

# Procedure References

Soil Test	Description	Reference/ Instrument
Soil drying/ grinding	Dried overnight at 105 degrees C, ground and sieved to 2 mm	Soil grinder: Dynacrush Soil Crusher, Custom Laboratory Equipment, Holden, MO, USA
pH, EC, SAR	pH determined on a saturated paste.	Thermo Orion Model 410A+, Thermo Electron, Waltham, MA, USA Rhodes, J.D. Soluble Salts, pp. 167-179. In: A.L. Page (ed), Methods of Soil Analysis Part 2. 1982. American Society of Agronomy, Inc. Madison, WI.
	EC Meter	RC-16C Conductivity Bridge, Beckman Instruments, Brea, CA, USA
	Ca, Mg, Na analyzed by AAS or ICP	AAAnalyst 200, PerkinElmer, Waltham, MA, USA or iCAP 7400, Thermo Electron, Madison, WI, USA
OM	Organic Matter by Walkley-Black, dichromate oxidation	Walkley, A., and I.A. Black. 1934. An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Science 37:29-38.
NO <sub>3</sub> -N	Chromotropic acid analysis of NO <sub>3</sub> -N	Sims, J.R., and G.D. Jackson. 1971. Rapid analysis of soil nitrate with chromotropic acid. Soil Sci. Soc. Amer. Proc. 35:603-606.
NO <sub>3</sub> -N + NH <sub>4</sub> -N	Ammonium and Nitrate extracted with 2 M KCl. Analyzed by Rapid Flow Analyzer	Keeney, D.R., and D.W. Nelson. Nitrogen - Inorganic forms. pp. 643-698. In: A.L. Page (ed.), Methods of Soil Analysis Part 2. 1982. American Society of Agronomy, Inc. Madison, WI.
		Fialyzer 1000, FIALab, Seattle, WA, USA
Total C and N	Carbon to nitrogen ratio, combustion	McGeegan, S.L., and D.V. Naylor. 1988. Automated instrumental analysis of carbon and nitrogen in plant and soil samples. Commun. Soil Sci. Plant Anal. 19:493-505.
		Vario EL Cube, Elementar, Langenselbold, Germany
P	Phosphorus extracted with 0.5 M sodium bicarbonate	Olsen, S.R., C.V. Cole, F.S. Watanabe, and L.A. Dean. 1954. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. USDA Cir. No. 939.
K	Potassium extracted with 0.5 M sodium bicarbonate. Analyzed by AAS	Schoenau, J.J., and R.E. Karamonos. Sodium Bicarbonate Extractable P, K, and N. pp. 51-58. In: M.R. Carter (ed.), Soil Sampling and Methods of Analysis. 1993. Canadian Society of Soil Science. Ottawa, Ontario, Canada.
		AAAnalyst 200, PerkinElmer, Waltham, MA, USA

SO <sub>4</sub> -S	Monocalcium phosphate extraction (500 ppm P). Analyzed by ICP-OES	Fox, R.L., R.A. Olson, and H.F. Rhoades. 1964. Evaluating the sulfur status of soils by plants and soil tests. <i>Soil Sci. Soc. Am. Proc.</i> 28:243-246. iCAP 7400, Thermo Electron, Madison, WI, USA
Exchangeable Ions	Exchangeable Calcium, Magnesium, Potassium, Sodium. Ammonium acetate method. pH 8.5. Analyzed by ICP-OES	Normandin, V., J. Kotuby-Amacher, and R.O. Miller. 1998. Modification of the ammonium acetate extractant for the determination of exchangeable cations in calcareous soils. <i>Commun. Soil Sci. Plant Anal.</i> 29(11-14), 1785-1791. iCAP 7400, Thermo Electron, Madison, WI, USA
Micronutrients	Zn, Fe, Mn, Cu — DTPA extraction (0.005 M DTPA, 0.1 M TEA, and 0.01 M CaCl <sub>2</sub> ). Analyzed by ICP-OES	Lindsay, W.L., and W.A. Norwell. 1978. Development of DTPA soil test for zinc, iron, manganese and copper. <i>Soil Sci. Soc. Am. Proc.</i> 42:421-428 iCAP 7400, Thermo Electron, Madison, WI, USA
CEC	Soil Cation Exchange Capacity - Ammonium Replacement Method. Analyzed by Rapid Flow Analyzer	Method S-10.10. <i>Plant, Soil and Water Reference Methods for the Western Region</i> . 1994. R.G. Gavlak, D.A. Horneck, and R.O. Miller. WREP 125. Fialyzer 1000, FIALab, Seattle, WA, USA
CaCO <sub>3</sub>	Calcium carbonate- titration	Allison L.E., and C.C. Moode. Carbonate. pp. 1387-1388. In C.A. Black (ed.), <i>Methods of Soil Analysis Part 2</i> . 1965. American Society of Agronomy, Inc. Madison, WI.
CaCO <sub>3</sub>	Calcium carbonate- gravimetric	Loeppert, Richard H. And Donald L. Suarez. 1996. Carbonate and gypsum. p. 437-474. In: J.M. Bartels et al. (ed.) <i>Methods of soil analysis: Part 3 Chemical methods</i> . (3rd.ed.) ASA and SSSA, Madison, WI. Book Series no. 5
Gypsum	water of hydration method	R.E. Nelson. Carbonate and Gypsum. pp. 181-197. In: A.L. Page (ed.), <i>Methods of Soil Analysis Part 2</i> . 1982. American Society of Agronomy, Inc. Madison, WI.
Texture	% Sand, Silt, Clay (Hydrometer)	Gee, G.W. and Or, D. Particle-Size Analysis pp. 278-281. In: J.H. Dane and G.C. Topp (eds.), <i>Methods of Soil Analysis Part 4</i> . 2002. Soil Science Society of America, Inc. Madison, WI.
ICP total element/metals	Microwave assisted acid digestion of soils, analyzed by ICP-OES	Nitric Acid Microwave assisted digestion (EPA Method 3051A) (Mars 6, CEM, Charlotte, NC) iCAP 7400, Thermo Electron, Madison, WI, USA
<b>Plant Tissue Test</b>	<b>Description</b>	<b>Reference/ Instrument</b>
Plant tissue drying/ grinding	Dried at 65 degrees C until dry weight is stable (typically 1–2 days)	Thomas Wiley Mini Mill, Thomas Scientific, Swedesboro, NJ, USA
Nutrient analysis	P, K, Ca, Mg, S, Na, Zn, Fe, Mn, Cu, B	Minerals by Nitric – Hydrogen Peroxide Microwave Digestion EPA Method 3052 (Mars 6, CEM, Charlotte, NC). Followed by ICP-OES Analysis (iCAP 7400, Thermo Electron, Madison, WI, USA).

Total N and C	Carbon to nitrogen ratio, combustion	McGeegan, S.L., and D.V. Naylor. 1988. Automated instrumental analysis of carbon and nitrogen in plant and soil samples. <i>Commun. Soil Sci. Plant Anal.</i> 19:493-505.  Vario EL Cube, Elementar, Langenselbold, Germany
NO <sub>3</sub> -N	2% acetic acid extraction. Analyzed by Rapid Flow Analyzer	Method B-3.10. <i>Plant, Soil and Water Reference Methods for the Western Region</i> . 1994. R. G. Gavlak, D. A. Horneck, and R. O. Miller. WREP 125.  Fialyzer 1000, FIALab, Seattle, WA, USA
Water Test	Description	Reference/ Instrument
pH	As received	Electrode: Ag/AgCl Symphony, VWR, Radnor, PA, USA  Meter: Thermo Orion 410A+, Thermo Electron, Madison, WI, USA
ICP-OES elements	Al, As, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, S, Se, Si, Sr, Ti, V, Zn	iCAP 7400, Thermo Scientific, Madison, WI, USA
Total Organic Carbon and Total Nitrogen	Catalytic oxidation	TOC/TN-L, Shimadzu Scientific, Kyoto, Kyoto Prefecture, Japan
Nitrate and Ammonium	Flow Injection Analysis (Fialyzer 1000)	Flow injection analysis was used to determine nitrate-N and ammonium-N (Fialyzer 1000, FIALab Seattle, WA USA). The concentration of NO <sub>3</sub> -N was determined using the cadmium reduction method (Keeney & Nelson, 1982), and the concentration of NH <sub>4</sub> -N was determined by the sodium salicylate-sodium nitroprusside method (Rowland, 1983). Keeney, D.R., and D.W. Nelson. Nitrogen - Inorganic forms. pp. 643-698. In: A.L. Page (ed.), <i>Methods of Soil Analysis Part 2</i> . 1982. American Society of Agronomy, Inc. Madison, WI. Rowland, A.P. (1983). An automated method for the determination of ammonium-N in ecological materials. <i>Commun. Soil Sci. Plant Anal.</i> 14:49-63.