Chapter 2: Soil Testing for Berries– *Ms. Janet Fallon, DairyOne*

What does a soil test measure?

A soil test is a process using chemical analyses to assess current nutrient levels in soil. Elements (phosphorus, potassium, calcium, magnesium, sodium, sulfur, manganese, iron, copper, aluminum and zinc) are chemically removed from the soil and measured for their "plant available" content within the sample. A soil test also measures soil pH, humic matter and exchangeable acidity. These analyses indicate whether lime or sulfur are needed to change the pH, and, if so, how much to apply. Components of soil testing include field sampling, extraction and chemical analysis, interpreting analytical results and making a fertilizer recommendation based on those results.

Why do I need to soil test and when?

As indicated in chapter 1, soil health management does not end once the plants are in the ground. Post-establishment soil and nutrient management is also important to successful berry crop production.

This includes periodic soil testing (every three years or so) in conjunction with foliar analysis to monitor plant nutrient status, pH monitoring and/or adjustment as needed to maintain nutrient availability for good plant nutrition, and addition of amendments such as fertilizers and/or compost side dressings to maintain fertility.

What are the benefits of soil testing? Think of soil testing as a crop management tool to be used both preplant and post-plant to optimize crop yield and quality. Much like the hand lens you may use to scout for diseases and insect pests, a soil test can provide an early warning that potential problems may be looming on the horizon. It also provides advisement on how to address potential issues once they have been identified, such as soil pH

Continued below.

modification and required fertilizer inputs. In the same fashion, soil test results may indicate all is well and no action is needed at this time. Thus costly over or under fertilization may be avoided maximizing profitability. In addition to avoiding costly over fertilization, soil testing may also be considered as an environmental protection tool, preventing introduction of excessive nutrients into the ecosystem.

A word about soil pH

Figure 4 shows the relationship between soil pH and nutrient availability in soil. Most nutrients are highly available around the middle of the pH range (7.0). Iron is an exception, becoming more available with lower pH. Most berries prefer a well-drained sandy loam at a pH of 6 .2 to 6.8, and an organic matter content of >3%. A good alfalfa soil would be suitable for strawberries or raspberries. Blueberries on the other hand prefer a loamy sand with an organic matter content of >4% and low P; they perform best at a pH between 4.2 and 4.8. Blueberries and cranberries typically thrive in poorer low cation exchange capacity (CEC) soils (<18). Iron deficiency in blueberries is often an indication pH is too high in the planting.

Poor sample = crummy results!

Soil and nutrient testing is often last on the priority list for berry growers and as a result sampling may done in a haphazard fashion if and when time permits, often by someone drafted for the task that is not familiar with it. How you take a soil sample determines the accuracy and repeatability of the soil test. It also determines lime and fertilizer requirements for the planting which, in turn, plays a role in optimizing yield and fruit quality. Avoid costly over and under fertilization errors by taking the time to collect clean, representative soil samples.

Routine vs. diagnostic soil testing

Use routine soil analysis to get lime and fertilizer recommendations for establishment or maintenance of a berry planting where no known history of fertilizer problems exists.

Diagnostic analysis is suggested when a nutrient imbalance is the suspected cause of poor crop performance and/or foliar symptoms. Collect paired samples from “good” and “bad’ areas of the field to confirm a problem. Consider adding a soluble salts test to the standard soil test package in this case. Use plant tissue analysis in conjunction with a diagnostic soil analysis to further assist in the diagnosis.

Collecting soil samples

Establishing a sampling schedule

Many Ag educators frequently receive panicked “after-the-fact” soil and nutrient management questions in cases where growers planted first and asked questions later. To best utilize this crop management tool it is important to establish a routine sampling schedule for berry crops, starting before planting establishment.

Soil testing should be done preplant; at minimum one year prior to blueberries and 6 months prior to other berries. This is critical because growers need to allow adequate time for added lime or sulfur to react with soil when remediating pH levels. Once berry crops are established, testing should be repeated every 2-3 years or as needed for troubleshooting. Post-establishment soil testing is often conducted in conjunction with plant tissue testing to determine what’s in the soil as compared to what’s getting into the plant. Periodic soil testing is also useful to determine fertilizer needs for permanent row middle cover crops.

Pick a time for routine soil sampling (spring or fall) and stick with it, rather than testing at various times during the year. Fall is the most reliable time of year to consider for several reasons:

- Soil pH determination is more reliable when soil is moist
- Seasonal fluctuation of soil pH occurs when soils dry out in mid-summer causing an increase in salt concentrations. This allows Ca^{++}, Mg^{++}, and K^{+} to replace H^{+} and Al^{+++} on the soil surface. The extra H^{+} and Al^{+++} in the soil solution will temporarily decrease soil pH hence pH determination is more reliable in fall when soil moisture is a bit higher.
- Fall sampling allows time to apply needed lime and fertilizer before spring establishment.
- Fall sampling and subsequent application allows time for lime or sulfur to react with soil.
- Leaf sampling for tissue analysis is typically done at the same time in late summer/early fall.

Using the right sampling tools

What tools of the trade are needed for soil sampling? It depends in large part on soil conditions and soil types that need to be sampled.

Use stainless steel probes for best results in sampling. This prevents iron contamination from rusting tools such as non-stainless steel shovels and/or trowels. For the same reason plastic pails are preferable to galvanized for holding and mixing subsamples to prevent zinc contamination.

A stainless steel soil probe is faster to use than an auger in soils with fewer stones or gravel; it is also easier on your back. A slit sided probe with a foot peg is a good place to start. A lubricant such as WD 40, PAM, Dove dish soap, or silicone may be used to prevent plugging of probe unless a micronutrient deficiency (Fe, Zn, Mn, or Cu) is suspected. A probe works best in dry soils with few rocks; in wet soil conditions a probe pushes wet soil down and rocks plug it up. Soil probe prices range from $50 to $1,000 for standard soil test probes or kits; more for automated sampling devices.

Sources for Soil Probes and Augers

- **Oakfield Apparatus** www.soilsamplers.com
- **Gemplers** http://www.gemplers.com
- **Graingers** http://www.grainger.com
- **Ben Meadows** http://www.benmeadows.com
- **Amazon** http://www.amazon.com

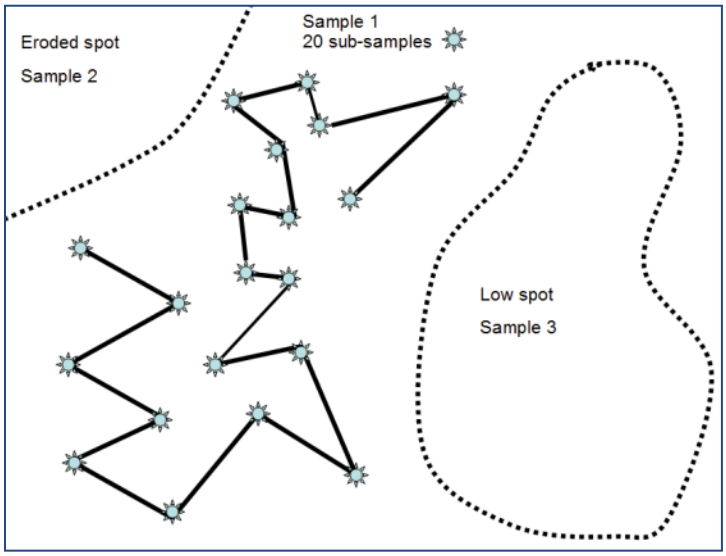
Augers work best for rocky or wet soils, or when sampling eroded knolls. Wet soils tend to stick to auger flights as they do soil probes but samples are better able to be collected using an auger. A plastic container (i.e. a pint freezer box) with a hole drilled in the middle collects soil as auger pulls it out of the ground. A power drill may be attached to the auger which speeds up the process if a lot of samples are being collected.

Shovels or spades, providing they are of stainless steel in construction, are OK for occasional use in soil sampling. However, when using these implements, you will need to “trim” edges as the wedge –shaped samples they collect are not representative. This makes it slower and tougher to get a good sample using these tools verses a probe or auger. When large numbers of samples are required, an automatic sampler should be considered. These are gaining in popularity with precision agriculture; they are most consistent in untilled sites and for deep sampling. Hand probes are best for the shallow sampling needed in berry plantings.

Sampling techniques

How do I decide what my sampling area should be? Sample each management area separately, especially problem areas with a suspected nutrient imbalance. For precision agriculture it is recommended that growers take one sample per acre; realistically smaller growers take one sample for each 4-5 acres.

How do I decide where to take my subsamples? Identify the sampling area or management area to be tested. Then take subsamples in a zigzag pattern in each management area. Grid sampling can be a good tool but can be very expensive and time consuming when done properly. "Directed" sampling based on topography may be more meaningful on smaller acreages. Here are some rules:



- Avoid unusual areas such as dead furrows, farm lanes, old hedge rows or fence lines, old manure, lime or burn piles, wet or severely eroded areas.
- Take separate samples from areas within the field that vary widely in color, slope, soil texture, drainage, productivity or crop history.
- Avoid sampling immediately adjacent to drip tape.

How many subsamples should be taken? "The more the better" to get an accurate and representative sample for the management area. In general, collect 8 to 10 subsamples on area of <2 acres; collect 10 to 20 subsamples on an area > 2 acres (between 2-3 subsamples per acre).

How deep should I sample? The rooting depth for most berry crops falls within the surface 0 to 8" of soil. It is also important to note that Cornell berry crop recommendations are based on this 0-8" sampling depth. So whether you are collecting samples for a preplant recommendation or established stand, be sure to sample to an 8" depth. Once you have the preplant recommendations, also be sure to plow down suggested amounts of lime, sulfur and/or nutrients to the same depth then disc. *(Left: proper soil sampling depth for berry crops. Photo source Ohiowine and more http://www.ohiowineandmore.com/)*

Taking the subsamples and preparing the final sample(s) for submission. Avoid sampling under extremely wet soil conditions. Samples usually leak in transit; moreover some nutrients undergo rapid biological transformations in very wet soils. Be sure to discard the organic "matt" (1-2") on top of the subsample along with any soil in the subsample below the 8" depth when collecting subsamples. Mix subsamples completely in clean plastic pail or bag; if subsamples are muddy, air dry before mixing. Remove large stones and break up large clods before mixing sample thoroughly. Air dry samples in a thin layer on a clean (plastic not metal) surface; fan assisted drying is acceptable, but heat assisted drying is not.

Complete **all** of the required information on the sample box before filling and make sure it matches the information on the sample information sheet; fill out the sample information sheet **completely.** Keep a copy for your own records.

Place about ¾ to 1 pint (roughly 2 cups or less) of the mixed sample in the box or bag provided by the lab and close it securely. Avoid using commercial bag or boxes; the glue for these has been found to contain Boron and may alter test results especially if sample is wet.

If using the Dairy One lab (http://www.dairyone.com/) for soil testing, fill out Form F for Commercial Fruit. You must provide a valid soil name to get a fertilizer recommendation. If you do not know the soil name for the management area you are testing, you may find it from a variety of sources listed below, including Web Soil Survey, an on line mapping tool. Instructions for using this tool are provided in Appendix A.

There are places on the form to include previous cropping history, and designate the future crop (preplant). Write legibly.

Types of Soil Tests

- **Bray 1** – acid/neutral soils of North Central USA
- **Mehlich 3** – works well on a broad range of soils
- **Olsen** (bicarbonate test) – used in alkaline soils of the western US
- **Morgan** – developed for acid soils in the northeast; uses sodium acetate.
- **Modified Morgan*** – Morgan with improved micronutrient extraction using ammonium acetate.

*Agro-One standard test

Ship the sample to: DairyOne, 730 Warren Road, Ithaca, NY 14850. Free pickup, shipping and handling may be available; visit the web site for details: www.dairyone.com. **Other soil testing services exist throughout the Northeast (see page 22).**

Soil test options

Comparing one lab to another is not a good idea in terms of uniformity and consistency of test results; different labs use different extraction procedures giving different numerical results and subsequent recommendations. Soil test options include: Olsen, Bray 1, Mehlich 3, Morgan, and Modified Morgan. Each type of test measures a different amount of P and K depending on the extractant chemical used for the test. Fertilizer recommendations are then based on field rate and response studies calibrated against the P and K determined by the soil test.

Resources for Determining Soil Names

- **Official Soil Series Descriptions (OSD)** http://soild.usda.gov/technical/classification/osd/index.html
- **Web Soil Survey** (mapping tool) http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm
- **iPhone app** http://itunes.apple.com/us/app/soil-web-for-the iphone/id354911787?mt=8
- **County soil map** your local CCE office
- **SoilWeb app for iPhones and Droid phones** http://casoilresource.lawr.ucdavis.edu/drupal/node/902
  This application retrieves graphical summaries of soil types associated with the phone's current geographic location. Sketches of soil profiles are linked to their official soil series description.

Sufficiency "values" (ppm or lb/A) are specific to the extractant used; thus they vary between test types. Test results provide an index of availability and crop response. In general, those falling in the low to very low range, if remediated, are likely to see a crop response with nutrient addition. Those falling in the optimal range are likely to see a marginal crop response; those in the high to very high range are unlikely to see a crop response.

Cornell Nutrient Analysis Lab ranges for Dairy-One soil tests are slightly more delineated. Nutrients in the very low range (below optimum) indicate the nutrient level or pH is sufficiently low to require extra inputs of lime or fertilizers. Low range (below optimum) indicates the nutrient level or pH is below normal and higher than normal fertilizer rates are required for maximum economic yields. Medium (optimum) range suggests the nutrient level or pH is sufficient for normal fertilizer and lime rates to produce maximum economic yields. High range (above optimum) indicates the nutrient level or pH is adequate for economic yields. And finally, excess (above optimum) indicates the nutrient level or pH is too high and may either cause plant injury or interfere with the availability or uptake of other nutrients. For some nutrients an excess will also increase the probability that the nutrient will contribute to pollution.

Boron testing

Most soil tests do not routinely include boron. A hot water soluble boron test is offered in addition to the standard soil testing for a small additional fee through either the Dairy-One lab or in conjunction with the Cornell soil health test (more on this test in chapter 8). Boron testing is highly recommended for berries and other crops as it plays a role in root development and elongation and is often deficient in northeastern soils.

Boron uptake is sensitive to pH, especially in blueberries; if pH is too high, boron may not be taken up by plants. In this instance, test results will indicate sufficient levels of boron present in soil while leaf test results indicate a deficiency; pH adjustment usually results in improved boron levels in leaves without additional boron amendment. Boron will be discussed in more detail in subsequent chapters.

University-related Analytical Labs

- **Agro-One Agronomic Laboratory http://dairyone.com/analytical-services/agronomy-services/about-agro-one/ and Cornell University Nutrient Analysis Laboratory http://cnal.cals.cornell.edu/**
- **University of Delaware Soil Testing Program http://ag.udel.edu/dstp/**
- Michigan State University Soil and Plant Nutrient Laboratory http://www.spnl.msu.edu/
- Penn State Agricultural Analytical Services Lab http://agsci.psu.edu/aasl
- Rutgers Soil Testing Laboratory http://njaes.rutgers.edu/soiltestinglab/
- University of Connecticut Soil Nutrient Analysis Laboratory. http://www.soiltest.uconn.edu/
- **University of Maine Analytical Laboratory and Sol Testing Service http://anlab.umesci.maine.edu/**
- University of Maryland
- UMass Amherst Soil and Plant Tissue Testing Laboratory http://soiltest.umass.edu/
- University of New Hampshire Soil Testing http://extension.unh.edu/Problem-Diagnosis-and-Testing-Services/Soil-Testing
- University of Vermont Agricultural and Environmental Testing Lab http://pss.uvm.edu/ag_testing/
- Rhode Island
- West Virginia University Soil Testing Laboratory http://soiltesting.wvu.edu/

Commercial Analytical Labs

- Spectrum Analytic (Ohio) http://www.spectrumanalytic.com/
- Logan Labs (Ohio) http://www.loganlabs.com/

How do I select which lab to use?

Select a lab that offers procedures and guidelines that are appropriate for your region and your soils. Do not use test results from one lab or procedure and sufficiency ranges from another lab or procedure.

Also use caution in comparing one lab to another even when they use the same extractant; there will be some lab-to-lab variability for the same procedure including: weigh vs. volume (in terms of test sample size), use of ICP phosphorus (P) tests vs. colorimetric P tests, soil to solution ratios used, shaking time for samples in extractants, types of grinders used to process samples.

Summary

The most important part of the whole puzzle in terms of soil testing and soil fertility for any berry crop is getting soil pH to the right level for optimum crop performance before planting, and keeping it there. Soil testing is required for optimum yield and quality of berries; sample technique is key- garbage in, garbage out!

Soil sampling checklist:

- *Establish a sampling schedule*
- *Use the right sample tools*
- *Sample at the correct depth*
- *Take enough subsamples*
- *Air dry, mix & ship to lab in box/bag provided from lab*
- *Select the appropriate service*
    - *Routine or diagnostic*
    - *Morgan/Modified Morgan/Mehlich 3*
- *Use the correct sufficiency ranges for the lab and services selected*
- *Follow up every 2 to 3 years with subsequent soil testing and tissue analysis*

Additional Resources

1. *Magdoff, F. and van Es, H. 2009. "How good are your soils?" Chapter 22 in Building Soils for Better Crops: Sustainable Soil Management, 3rd edition. Sustainable Agriculture Research and Education (SARE) program handbook series no. 10. 294 pp.*
2. *Pritts, M. 2012. Site and Soil Requirements for Berry Crops: http://www.fruit.cornell.edu/berry/production/pdfs/sitesoireqsmfru.rev.pdf*