

# **Soil Sampling and Testing**

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### Why soil test

Plants need adequate mineral nutrients to grow at their optimum rate. They obtain these nutrients by root uptake from the soil. This may be direct root uptake or through a symbiotic relation with mycorrhizal fungi that help extract nutrients from the soil.

When soils contain adequate levels of a plant nutrient, no addition of that nutrient is needed for maximum plant growth. However, when the concentration of a nutrient in the soil is below a critical value it will limit plant growth. When a soil is low in a nutrient, adding adequate amounts of the proper fertilizer can increase the soil content of that nutrient. When crops are removed from the land, plant nutrients are removed, and over time soil nutrient content will decrease, if not replaced through fertilization with mineral or organic fertilizers containing that nutrient. To maintain soil fertility, replacement of plant nutrients equal to the crop removal rate is recommended for soils near the critical level for that nutrient.

Soil testing is a tool that provides an index of a soil sample's plant nutrient content and pH. By correlating soil test index values with plant growth and health we learn how to properly lime soils and add plant nutrients to achieve and maintain optimum plant growth. When a soil contains an adequate amount of a plant nutrient, adding more by fertilization is a waste of money. Also, applying more nitrogen or phosphorus than can be used by the plants will result in poor water quality as these nutrients move into the ground and surface water. Excess nitrogen can show up as toxic levels of nitrates in well and spring water used in homes or for watering livestock. Excess phosphate can cause algae blooms in surface water that are detrimental to aquatic life in streams, lakes, and bays.

The WVU Soil Testing Lab's basic soil test measures the extractable soil phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) as well as the soil acidity (pH) and lime required to bring the soil pH to 6.5. Other tests can be requested at an additional cost (soil organic matter, copper (Cu), zinc (Zn)). Soil testing is a chemical analysis and does not evaluate a soil's physical properties such as poor drainage, droughtiness, or impervious layers due to hardpans or compaction.

The soil sample sent to the laboratory represents a much greater volume of soil in the field, lawn or garden. A one-pint soil sample, which weighs about one pound, taken from a one-acre field or

lawn (an area 209 feet square) represents about 2 million pounds of soil in that area. The soil sample must be representative of the area or the results will be meaningless. To ensure that the sample represents the soil that the plants are growing in, make sure that the soil sample:

- 1. represents a uniform area of land,
- 2. is not contaminated with lime or fertilizers in dirty sampling containers,
- 3. is not contaminated with soil from a small atypical area such as where manure or lime was piled or spilled,
- 4. is not contaminated with course plant material such as leaves or roots,
- 5. is taken to a depth reflecting previous tillage practices,
- 6. is taken when the soil is moist but not when it is excessively dry, wet, or frozen,
- 7. is not dried in an oven or hot sun,
- 8. is of adequate size, about 1-2 cups (0.5-1.0 pint) in volume.



Figure 1. Proper tools for soil sampling make the work easier: soil core sampler or probe (P) for taking soil cores, clean bucket (B) for collecting the soil cores, plastic glass (G) for grinding the cores, and a slotted spoon (S) for removing small rocks and course organic matter from the soil.

#### Use the right tools to take the sample

The best tools for taking a soil sample are the soil core sampling tube or auger (Figure 1). These tools are pushed (tube) or twisted (auger) into the soil to the proper depth to extract a small core of soil. A number of these cores are combined to provide a soil sample. Other tools such as a shovel or trowel can be used but require more time and effort. If using a shovel cut a "V" shaped hole to the desired depth in the soil. Then take a 1-inch slice down one side of the hole to the desired depth. Cut off the sides of this slice leaving a 1- by 1-inch column of soil as long as the desired depth. In a roto-tilled garden use a garden trowel to take several small samples to the depth of tillage to represent a bed in the garden.

## Pulling the soil core

Before pulling a soil core, move aside any organic surface debris to expose the mineral soil. Push the soil sampling probe (or twist the sampling auger) into the soil to the desired sample depth (Figure 2). Pull the probe out and put the soil core into a clean sample bucket or plastic bag.

When sampling a lawn, pasture, or hay meadow and the sod is too tight to see mineral soil, take the sample through the sod. There will be a cap of sod and roots on the top of the core. Do not remove this sod cap until crushing and preparing the sample (see below).

## Sample to the proper depth

Lime and fertilizer applied to the surface requires many years to move down into the soil. This movement of lime and fertilizer into the soil depends upon the amount applied, the activity of earthworms in the soil, the amount of frost action affecting the soil in winter, and how much time has elapsed since application. Lime and fertilizer can be physically incorporated into the soil by disking (shallow incorporation) or plowing/roto-tilling (deep incorporation). The depth that soil cores are taken to should be based on the crop and tillage management (Figure 2).

Depth of Sampling 0"	Permanent Pasture	Permanent Meadows	Tilled Cropland	No-till (2 samples)
2"				↓
4"				
6"				
8"				

Figure 2. Take soil samples to the depth representative of tillage management practices used in the field. Pastures and permanent meadows that are not tilled should be sampled to a 2-inch depth since fertilizer and lime are not incorporated into the soil. Tilled cropland should be sampled to a 6- to 8-inch depth while no-till crop land should be double sampled, one sample to a 1- to 2-inch depth and a second sample to a 6- to 8-inch depth.

It is important to take soil samples to the same depth each year if the samples are to be used to evaluate the effects of a nutrient management program over time. In permanent pastures, hayfields, lawns, and no-till cropland, nutrients are concentrated in the upper level of the soil and decrease with increasing depth (Figure 3). If a 2-inch sample is taken one year and a 6-inch sample taken in another year, the effect of soil depth on nutrient concentration will make it impossible to compare the samples with any meaning.



Figure 3. Nutrients in nontilled soils concentrate near the surface. To compare a field's soil samples from year to year it is necessary to sample to the same depth each time. For nontilled areas (permanent hay fields, pastures, and lawns) soil samples taken to a 2-inch depth best reflect the effect of lime and fertilizer management.

#### Sample management units

Soils are variable due to parent material, slope and slope position, drainage, and previous management. When taking soil samples we often think in terms of fields; however, it is best to subdivide fields (gardens or lawns) into management zones based on soil type, slope position, previous management, and expected future management (Figure 4). Areas not characteristic of a management zone should be sampled separately. For example, wet spots, eroded areas, and field edges should not be combined with soil representing the rest of the area. Do not combine soil cores from areas that were limed and fertilized recently with areas that were not treated. If the sample does not represent the area, then the lime and fertilizer recommendations will be inaccurate.

An example of the need to subdivide fields into smaller management zones is shown in Table 1. Samples 1 and 2 were taken from a slope on the north side of the field while samples 3 and 4 were taken on a level area at the foot of the slope, on the south side of the field. The slope on the north side has a higher soil pH and P status than the south side. On average the K status of the north side is the same as that of the south side. However, the west ends have high K while the east ends are low in K. If one average sample had been taken for the whole field, these differences in soil fertility would not have been measured.



Figure 4. Soil samples should represent management zones within a field. Take different samples from areas managed differently (A vs. B) and different samples from areas that have different slopes (B vs. C). Walk across each management zone and take soil cores at random.

Table 1. Analysis for soil test pH, phosphorus (P), and potassium (K) of samples taken from four
management zones based on soil slope and previous management, compared to the average
sample across slope, and the average across the whole field.

Sample	рΗ	Р	K
1 Northeast on slope	6.6	65	137
2 Northwest on slope	6.7	69	123
3 Southeast on flat	6.0	40	99
4 Southwest on flat	5.9	42	164
Avg. North side slope	6.6	67	130
Avg. South side on flat	6.0	41	132
Avg. Whole field	6.3	54	131

## Grid or precision sampling

An alternative to sampling management units is grid or precision sampling. In this system, soil cores are taken across a uniform grid over the farm (Figure 5). At each sample point, five soil cores are taken and the point is identified by its GPS coordinates. The five cores are combined and processed as a single soil sample. Each soil sample is analyzed and the values are entered along with the points' GPS coordinates. Computer software is then used to statistically average the variation in soil fertility across the grid of sample points (Figure 6). This analysis is used to construct maps showing the varying soil fertility over the field and maps of the variable fertilizer recommendations (Figure 7) across the field. The variable recommendation maps are used by the computer in a variable application spreader truck equipped with a GPS receiver to regulate the application of fertilizer or lime, supplying what is needed in any given part of the field.



Figure 5. In grid sampling a GPS grid is laid out over the field and at each established sample point five soil cores are taken and combined to make a sample representing that part of the field.



Figure 6. Grid sampling uses computer software to estimate soil fertility across the field based on the analysis of soil from each of the sample points.



Figure 7. Grid sampling provides variable recommendation maps that allow for the precision application of fertilizer and lime across the field using spreaders equipped with computers and GPS receivers.

## Take enough cores for each sample sent to the lab

A soil sample is composed of soil from several soil cores taken with a sampling tool, auger, or shovel. For management units less than 5 acres, take 10 to 20 randomly selected soil cores. For fields approaching 10 acres, take 20 to 30 cores. When appropriate, fields larger than 10 acres should be divided into smaller management units based on soil type, yield potential, and prior management. When using precision sampling, sample grid areas of 2.5 acres and take 5 cores per sample area. For lawns and gardens take 10-15 cores for each management area.

Taking a large number of soil cores never corrects for mixing soils from areas that should be sampled separately. Any sample area should represent a uniform soil type, yield potential, and past management. For example, take a hay field that had a winter feeding area at one end. Where hay was not fed, soil test K is 100. In the winter feeding area the soil test K is 400. If 15 cores are taken in the non-feeding area and 5 cores taken in the feeding area, the sample would come back indicating a soil test K of 175. This is a high soil test K when most of the field has a low soil test K. This may look like an extreme example, but is one found fairly frequently when doing precision sampling at the 2.5-acre scale. It only takes 2 years of concentrated winter feeding to raise the soil test K into the 400 index range.

#### Prepare the sample going to the lab

If the soil cores are too damp to crumble apart easily, dry them on clean paper in a cool dry place out of the sun. Do not oven or sun-dry soil samples as this will adversely affect the test results. Once the cores are adequately dry, place them into a clean plastic bucket. Gently crush and mix these soil cores using a clean, hard object such as the bottom of a plastic tumbler or smooth rock.

If a trace mineral analysis is going to be requested, do not use galvanized tools since they will contaminate the soil sample, making the analysis meaningless. Use a slotted spoon to remove stones and course organic matter from the soil sample. If the amount of soil is greater than that needed for submission, take a subsample of the thoroughly mixed soil.

# When to Sample

Soil samples should be taken in late summer or early fall since these samples will better represent the nutrient status of the soil that a growing crop encounters. Do not take soil samples when the soil is wet or frozen or shortly after applying lime, fertilizer, or organic matter. Only a little fertilizer or lime in a soil sample will give a very high analysis resulting in a non-representative analysis.

Soil samples should be submitted to the lab well in advance of needing the analysis. Allow 3 to 4 weeks for processing the samples. Samples sent to the laboratory between March and May take longer to process due to the number of samples being submitted to the lab at that time of year. Copies of the results are sent to local West Virginia University County Extension Agents, who will be pleased to discuss the results with you.

# **Frequency of Sampling**

The desired frequency of soil testing depends on the crop grown, when lime was applied, and the intensity of management. Land recently converted to cropland or garden may be tested every year until the proper fertility level is reached. The following testing interval is recommended:

- Permanent pastures and hay meadows every 3 to 5 years.
- Continuous row crops and alfalfa every 1 to 3 years.
- Crops in rotation every 3 years or once each rotation.
- Gardens every 2 to 3 years.
- New lawns after topsoil has been placed and final grading completed.
- Established lawns every 3 to 5 years.

## Fill out the sample submission sheet

Fill out the information sheet as completely as possible, including your name and address written legibly. Include as much information as possible. Other additional information or questions may be included in the remarks section. If you want an analysis for soil organic matter or trace minerals, list it in the remarks section. Use a separate submission sheet for each sample submitted.

#### **Submitting the Sample for Analysis**

Submit the prepared soil sample and completed submission sheet to your local county agent or mail them to:

Soil Testing Laboratory West Virginia University P.O. Box 6108 Morgantown, WV 26506-6108

The Soil Testing Laboratory, at no cost to West Virginia residents, will test soil samples for pH (acidity), lime requirements, and extractable phosphorus, potassium, calcium and magnesium. Upon special request for a small fee, the lab can test for other plant nutrients and soil organic matter. Contact the Soil Testing Lab for details on these services.

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