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Agriculture and Natural Resources

Soil Fertility Interpretation

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General Soil Fertility Test Interpretation Guide
Source: Western Fertilizer Handbook, 10th Edition

	OM (%)	**pH**	**EC** (dS/m)	**NO_3-N** (ppm)	**Olsen PO_4-P** (ppm)	**Bray PO_4-P** (ppm)	**K** (ppm)
Low	<1.0	<6.2	<0.7	<10.0	<12.0	<30.0	<100
Optimal	1.0-3.0	6.2-7.8	0.7-2.0	10.0-25.0	12.0-25	30.0-50.0	100-300
High	>3.0	>7.8	>2.0	>25.0	>25.0	>50.0	>300

	SO_4-S (ppm)	**Ca** (meq/L)	**Mg** (meq/L)	**Na** (meq/L)	**Cl** (meq/L)	**Cl** (ppm)	**Fe** (ppm)
Low	<10.0	<5 (T)	(T)	N.A.	<5.0	<170	<5.0
Optimal	10.0-15.0	5-30	1-10	<3	5.0-10.0	170-350	5.0-15.0
High	>15.0	>30	>10	>5	>10.0	>350	>15.0

(T) indicates that tissue analysis is often a better measure of sufficiency for the nutrient

	B (ppm) via saturated paste extract	**B** (ppm) via BaCl2 or DTPA-sorbitol	**Zn** (ppm)	**Mo** (ppm)	**Cu** (ppm)
Low	<0.2	<0.5	<0.8	<0.1	<0.5
Optimal	0.2-0.7	0.5-1.2	0.8-1.5	0.1-0.2	0.5-1.2
High	>0.7	>1.2	>1.5	>0.2	>1.2

Cation Exchange Capacity (CEC) indicates the ability of a soil to hold cations on exchange sites and is largely dependent on soil type:

Soil Texture	**Typical CEC Range** (meq/100 g soil)
Sand & loamy sand	2 – 6
Sandy loam	3 – 8
Loam	7 – 15
Silt loam	10 – 18
Clay	15 – 30

Notes

- Goal: use soil fertility test results to guide nutrient management decisions through appropriate amendment applications
    - Supply enough plant essential nutrients to support plant health and productivity
    - Avoid over-applying nutrients which can lead to nutrient runoff to the environment, lower productivity, and plant toxicity damage

- Collect soil samples from the same field locations annually and use the same soil testing lab to ensure consistent and comparable results
- Some soil testing labs provide their own interpretation guides and recommended ranges based on the specific crop system where you sampled (this guide shows general ranges)
- Abbreviations, associated charges, and notes:
  - OM: Organic Matter, contains an overall negative charge which helps adsorb and retain cations for plant uptake
  - pH: potential hydrogen, a logarithmic scale expressing acidity/alkalinity
  - EC: electrical conductivity, the ability of the soil to conduct electrical current
  - NO_3-N: nitrate-nitrogen, negatively charged (1-), very mobile in soil especially under high water applications
  - PO_4-P: phosphate-phosphorus, negatively charged (3-), not very mobile in soil
  - K: potassium, positively charged (1+), not very mobile in soil unless under high water applications and/or in sandy soils
  - SO_4-S: sulfate-sulfur (2-)
  - Ca: calcium (2+)
  - Mg: magnesium (2+)
  - Na: sodium (1+)
  - Cl: chloride (1-)
  - Fe: iron (2+ or 3+)
  - B: boron (present as boric acid in soil, which is neutral)
  - Zn: zinc (2+)
  - Mo: molybdenum (above pH>5.0, present as MoO_4 which has a 2- charge)
  - Cu: copper (2+)
- Proportions of cations: generally, Ca should be greater than Mg which should be greater than Na, within the ranges listed in the above chart
- Nutrient mobility in soil depends on the charge, soil pH, moisture, temperature, soil texture, type of clay, and OM, but typically, anions (negatively charged ions) move more easily relative to cations (positively charged ions)
- The Lyotropic series shows more strongly held cations that are adsorbed to negative exchange sites (on soil minerals and soil organic matter) on the left side, and more weakly held cations on the right: $Al^{3+} > Ca^{2+} = Mg^{2+} > K^{+} = NH_4^{+} > Na^{+}$
- Bray vs. Olsen phosphate: two different analytical methods for assessing phosphate
  - The Bray test works well for soils that are neutral and acidic
  - The Olsen test is best when soil pH is alkaline, ~ 7.4 or higher (UC ANR, UMN)
- Conversions
  - 1 ppm = 1 mg/kg
  - Converting from meq/L to ppm requires calculations for each ion individually (see conversion chart from UFL if interested). On a practical basis, it is easier to simply compare the values in your test result with the provided sufficiency range for each nutrient.

Thank you, Keith Abeles, Sonoma Resource Conservation District (RCD), for helpful feedback!