AGVISE LABORATORIES

INTERPRETING A SOIL TEST REPORT

To gain the most information from soil testing, it is necessary to become familiar with the soil test report. This guide will explain where each soil test parameter is displayed on the report. You will also find basic information about each soil test method and its role in soil fertility and plant nutrition in the Upper Midwest and Northern Great Plains of the United States and western Canada. Remember to follow accepted guidelines for soil sampling to ensure data on the soil test report represents the field area being sampled.

LABORATORY ANALYSIS OF SOIL

The soil tests routinely conducted on each soil sample depth are shown in Table 1. The topsoil sample (0-6 inch) is analyzed for all plant nutrients and soil properties. The subsoil sample (6-24 inch) is analyzed for mobile nutrients and soil properties such as nitrate-N, sulfate-S, chloride, and salinity. The deep subsoil sample (24-48 inch or deeper) is also analyzed for nitrate-N.

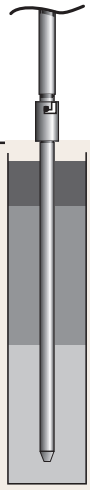
Table 1. Soil analyses routinely conducted on soil sample depths.

Analysis conducted on topsoil

Nitrate-N	Chloride	Copper	Salinity	Base saturation
Ammonium-N	Boron	Magnesium	Carbonate	Soil texture
Phosphorus	Zinc	Calcium	Soil pH	Water holding capacity
Potassium	Iron	Sodium	Buffer pH	
Sulfate-sulfur	Manganese	Organic matter	CEC	

Analysis conducted on subsoil

Nitrate-N	Sulfate-sulfur	Salinity	Soil texture
Ammonium-N	Chloride	Soil pH	Water holding capacity



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The 0-6 inch topsoil sample is required for analysis of non-mobile nutrients such as phosphorus and potassium. If 0-12 inch or 0-24 inch soil samples are submitted for non-mobile nutrient analysis, the resulting laboratory data and fertilizer guidelines may not be correct (Table 2). For example, there is little plant-available phosphorus in subsoil; therefore, the soil test phosphorus value will be skewed lower from the incorrect soil sampling depth (dilution effect) and the resulting phosphorus guideline will be greater than required.

Table 2. Proper soil sample depth ensures accurate soil test results.

Soil sample depth	Soil test phosphorus (Olsen)
inch	**ppm**
0-6	15
0-12	9
0-15	6

GENERAL SOIL SAMPLE INFORMATION

1 **Submitted for:** Usually the name of the grower for whom the soil sample was submitted. This may also be the name of the farm manager, consultant, etc. Some customers prefer to use a client number instead of the grower's name.

2 **Submitted by:** Name of the firm or individual who submitted the soil sample to the laboratory. This individual or firm is billed for soil analysis completed.

3 **Field:** Field or parcel where the soil sample was collected. The field name can include any combination of letters and numbers, often a brief legal description or local name. (30 character limit)

4 **Sample:** Identifies the soil sample when there is more than one soil sample collected from each field, often the grid or zone ID. A grid or zone submission allows up to 100 sample IDs per field. (30 character limit)

5 **County:** County where the soil sample was collected. (15 character limit)

6 **Township:** Township where the soil sample was collected. (25 character limit)

7 **Section:** Section of the township where the soil sample was collected. (4 character limit)

8 **Quarter:** Quarter or half of the section where the soil sample was collected. (15 character limit)

9 **Acres:** Acres represented by the soil sample collected. (5 character limit)

10 **Previous crop:** Crop that was grown just prior to soil sampling. Nitrogen guidelines may be adjusted if a legume was the previous crop.

11 **Reference Number:** Unique identification number printed on the soil sample information form sent to the laboratory with the soil sample. Each soil sample has a unique reference number that is tracked through the laboratory. When contacting AGVISE for soil sample information, you must know the reference number before soil test information will be provided.

12 **Laboratory Number:** Assigned for internal use and quality control in the laboratory.

13 **Box Number:** Temporary storage box for soil sample in the laboratory.

14 **Date Sampled:** Date the soil sample was collected.

15 **Date Received:** Date the soil sample arrived at the laboratory.

16 **Date Reported:** Date the soil test report was printed.

SOIL TEST DATA

17 **Nitrate-nitrogen (nitrate-N):** Nitrate-nitrogen is reported as lb/acre. Nitrate is mobile in the soil solution and should be tested on the topsoil and subsoil (0-6 and 6-24 inch) for most crops. For deep-rooted crops, like sugar beet or sunflower, nitrate should be tested on the deep subsoil (24-48 inch) as well. Residual soil nitrate testing is a useful tool to evaluate nitrogen fertilizer programs, indicating if too little or too much nitrogen remained after the previous crop grown. Sandy, well-drained soils often have low soil nitrate. If topsoil nitrate-N is low, additional nitrogen fertilizer may be necessary to provide sufficient early season nitrogen. High residual nitrate can be a contributing risk factor in iron deficiency chlorosis (IDC).

18 **Phosphorus (Olsen bicarbonate P, suitable on acidic and basic soils):** The Olsen bicarbonate phosphorus test is reported as parts per million (ppm). Phosphorus is not mobile in soil and should be tested on the topsoil (0-6 inch). Soils with very low pH or very high pH often have low phosphorus.

19 **Phosphorus (Bray-1 P, suitable only on acidic soils with pH < 7.0):** The Bray-1 phosphorus test is reported as parts per million (ppm). Phosphorus is not mobile in soil and should be tested on the topsoil (0-6 inch). Soils with very low pH or very high pH often have low phosphorus.

AGVISE LABORATORIES

Soil Analysis by Agvise Laboratories
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SOIL TEST REPORT

FIELD ID **PL33NE69** 3
SAMPLE ID **S of Trees** 4
FIELD NAME
COUNTY **Grand Forks** 5
TWP **Pleasant** 6 RANGE
SECTION **33** 7 QTR **NE** 8 ACRES **69** 9
PREV. CROP **Wheat-Spring** 10

SUBMITTED FOR: 1
Nelson Farms
P.O. Box 78
321 N 5th St
High Tower, ND 58563

SUBMITTED BY: **GS1234**
GREEN STREET AG CENTER
GREEN STR. N
PO BOX 567
ANYTOWN, ND 52341 2

REF # **826032** 11 BOX # **0** 13
LAB # **NW5226** 12

Date Sampled **10/01/2014** 14 Date Received **10/02/2014** 15 Date Reported **10/03/2014** 16

Nutrient In The Soil		Interpretation			
		VLow	Low	Med	High
0-6" / 6-24"	10 lb/ac / 30 lb/ac	********			
0-24'' Nitrate 17	40 lb/ac			38	
18 Olsen/Bray Phosphorus 19	5 ppm / 10 ppm	********	**********		
Potassium 20	125 ppm			********	
0-24'' Chloride 21	24 lb/ac		*********		
0-6" / 6-24" Sulfur 22	4 lb/ac / 12 lb/ac	****	**********		
Boron 23	0.6 ppm		*********		
Zinc 24	0.58 ppm		**********		
Iron 25	6.0 ppm			********	**
Manganese 26	10.0 ppm				**********
Copper 27	0.4 ppm		*********		
Magnesium 28	450 ppm				**********
Calcium 29	2300 ppm				**********
Sodium 30	35 ppm	******			
Org.Matter 31	4.3 %			**********	
Carbonate(CCE) 32	1.0 %	*******			
33 0-6" / 6-24" Sol. Salts	0.2 mmho/cm / 0.6 mmho/cm	******	**********	**	

1st Crop Choice		
Corn-Grain		
YIELD GOAL		
160 BU		
SUGGESTED GUIDELINES		
Broadcast 39		
LB/ACRE		APPLICATION
N	152	
P_2O_5	123	Broadcast
K_2O	83	Broadcast
Cl		Not Available
S	20	Broadcast
B	0	
Zn	8	Broadcast
Fe	0	
Mn	0	
Cu	0	
Mg	0	
Lime		

2nd Crop Choice		
Wheat-Spring		
YIELD GOAL		
60 BU		
SUGGESTED GUIDELINES		
Band		
LB/ACRE		APPLICATION
N	122	
P_2O_5	41	Band *
K_2O	32	Band *
Cl	16	Broadcast
S	10	Band
B	0	
Zn	2	Band (Trial)
Fe	0	
Mn	0	
Cu	2	Band
Mg	0	
Lime		

3rd Crop Choice		
Soybeans		
YIELD GOAL		
40 BU		
SUGGESTED GUIDELINES		
Broadcast		
LB/ACRE		APPLICATION
N	***	
P_2O_5	64	Broadcast
K_2O	45	Broadcast
Cl	0	
S	20	Broadcast
B	0	
Zn	4	Broadcast
Fe	0	
Mn	0	
Cu	0	
Mg	0	
Lime		

Soil pH 34	Buffer pH	Cation Exchange Capacity	% Base Saturation (Typical Range) 37				
			% Ca	% Mg	% K	% Na	% H
0-6" 7.1 6-24" 7.2	35	15.7 meq 36	(65-75) 73.1	(15-20) 23.9	(1-7) 2.0	(0-5) 1.0	(0-5)

General Comments: Coarse Loams (CEC range = 11 to 20) (Medium)

Crop 1: ** Chloride yield data is limited for this crop. Many crops may respond to a starter application of P & K even on high soil tests. Crop Removal: P2O5 = 64 K2O = 43 AGVISE Broadcast guidelines will build P & K test levels to the high range over several years.

Crop 2: 35 lbs of 0-0-60 = 16 lbs of Chloride" * Caution: Seed Placed Fertilizer Can Cause Injury * Many crops may respond to a starter application of P & K even on high soil tests. Crop Removal: P2O5 = 38 K2O = 23 AGVISE Band guidelines will build P & K test levels to the medium range over many years.

Crop 3: Many crops may respond to a starter application of P & K even on high soil tests. The risk of the development of iron chlorosis on soybeans on this field is low based on the salt and carbonate levels. Crop Removal: P2O5 = 35 K2O = 60 AGVISE Broadcast guidelines will build P & K test levels to the high range over several years. Soybeans may respond to nitrogen on fields testing less than 60 lb/ac with a limited soybean history.

20 **Potassium (K):** Ammonium acetate exchangeable potassium is reported as parts per million (ppm). Potassium is generally not mobile in soil and should be tested on the topsoil (0-6 inch). Coarse-textured or low cation exchange capacity (CEC) soils are often low in potassium.

21 **Chloride (Cl):** Chloride is reported as lb/acre. Chloride is mobile in the soil solution and should be tested on the topsoil and subsoil (0-6 and 6-24 inch). Soils that have never received potassium chloride (potash) fertilizer and non-saline soils are often low in chloride. Small grains (wheat, barley, oat, rye) are most sensitive to chloride deficiency.

22 **Sulfate-sulfur (sulfate-S):** Sulfate-S is reported as lb/acre. Sulfate is mobile in the soil solution and should be tested on the topsoil and subsoil (0-6 and 6-24 inch). Sandy, well-drained soils are often low in sulfate. Saline soils are often very high in sulfate because the major soluble salts in the region are sulfate-based salts. Shallow-rooted crops or crops with high sulfur requirement (e.g., canola) may require more sulfur.

23 **Boron (B):** Boron is reported as parts per million (ppm). Boron is mobile in the soil solution and should be tested on the topsoil (0-6 inch). Sandy, well-drained soils are often low in boron. Alfalfa and clover are most sensitive to boron deficiency. Exceptionally high boron may be toxic to plant growth.

24 **Zinc (Zn):** Zinc is reported as parts per million (ppm). Zinc is not mobile in soil and should be tested on the topsoil (0-6 inch). Soils with high pH and high carbonate are often low in zinc. Corn, dry bean, flax, and potato are most sensitive to zinc deficiency.

25 **Iron (Fe):** Iron is reported as parts per million (ppm). Iron is not mobile in soil and should be tested on the topsoil (0-6 inch). Dry bean, flax, and soybean are most sensitive to iron deficiency. Regardless of soil iron level, iron deficiency chlorosis (IDC) may occur in sensitive crops on soils with high carbonate or high salinity, particularly when waterlogged.

26 **Manganese (Mn):** Manganese is reported as parts per million (ppm). Manganese is not mobile in soil and should be tested on the topsoil (0-6 inch). Soils with high pH and high organic matter are often low in manganese. Soils with very low pH (<5.5) can have exceptionally high manganese, which may be toxic to plant growth.

27 **Copper (Cu):** Copper is reported as parts per million (ppm). Copper is not mobile in soil and should be tested on the topsoil (0-6 inch). Sandy soils with low organic matter or soils with very high organic matter (peat and muck soils) are often low in copper. Small grains (wheat, barley, oat, rye) are most sensitive to copper deficiency.

28 **Magnesium (Mg):** Magnesium is reported as parts per million (ppm). Magnesium is not mobile in soil and should be tested on the topsoil (0-6 inch). Sandy soils with very low pH (<5.5) may be low in magnesium. Alfalfa, corn, potato, and onion are most sensitive to magnesium deficiency.

29 **Calcium (Ca):** Calcium is reported as parts per million (ppm). Calcium is not mobile in soil and should be tested on the topsoil (0-6 inch). Sandy soils with low pH (< 6.0) may be low in calcium.

30 **Sodium (Na):** Sodium is reported as parts per million (ppm). Sodium is not a plant nutrient, but it may impair soil water movement and destroy soil structure, causing reduced crop productivity. Sodium is not readily mobile in soil and should be tested on the topsoil (0-6 inch). If soil structure is impaired, sodium should be tested on subsoil as well. High sodium is often associated with high pH (>8.5) soils, saline soils, and poor-quality irrigation water.

31 **Organic Matter (OM):** Organic matter is reported as percent by weight. Organic matter distribution in soil profiles is highest in the topsoil. Organic matter should be determined on the topsoil (0-6 inch). Peat soils have organic matter > 20%. Sandy, well-drained soils and eroded soils are often low in organic matter. Soil-applied herbicide rates may be adjusted for organic matter content.

32 **Carbonate (calcium carbonate equivalent, CCE, or free lime):** Carbonate is reported as the calcium carbonate equivalent (CCE) percent by weight. The carbonate soil test measures all carbonate species (e.g., calcium carbonate, magnesium carbonate, sodium carbonate). Carbonate should be determined on the topsoil (0-6 inch). Carbonate is the primary risk factor in iron deficiency chlorosis (IDC). Soils with high carbonate may require more phosphorus fertilizer because the formation of insoluble calcium phosphate complexes reduces fertilizer phosphorus availability. Soils with pH < 7.3 contain little or no carbonate. Soils with pH > 7.3 contain some amount of carbonate, but the soil carbonate test is necessary to determine if the amount is low or high.

33 Salinity (electrical conductivity, EC, or soluble salts): Salinity is reported as decisiemens per meter (dS/m). Salinity is measured as the electrical conductivity of dissolved ions (soluble salts) in the soil solution. The greater the electrical conductivity, the higher the salinity. Soluble salts are mobile in the soil solution and move with soil water via leaching or capillary rise (e.g., high water table). Salinity should be tested on the topsoil and subsoil (0-6 and 6-24 inch). Salinity can severely reduce crop productivity. Crop tolerance to salinity varies widely (e.g., soybean, very sensitive; barley, tolerant). Salinity is a contributing risk factor in iron deficiency chlorosis (IDC).

34 Soil pH: Soil pH is the measurement of hydrogen ion concentration in soil. Soils with pH < 7.0 are acidic. Soils with pH > 7.0 are basic or alkaline. Soil pH affects the availability of several nutrients. Soils with pH < 6.5 may require lime to raise soil pH. Soils with very low pH (<5.5) may present aluminum or manganese toxicity to plant growth. Crop sensitivity to soil pH varies widely and affects how much, if any, lime should be applied.

35 Buffer pH: Buffer pH determines the amount of lime required to raise soil pH on very acidic soils. The buffer pH test is generally used on soils with pH < 6.0.

36 Cation Exchange Capacity (CEC, summation of cations method): Cation exchange capacity is reported as centimoles of charge per kilogram ($cmol_c/kg$). Cation exchange capacity is the ability of soil to hold exchangeable cations (e.g., NH_4^+, Ca^{2+}, Mg^{2+}, K^+, Na^+, H^+, Al^{3+}) and should be determined on the topsoil (0-6 inch). Soil texture, clay type, and organic matter contribute to CEC. The estimated soil texture from CEC is: sand = 0-8 $cmol_c/kg$, loamy sand = 9-12 $cmol_c/kg$, sandy loam or silt loam = 13-20 $cmol_c/kg$, loam = 21-28 $cmol_c/kg$, clay loam = 29-40 $cmol_c/kg$, clay or peat > 40 $cmol_c/kg$. The summation of cations method produces accurate CEC results on soils with pH < 7.0. For soils with salinity or pH > 7.3, the excess soluble and carbonate salts will inflate CEC results. Soil-applied herbicide rates may be adjusted for CEC.

37 Base Saturation: Base saturation is the relative proportion of base cations (Ca^{2+}, Mg^{2+}, K^+, Na^+) to the total cation exchange capacity (CEC), reported on a percent basis. It is calculated from the total base cations (Ca^{2+}, Mg^{2+}, K^+, Na^+) and acid cations (H^+) measured. For example, a soil may have 70% calcium, 20% magnesium, 7% potassium, 3% sodium, totaling 100% base saturation. Typical base saturation ranges are: calcium 65-75%, magnesium 15-20%, potassium 1-7%, sodium 0-5%, and hydrogen 0-5%.

Table 3. General interpretation of soil test levels

			SOIL TEST INTERPRETATION CATEGORY				
SOIL TEST PARAMETER	**Unit**	**Depth (inch)**	**Very Low**	**Low**	**Medium**	**High**	**Very High**
Primary macronutrients							
Nitrate-N (residual NO_3-N)	lb/acre	0-24	≤20	21-40	41-60	61-80	>80
Phosphorus (Bray-1 P)	ppm	0-6	≤5	6-10	11-15	16-20	>20
Phosphorus (Olsen P)	ppm	0-6	≤3	4-7	8-11	12-15	>15
Potassium (K)	ppm	0-6	≤40	41-80	81-120	121-160	>160
Secondary macronutrients							
Calcium (Ca)	ppm	0-6	≤500	501-1000	1001-1500	1501-2000	>2000
Magnesium (Mg)	ppm	0-6	≤83	84-166	167-250	251-400	>400
Sulfate-S (SO_4-S)	lb/acre	0-6	≤6	7-14	15-30	31-40	>40
Sulfate-S (SO_4-S)	lb/acre	0-24	≤25	26-56	61-120	>120	
Micronutrients							
Boron (B)	ppm	0-6	≤0.40	0.41-0.80	0.81-1.20	1.21-1.60	>1.60
Chloride (Cl)	lb/acre	0-24	≤15	16-30	31-40	41-60	>60
Copper (Cu)	ppm	0-6	≤0.20	0.21-0.40	0.41-0.60	0.61-0.80	>0.80
Iron (Fe)	ppm	0-6	≤2.5	2.6-5.0	5.1-7.5	7.6-10.0	>10
Manganese (Mn)	ppm	0-6	≤0.5	0.51-1.0	1.1-2.0	2.1-10.0	>10
Zinc (Zn)	ppm	0-6	≤0.30	0.31-0.60	0.61-1.00	1.01-2.00	>2.0
Soil properties							
pH (1:1)	---	0-6	<5.5	5.6-6.5	6.6-7.5	7.6-8.5	>8.5
Salinity (EC 1:1)	dS/m	0-6	<0.25	0.26-0.50	0.51-0.75	0.76-2.0	>2.0
Sodium (Na)	ppm	0-6	≤40	41-80	81-120	120-160	>160
Carbonate (CCE)	%	0-6	<1.0	1.1-2.5	2.6-5.0	5.1-10	>10
Organic matter	%	0-6	<1.5	1.6-3.0	3.1-4.5	4.6-6	>6

38 **Relative Test Level:** Indicates the relative soil test interpretation categories. A field-calibrated soil test measures the plant-available nutrient fraction in soil, which is calibrated to the crop response to fertilizer. The soil test interpretation categories (low, medium, high) predict the probability of crop response to fertilization. If the soil test level is high or greater, then the likelihood of crop yield increase to fertilization is low. The soil test interpretation categories for each soil test parameter are listed in Table 3.

SUGGESTED FERTILIZER GUIDELINES

39 AGVISE Laboratories offers three types of guidelines for phosphorus and potassium fertilization: broadcast, band, and university. The fertilizer guidelines are adjusted based on crop choice, soil nutrient level, crop yield goal, and fertilizer placement. Fertilizer guidelines are reported as lb/acre on elemental basis and P_2O_5 and K_2O conventions for P and K, respectively. The fertilizer guidelines were developed utilizing university and industry research along with the professional experience of AGVISE agronomic staff.

Broadcast P & K Fertilizer Guideline: The AGVISE broadcast fertilizer guideline is based on uniform fertilizer application and incorporation with tillage, except for alfalfa and other perennial crops. Seed safety concern is minimal for broadcast fertilizer application.

At very low to medium soil test levels, the broadcast guideline will build soil test levels to the high range over several years. If soil test levels are very high, the broadcast guideline is reduced to the suggested starter P and K fertilizer rate.

Broadcast with Maintenance P & K Fertilizer Guideline: The AGVISE broadcast with maintenance fertilizer guideline is the same as the broadcast fertilizer guideline except that when soil test levels are high or greater, the broadcast with maintenance guideline is equal to crop P and K removal based on selected yield goal.

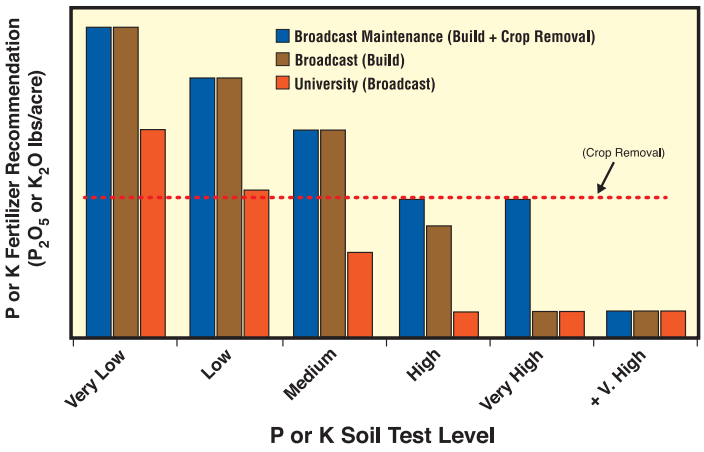
Band P & K Fertilizer Guideline: The AGVISE band fertilizer guideline assumes that P and K fertilizer is placed at least 2 inches away from seed. If too much fertilizer is placed directly with seed, delayed emergence and plant stand loss may occur. The seed-safe fertilizer rate placed with seed is determined by soil water content, soil texture, row width, seed opener spread, fertilizer material, and crop sensitivity. Utilize local information from crop consultants and equipment manufacturers to determine the seed-safe fertilizer rate.

At very low soil test levels, the band guideline will slowly build soil test levels to the medium range over several years. If soil test levels are high, the band guideline is reduced to the suggested starter P and K fertilizer rate. If soil test levels are initially high, the band guideline will lower soil test levels to the medium range over many years.

Band with Maintenance P & K Fertilizer Guideline: The AGVISE band with maintenance fertilizer guideline is the same as the band fertilizer guideline except that when soil test levels are medium or greater, the band with maintenance guideline is equal to crop P and K removal based on selected yield goal.

University Broadcast Fertilizer Guideline: The university broadcast fertilizer guideline has been compiled as one equation set from the University of Manitoba, the University of Minnesota, Montana State University, North Dakota State University, and South Dakota State University. At very low soil test levels, the university broadcast guideline will slowly build soil test levels to the medium range over several years. If soil test levels are high, the university broadcast guideline is reduced to near zero. When the university broadcast guideline is zero, university soil fertility specialists still recommend starter fertilizer for most crops.

Comparison of Broadcast Guidelines



Comparison of Band Guidelines