chemical, and physical properties that can influence nutrient availability. A general guideline is to reduce N recommendations by 20 lb/acre for soils with more than 3% OM and increase N recommendations for soils with less than 1% OM.[4] You should consult regional guidelines for more precise recommendations on the influence of OM on nutrient availability.

Soil pH defines the level of acidity of alkalinity of the soil, ranging from 0 to 14. Crops typically grow best when the pH is between 6 (slightly acidic) and 7.5 (slightly alkaline). A soil with a pH of 6 is 10 times more acidic than a soil with a pH of 7. A pH of 5 is 100 times more acidic than a pH of 7. When the soil pH is not within the optimum range, nutrient availability may be reduced.

Table 1. Phosphorus recommendations for corn and soybean production when 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+
Mehlich-3 ICP P	0-15	16-25	26-35	36-45	46+
P_2O_5 to apply (lb/A)					
Corn	100	75	58	0	0
Soybean	80	60	40	0	0

Table 2. Potassium recommendations for corn and soybean production. Ammonium acetate and Mehlich-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/A)					
Corn					
Fine Textured	130	90	40	0	0
Sandy Textured	110	70	40	0	0
Soybean					
Fine Textured	120	90	66	0	0
Sandy Textured	100	85	66	0	0

Soil test labs use a buffer pH (BpH) test to determine lime rate requirements. By mixing a buffer solution (with a known pH) with soil and measuring the change in pH, soil labs can estimate the amount of lime needed to increase soil pH to desirable levels. If the change in pH is large after the buffer is added, the soil pH is easily changed and a low lime recommendation rate will be made. If the change is small it means the soil pH is difficult to change, requiring a larger lime recommendation.

Soluble Salts High soluble salt content (salinity) can cause water stress, nutrient imbalances in plants, and may affect nutrient uptake. Seedlings are more sensitive to higher than normal soluble salts. Because leaching can cause salinity levels in soil to change rapidly, you should sample periodically during the growing season.

Cation Exchange Capacity (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/100g) is considered adequate.[4] A high CEC 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+}.

Sources:
[1] Mallarino, A.P. and Sawyer, J.E. 2013. Interpretation of soil test results. Iowa State University Extension. Publication No. PM1310. [2] Mallarino, A.P. and Sawyer, J.E. 2013. A general guide for crop nutrient and limestone recommendations in Iowa. Iowa State University Extension. Publication No. PM1688. [3] Lickacz, J. and Penny, D. 2001. Soil organic matter. Government of Alberta. Agriculture and Rural Development. http://www1.agric.gov. [4] Dinkins, C.P. and Jones, C. 2013. Interpretation of soil test results for agriculture. Montana State University Extension. MontGuide. Publication No. MT200702AG. [5] Pagani, A., Mallarino, A.P., and Sawyer, J.E. Soil pH and lime management for corn and soybean: an ongoing on-farm project. 2009. Iowa State University. [6] Tisdale, S.L., Nelson, W.L., Beaton, J.D., and Havlin, J.L. 1993. Soil fertility and fertilizers, fifth edition. Web sources verified 8/20/15. 140728141718.

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