Soil Sampling as a Basis for Fertilizer Application

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Importance of Soil Sampling

Soil tests measure the relative nutrient status of soils and are used as a basis for profitable and environmentally responsible fertilizer application. The accuracy of a soil test result is influenced by the laboratory analysis but may be influenced even more by the quality of the soil sample. Sample collection is extremely important in the accuracy and repeatability of a soil test. Sample handling following collection is also important. A soil sample which does not represent the area being sampled will be misleading and result in over or under-application of fertilizer. It is therefore very important to collect and handle soil samples properly.

There have been several changes in field sampling methods since the last revision of this circular. This revision will help direct soil samplers in methods for determining a composite soil test, but will also introduce site-specific methods for revealing within-field nutrient levels. The challenge has been to provide meaningful information about field and within field nutrient levels with minimal costs to the producer.

When to sample

Soil samples to be analyzed for soil pH, salt content, zinc (Zn) and phosphorus (P) can be taken nearly any time of year. Potassium (K) values from samples taken in frozen soil may test high compared to other times of the year. Sulfur (S) and chloride (Cl) are mobile in the soil, so sampling in the fall or spring is recommended.

Most soil samples in North Dakota are taken for nitrate-nitrogen (NO_3-N) analysis. When samples are collected in the fall before September 15, a sampling date adjustment (SDA) should be used to compensate for additional N releases anticipated from soil organic matter and previous crop residue decomposition. Soil samples for NO_3-N may be taken without sampling date adjustment after September 15. After this date, most additional N releases from soil micro-biological activity are low. Soil samples may be taken for NO_3-N as early as August 1. The SDA adds one-half pound of NO_3-N to the soil test analysis for each day the sample is collected prior to September 15 (Table 1).

Table 1. Sampling date adjustments if soil samples are

taken in the fall prior to September 15.

Date of sampling	Sampling date adjustment
	lb NO_3-N/acre
August 1	23
August 15	15
August 30	8
September 5	5
September 15	0

Producers should not be reluctant to sample in early August following small grain harvest because of fear of greater N release from organic matter and residues compared to late fall sampling. If yields were relatively high, the SDA adjustment represents potential N release well. Sampling fields before tillage also increases the reliability of the 0-6 inch soil core depth because of more uniform soil conditions compared to tilled fields. Waiting to sample small grain fields until late fall increases the risk of N uptake by small grain regrowth, which may contain up to 100 lb N/acre. Sampling standing row crops for NO_3-N is not recommended.

Fall soil sampling results for NO_3-N and S are similar in most years to spring sampling. However, warmer than normal winters followed by an early spring combined with good soil moisture could increase NO_3-N and S levels through organic matter and residue mineralization. Green sugarbeet leaves or other crop residues with relatively high N content may also contribute to early mineralization and increase spring NO_3-N levels compared to a fall soil sampling. In sandy soils with high rainfall or snow-melt following a fall sampling, levels of NO_3-N and S in the spring compared to a fall sampling may decrease as nitrate and sulfate is leached out of the sampling zone. In most situations, however, fall sampling is a good guide to N and S application.

Depth of Sampling

Soil sampling and analysis assumes 2,000,000 lb/acre of soil from 0-6 inches in depth. This weight per unit volume (bulk density) assumes a medium soil texture with some compaction typically found following cropping and harvest. Bulk density differences can make a difference of 10% in soil test results. Bulk density is ignored in commercial soil sampling, but consistency in soil sampling techniques is important because of soil bulk density differences, especially in surface cores. The depth of sampling required depends mainly on the nutrient of interest, the crop to be fertilized, and in some cases, the tillage system in place (Figure 1).

Figure 1. Depth recommended generally for soil analysis of certain properties and nitrate analysis for crops.

Soil Surface	Soil Properties	Crops
0-6 inch	pH, P,K, OM, Cl, S, Ca, Mg, CEC, Zn, $NH4^+$-N, Fe, Mn, Cu, soluble salts, NA	Alfalfa, clovers (analyze only 0-6 inch depth, nitrate analysis at deeper depths not necessary).
6-24 inch	Soluble salts, NO_3-N, S, Cl (in addition to 0-6 inch depth)	Wheat, barley, oats, durum, corn, soybean, dry bean, potato, canola, crambe, mustard, sunflower, grass hay, pasture, millet, canary seed, flax, safflower, buckwheat, lentil, field pea,

		sorghum, sudangrass. (Separate 0-24 inch depth into a 0-6 inch and 6-24 inch depth.)
24-48 inch	NO_3-N, in addition to the 0-6 inch and 6-24 inch depths	Sugarbeet, malting barley. (Sunflower if greater than 30 lb N/acre are anticipated at the 24-48 inch depth.) (Separate cores into 0-6 inch, 6-24 inch and 24-48 inch depths.)

Nutrients

For soil pH, P, K, Zn, copper (Cu) and manganese (Mn), sampling the 0-6 inch depth is adequate. In long-term no-till fields, soil pH, P, and K may become stratified. Most studies for P and K suggest that stratification is not important as long as the fertilizer P and K rates based on a 0-6 inch value is followed. However, soil pH may be important in the surface 0-2 inch layer because of possible herbicide interaction with lower pH levels. The 0-6 inch depth is also important for soluble salts, in addition to the 6-24 inch depth.

To determine soil NO_3-N, S and Cl, samples are taken from at least the 0-24 inch depth. The 0-24 inch sample should be broken into a 0-6 inch depth and a 6-24 inch depth, so that the relative position of N in the soil can be determined. In some years, NO_3-N can be leached to lower depths so that large amounts are in the 6-24 inch layer but only a small amount may be left in the 0-6 inch layer. Depending on the crop, soil NO_3-N may need to be determined on the 24-48 inch depth (2-4 foot) also. A few areas within the Red River Valley have a history of poor sugarbeet quality due in part to the presence of especially high levels of soil NO_3-N at deep depths. In these special areas, deep N to 6 feet may also need to be checked.

Crop

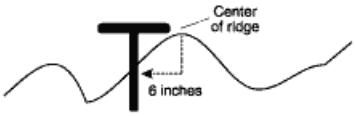
For most crops, NO_3-N should be determined on the 0-24 inch depth. For sugarbeet and malting barley, the 24-48 inch depth should also be sampled to fine-tune N rates necessary to improve beet and grain quality. Sunflower also may use deep N; however, deeper sampling is conducted not to improve quality, but to save money on N fertilizer when there is reason to suspect the presence of large quantities of N at deep depths, such as following years of growing shallow rooted crops, following fallow, and when previous crop yields have been low.

Tillage system

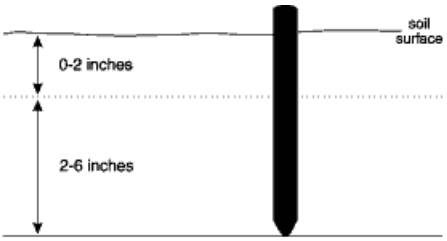
Under conventional tillage and conservation tillage, sampling 0-6 inch, 6-24 inch and the 24-48 inch depths described previously are appropriate. Under long-term no-till, stratification of soil non-mobile nutrients and soil pH will occur. Phosphate and soil pH stratification are common, with high P and lower pH levels at the surface 0-2 inch depth and lower P and higher pH levels at deeper depths. If the lower depths become depleted in P, application of more deeply placed P may be beneficial, especially in drier seasons. Soil pH tends to become acid at the surface, especially if N fertilizers are applied to the surface. Separating the 0-6 inch depth into a 0-2 inch depth and 2-6 inch depth would identify these trends (Figure 2).

Figure 2. Sampling under special tillage conditions.

Ridge till	No till for soil pH and P if stratification from long-term no till is suspected



Sample is obtained straight downwards,
6 inches from the ridge center



The 0-6 inch core is separated into a 0-2 inch and 2-6 inch depth for soil pH and P

Special sampling situations

Ridge-till is occasionally used in North Dakota, but it is a popular tillage system in some areas of the corn-soybean belt. In ridge till, ridges are built by deep cultivation during the growing season and remain in the field following harvest and through the winter. At planting, the top of the ridge is removed, exposing moist soil for seeding, and soil from the top of the ridge is moved into the row middles. Starter fertilizer is often used at planting, and sometimes deep-placed fertilizer is applied right under the ridge-top in the fall. Ridge-till should be sampled 6 inches to either side of the ridge-top and straight down into the ridge (Figure 2).

Fields with a history of large band applications of P and K are special problems, especially where within-field P and K levels are to be determined. When band rates greater than about 30 lb P_2O_5 or K_2O are used, there may be a residual effect of the fertilizer band for several years. If the bands can be located, they should be avoided when sampling. In North Dakota, high reproducibility of P levels has been achieved in grids or zones using eight to 10 soil cores where 20-30 lb P_2O_5 has been applied annually. For sampling whole fields, the 20 cores per field recommendation is appropriate.

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