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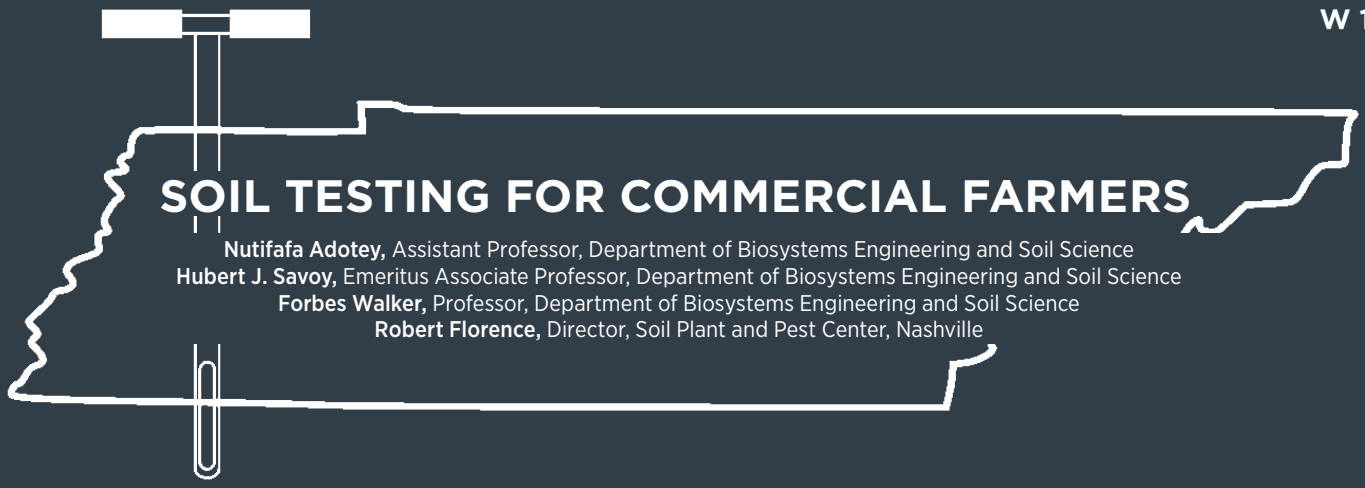

SOIL TESTING FOR COMMERCIAL FARMERS

Nutifafa Adotey, Assistant Professor, Department of Biosystems Engineering and Soil Science
Hubert J. Savoy, Emeritus Associate Professor, Department of Biosystems Engineering and Soil Science
Forbes Walker, Professor, Department of Biosystems Engineering and Soil Science
Robert Florence, Director, Soil Plant and Pest Center, Nashville

Soil testing is the only practical means to adequately evaluate the nutrient content of a field and to prescribe appropriate lime and fertilizer recommendations for a particular crop. The three Ps of soil testing—*productivity, profitability,* and *protection*—highlight the importance of soil testing. Growers who follow soil test recommendations can expect higher fertilizer efficiency and therefore optimum benefits from their lime and fertilizer investments. Soil testing should be the first step in planning a sound fertilization program. The guesswork of knowing how much lime and fertilizer to apply is eliminated with a soil test. If possible, use a state or regional soil testing lab such as the University of Tennessee Soil, Plant and Pest Center, which will be familiar with your local soils and crop yield responses to fertilizer. The University of Tennessee Soil, Plant and Pest Center recommendations are derived from research-based field trials conducted in Tennessee in order to avoid misleading results and/or interpretations for Tennessee growers.

THE CONCEPT OF SOIL TESTING

Soil testing is a multiple-step process that begins with collecting a soil sample that adequately represents the field and soil which is being tested. After the sample is submitted to the University of Tennessee Soil, Plant and Pest Center, or any other reputable soil testing laboratory, the next step is to estimate the potential plant available nutrients in the soil using modern chemical soil test extraction (step 2). In Tennessee, fertilizer recommendations are based on use of the Mehlich 1 (or double acid) extraction. Detailed information on how University of Tennessee (UT) fertilizer recommendation were developed can be found in UT Publication W795, University of Tennessee Fertilizer Recommendation Development. If you are using soil test analyses from laboratories that are using the Mehlich 3 soil test extraction, an initial calibration to Mehlich 1 is described in the UT Publication SP 763, UT Fertility Recommendations for Tennessee Row Crops. The third step is to predict the probability of obtaining a profitable crop response from the soil test results by using the most recent plot research to make each lime and fertilizer recommendation. All of these steps are equally important in order to accurately recommend lime and fertilizer applications. Levels of Mehlich 1 extractable nutrients present in the soil are determined in the laboratory, while crop nutrient needs and fertilizer responses in the major soil types across the state are determined at the University of Tennessee AgResearch and Education Centers. The University's soil testing program is geared to the crops and soils of Tennessee and serves as a vehicle for delivering the latest scientific information to individual growers. The emphasis of this publication is to provide guidelines for obtaining a reliable soil sample, submitting the sample, and selection of the appropriate analysis, and interpreting soil test results.

WHEN TO SAMPLE?

Soil samples can be collected at any time from September to November (fall) or March to April (spring). Some soil properties such as soil pH, phosphorus (P), and potassium (K), can vary depending on the time of sampling. Spring soil sample gives a more accurate picture of available plant nutrients. However, sampling in the fall or early winter

is a very desirable time because fields are usually drier but still have enough moisture to allow soil collection with a soil probe. Also, testing in the fall allows recommended rates of lime, phosphate (P) and potash or potassium (K) to be applied well in advance of spring planting. By sampling at approximately the same time each year, there is less seasonal variability when comparing soil test results with previous results from the same field. Soil nitrogen (N) is not routinely analyzed by the UT lab. Nitrogen fertilizer rates are made based on historical yield goals for the crop being grown in the field.

Soils should be dry enough to plant when sampling. If wet samples are collected, they should be air-dried before being packaged and mailed. Wet samples can dry into bricks and are difficult to grind prior to analysis. Samples sent soaking wet are not advisable for nitrate-nitrogen analysis as you may lose nitrogen from the sample. These samples should be air dried immediately after collection and before mailing to the lab.

SAMPLING TOOLS AND DEPTHS

Several types of tools can be used for collecting soil samples (Figures 1A-C). A uniform portion of soil is collected rapidly and accurately by pushing the tube into the ground to the desired depth and removing a soil core.

Figure 1. Collecting a soil sample with (A) vehicle mounted hydraulic soil probe, (B) a hand-held soil probe, and (C) drill mounted soil auger and auger bucket. Picture B by Hubert Savoy.

Remove organic debris, rocks and trash from the soil surface before collecting the sample. For determination of pH, phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), micronutrients (such as copper, zinc and boron) and organic matter, the recommended sampling depth at University of Tennessee is six inches (or 15 cm). Other agricultural soil testing laboratories may recommend a different sampling depth. Interpretation of P, K, and zinc soil test values and subsequent nutrient recommendations by the University of Tennessee are based on soil samples collected from a depth of six inches because research has shown that is the best and most cost-effective depth for conditions in Tennessee. For determination of soluble salts, sample within the rooting zone of the affected crop or the expected rooting zone if the sample is taken prior to crop establishment. For the corn pre-sidedress nitrate-nitrogen test, collect samples to a depth of twelve inches (or 30 cm).

Sub samples for each composite sample should be placed in a clean container (not zinc-coated if determining Zn) and mixed thoroughly. Then, remove enough soil to fill a sample box. Soil sample boxes are available at all University of Tennessee Extension county offices. When sampling for nitrate-nitrogen, the sample should be air-dried thoroughly within 36 hours to obtain the best results.

HOW OFTEN SHOULD SOILS BE TESTED?

The following general guidelines may be used to determine how often soils should be tested. However, the frequency can vary depending on cropping intensities, soil types, fertilization rates, tillage methods, weather conditions and new research findings.

1. Continuous Row Crops (conventional) — *every two to three years.*
2. Double-cropping Systems — *every two years.*
3. Continuous No-till Soybeans (only) — *every three to five years.*
4. Continuous No-till Corn or Cotton — *every two years.*
5. Hay Systems — every two years.
6. High-value Cash Crops (tobacco, vegetables) — *annually.*
7. Pasture Crops — *every three to five years.*
8. Any time a nutrient problem is suspected.
9. At the beginning of a different cropping rotation.

THE SAMPLING METHOD

Soil test results are no better than the sample collected. Thus, a good rule of thumb for soil sampling is to collect samples in a way that adequately represents the soil in that field. Hence a systematic sampling method is necessary to accurately access soil fertility needs. A well represented sample will depend on the sampling method employed. The commonly used sampling methods include the composite/whole field, the grid, and the zone.

Composite/Whole Field Method

The composite method is the conventional method where fertilizer recommendations are based on sample averages. On the plus side, this method is relatively affordable because of the small number of samples, but, on the negative side, it does not provide much information on spatial nutrient variability. With this method, a composite sample consisting of small portions of soil taken from approximately twenty locations (subsamples should be collected in a zigzag pattern from an area not to exceed ten acres (Figure 2). Areas of contrasting soils, problem spots, areas under different management within the same field, or portions of fields where crop response is significantly different should be sampled separately, provided the area can be fertilized separately. For example, if a small portion of a larger field had been used to produce a crop with vastly different fertility, like tobacco, then it should be sampled separately. Other examples would include old home sites, areas of animal confinement or where fence rows were removed to make a larger field.

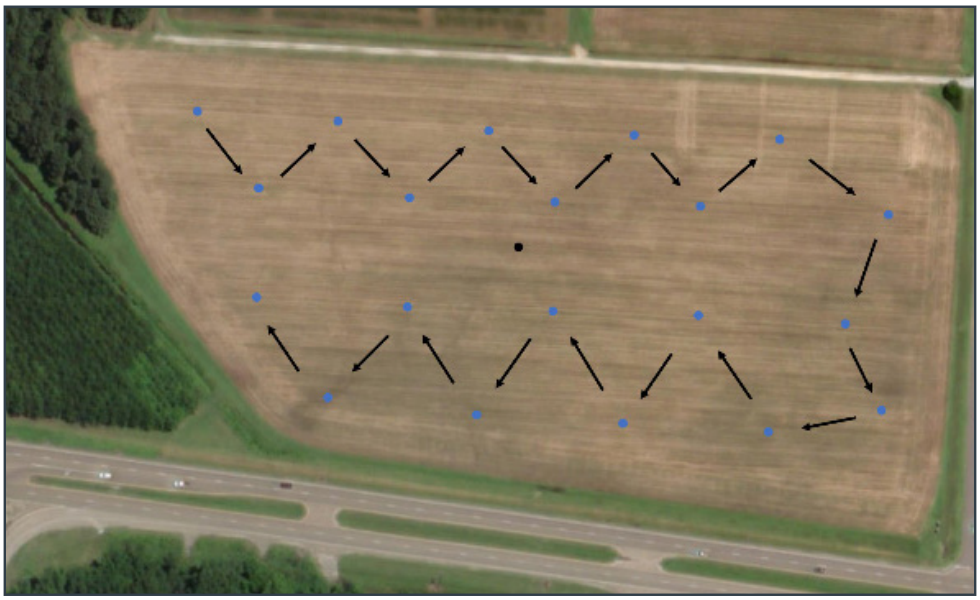

Figure 2. Composite Method. Subsamples are collected in a zig-zag pattern.

Grid Method

This approach works well for variable-rate applications of lime and fertilizer within the field. It's the most expensive soil sampling method. This is an example of grid sampling where the field is divided into approximately equal squares. The sample in each block consists of six or eight cores taken within a 60-foot radius from the sampling point. A widely used method is to grid fields into two and a half or five acres. It does require more intensive sampling, which increases costs (Figure 3a and 3b). The advantage is that spatial variations in soil nutrient needs are more likely to be detected.

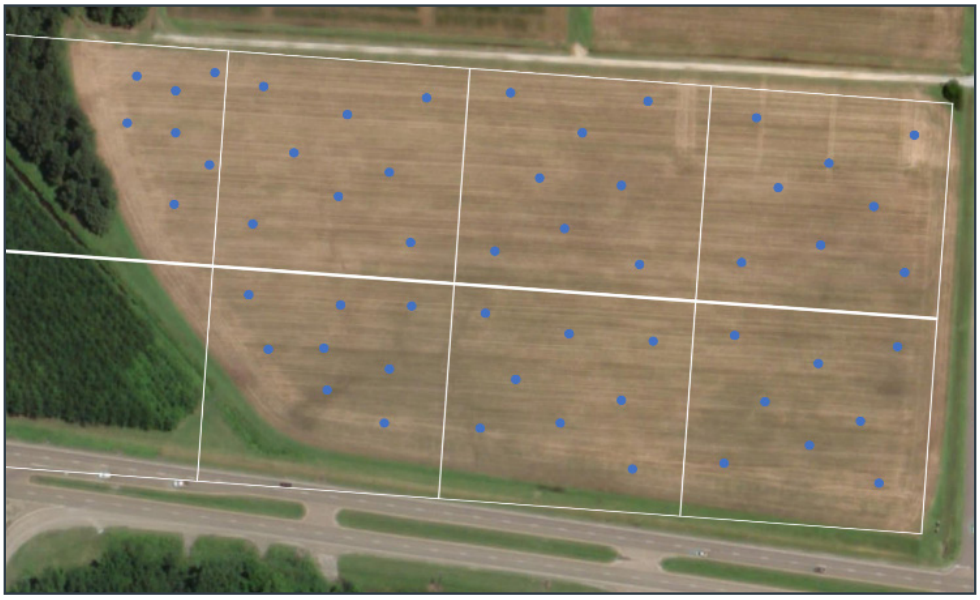

Figure 3a. An example of 2.5-acre grid sampling with sampling points within the grids.

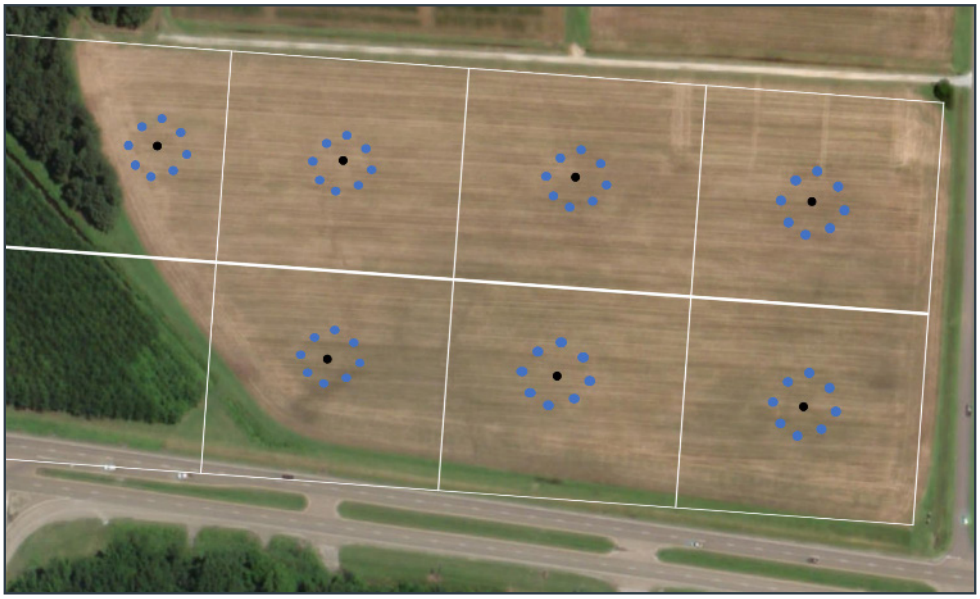

Figure 3b. An example of 2.5-acre grid sampling with sampling points around grid points.

Zone method

This is a hybrid approach which combines the principles from whole fields and grid approach. Zones are developed based on knowledge about the field such as soil type, past lime and fertilization histories, yield maps, that show consistent variation in yield, soil management practice (Figure 4).

Figure 4. Zone method. The different management zones depicted by the lines. Subsamples are collected from each zone and composited together.

LABORATORY TESTS AND FEES

The University of Tennessee Soil, Plant and Pest Center is located at the Ellington Agricultural Center in Nashville, Tennessee. It is equipped for routine soil analysis to make lime and fertilizer recommendations and offers its services to all Tennesseans. Currently, the laboratory uses the Mehlich 1 (or Double Acid) extractant for nutrient determinations and a buffer for determining lime requirements.

Routine tests for other nutrients are not offered for two reasons: First, UT research and field trials did not show a crop response to their use, and, second, recommendations are made more accurately based on soil conditions and specific crop needs.

SELECTING THE PROPER TESTS

Most crop fertilization problems in Tennessee are associated with the lack of and improper use of nitrogen, phosphorus, potassium and lime. Therefore, the greatest need for soil test information arises from these four variables. The need for secondary and micronutrient soil tests is much less since research and demonstrations indicate that responses are limited to certain crops and soil conditions. Selected situations where the various soil tests are most likely needed are shown in Table 1. Tests desired for each sample must be indicated on the sample information sheet.

PRE-SIDEDRESS NITRATE-N SOIL TEST

The laboratory offers a special soil test, the pre-sidedress nitrate-N soil test (PSNT) for nitrate-nitrogen to assist with nitrogen management decisions in corn production systems. In Tennessee, the PSNT is calibrated only for corn production and is recommended only for producers using animal manure, poultry litter or biosolids. Detailed information on sample collection and processing procedure are described in the UT publication BESS #105, "The Pre-Sidedress Nitrate-N Soil Test (PSNT) For Nitrogen Management in Corn Production Systems of Tennessee." Interpretation of the PSNT in Tennessee is made based on yield potential of the field, soil test nitrate level and field history.

GREENHOUSE CONTAINER MEDIA

A saturated paste extract is used in analyzing the nutrient levels in greenhouse or potting media mixes. To have enough extract, we need one-half gallon of media. Additional information is available at UT Soil, Plant and Pest center website at https://soillab.tennessee.edu.

SOIL TEST REPORT

Results of each soil test and corresponding recommendations are printed by computer and emailed and/or mailed to the grower. In addition, a copy of each report is retained by the laboratory, and one copy is sent to the grower's county Extension office. Each nutrient tested is reported in pounds per acre and assigned a soil test rating. The ratings for phosphorus and potassium are low (L), medium (M), high (H) and very high (VH). The secondary and micronutrients tested are rated as either sufficient (S) or deficient (D). Interpretations of ratings are printed on the back of the soil test report form. Some other labs may report nutrients tested in parts per million (ppm). For a 6-inch soil sample parts per million (ppm) can be converted to pounds per acre by multiplying by two. Recommendations for field crops are reported in pounds of plant nutrients and tons of agricultural limestone to apply per acre.

INFORMATION SHEETS AND SAMPLE BOXES

Information sheets, soil sample boxes, and sampling instructions can be obtained from your local UT Extension office or online at https://soillab.tennessee.edu. These materials provide necessary information and guidelines for collecting and mailing samples to the laboratory. When filling out information sheets, please be as complete as possible. For each sample name listed in the left column of the form, you may request up to four recommendations. Use the UT crop codes listed on the second page of the information sheet to determine the appropriate codes to list under the "Crop" column. If your crop is not coded or if you are uncertain about which code to choose, list the name of the crop in place of a code. If there are no crop codes, then no recommendations can be given. Soil sample boxes should be labeled properly with identifications corresponding to those shown in the sample ID box on information sheets. Please be sure to put your name or company name on all boxes. Please keep sample IDs simple and legible. Last names, numbers and simple descriptors or GPS coordinates are common. Examples are Smith 1, Field 2, NW corner.

Table 1. Guidelines for Using Laboratory Test Results.

Test	Crop	Location	General Conditions
Nutrient Test	All	This test is suggested for all production systems, crops, lawns and gardens for developing and maintaining fertilization programs.	
Calcium (Ca)	Tomatoes, Peppers, Eggplant, Watermelon	Vegetable-producing areas	Sandy or light-textured soils. Where blossom-end-rot is an annual problem.
Magnesium (Mg)	Tomatoes, Tobacco, Cabbage, Grapes	Cumberland Plateau, Highland Rim	Sandy or light-textured soils. Magnesium deficiencies in each of these crops may be induced by excessive amounts of potassium or ammonium fertilizers.
Zinc (Zn)	Corn, Snap Beans	Cumberland Plateau, Middle Tennessee	When soil pH is above 6.0 or lime is applied and phosphate is high.
Iron (Fe)	Ornamentals (only)	Isolated or problem areas	High soil pH.
Manganese (Mn)	Soybeans	Isolated or problems areas	Sandy or light textured soils with a pH above 7.0.
Boron (B)	All	All	All
Soluble Salts	All	Isolated or problem areas	Excessive fertilizer rates
Pre-sidedress Nitrate-N	Corn	The nitrate-nitrogen test is offered to assist with nitrogen management decisions in corn production systems, especially when manures are being used.	
Others listed in Table 1 or online	All	Problem-solving in trouble fields/Provide basic information/Other	

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