Soil Testing: Getting a Good Sample

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Soil sampling is an important step in getting the right fertilizer rate, which can increase yield and/or save on fertilizer costs, and decrease environmental risks. The worth of soil testing depends on:

- selecting a sample representative of the field, which includes choosing the right sampling time and location,
- correct sample handling,
- the quality of the diagnostic lab testing the soil, and,
- providing a realistic yield goal for the lab to base fertilizer rate recommendations.

See The Soil Scoop *Feeding the Vegetable Garden* for home garden soil testing information.

TIMING

In Montana, soil sampling is often conducted from late summer to late fall because of better soil sampling conditions than in winter or spring. Fall sampling also provides more time for growers to make fertilizer decisions prior to application.

MSU fertilizer rate guidelines are based on spring rather than fall soil test levels because spring levels are more indicative of growing season available nutrients than fall nutrient levels. If soil nutrient levels are substantially different between fall and spring, then fertilizer would be either over- or under-applied. While phosphorus (P) and potassium (K) levels have not been found to change much between fall and spring, nitrogen (N) in the form of nitrate can change dramatically. Over-application is an economic loss and excess nitrate may contaminate groundwater. Under-application of N may cause sub-optimal yields and grain protein.

Unfortunately, early fall to spring nitrate changes are highly variable and hard to predict. A 3 year study at each of the 7 MSU Agricultural Research Centers and at the Post Farm in Bozeman, found N fertilizer would be over-applied by an average of 18 lb N/acre if August samples were used to make spring N recommendations. But, 1 in 3 times, it would be under-applied, and sometimes by a lot. The large range suggests that late summer or early fall soil samples may not accurately determine spring fertilization N rates.

In general, soils gained nitrate from August to April, especially following annual legumes and oilseeds. However, some soils lost nitrate from August to April. Shallow soils and those with high end-of-summer nitrate levels, had a greater chance of losing nitrate than deep soils with low end-of-summer nitrate levels. Most of the soil nitrate gains occurred from August to November. Fresh residues, warm soils in late summer and fall, and summer or fall rains would encourage plant decomposition leading to increased available N. However, this N can be lost, especially in shallow and/or coarse soils.

Overall, nitrate changed less from November to April, likely because microbial activity and downward water movement were decreased due to frozen soil. Therefore, sampling in late fall to mid-spring is recommended to best capture growing season N availability.

If fall fertilizing is preferred, soil test as late as possible while still allowing time to receive test results before fertilizing. If fall nitrate levels are very high (e.g., greater than about 60 lb N/acre) and soil depth is less than two feet, a second sampling in spring is strongly suggested because there is a higher likelihood of overwinter nitrate losses.

Although it may seem wasteful to soil sample twice, lab soil N analyses often cost around $5. Under or over applying by just 10 -15 lb N/acre can affect your bottom line more than this for a 160 acre field. Consider both fall and spring sampling a few times to get an idea of overwinter N changes to guide future adjustments of fall samples to determine N fertilizer rates.

LOCATION

Whether to submit samples based on grid sampling or from different zones in the field depends on the field history and diversity. Grid sampling is good for fields with a history of manure or high fertilizer levels (especially P and K), and small fields merged to form a larger field. Zone based sampling is suggested for fields with

unknown or long cropping history, historically low levels of fertilization, no manure applications, and high with-in field variability or a relationship of yield to landscape. Zone sampling may require fewer samples, therefore less cost than grid sampling, but may take more planning time. Keep records of sampling locations and timing.

DEPTH

Depth depends on the soil characteristic being tested and intended land use (see The Soil Scoop *Soil Testing: Once You Have the Sample*). Pasture and forage get sampled to 12-inch depth, and annual crops to 6-inch for most characteristics and at least to 2-foot depth for N. Sampling to 2 feet will almost always require a hydraulic mounted probe truck.

If it is not possible to get a 2-foot sample, the 2-foot nitrate-N can be estimated from the 6-inch nitrate-N. In a random sample of 16 fields from 7 farms, soil lb N/acre in the 2-foot profile contained from 1 to 7 times the lb N/acre in the top 6-inch profile. The average was 2.7, meaning one could multiply the top 6-inch nitrate-N by 2.7 to estimate the 2-foot nitrate-N. Given the variability, 2-foot sampling would be better.

If deep soil nitrate is not taken into consideration, then N available to the plants can be greatly underestimated and N will be over-fertilized at a financial and environmental cost.

NUMBER

The number of subsamples to composite for the sample to send to the lab depends on the variation within the 'zone' and the soil attribute (e.g., N, pH, P, organic matter) of most interest. Phosphorus tends to vary highly across space, while K does not. Ten subsamples per composite sample is a reasonable average. More subsamples require more time, but improve accuracy.

SAMPLE HANDLING

- Remove surface residue from sample location.
- Composite and thoroughly mix the subsamples to get a single sample per depth from a relatively homogenous field.
- Store samples below 40°F or dry at 110-120°F to stop microbial activity which changes soil nutrient levels.
- Deliver or over-night ship to lab. Multiple studies have shown large increases in soil nitrate occur within a soil bag in just 3 days, unless frozen.

LAB SELECTION

Use a reputable lab that uses regionally appropriate tests. For example, soil P levels in Montana soils are best tested with the Olsen rather than Bray or Mehlich tests, which are not suitable for soil pH > 6. Also, Montana's P fertilization guidelines are based on Olsen P values.

Ask if the lab is enrolled in a 'proficiency' testing program. If so, they can give you data showing how their test results compare to averages for a specific 'standard' soil, to help you pick a reliable lab.

If a lab is reliable, stay with the same lab in subsequent years, because soil test results and recommendations can vary greatly among labs. Follow yearly trends in soil nutrients, especially for P and K. Currently there is no reliable test for soil sulfur in Montana.

If a lab provides fertilization recommendations, know whether they are based on a 'sufficiency', 'maintenance', or 'build' approach. MSU fertilization recommendations are based on the 'sufficiency' approach – the minimum amount necessary to maximize yield, and generally economic return, in most years. In contrast, a 'maintenance' approach replaces those nutrients removed by harvest, without substantially changing the soil test level, while the build approach often adds sufficiency rates and maintenance rates.

The Soil Scoop *Soil Testing: Once You Have the Sample* offers a list of items to check after the soil sample is collected and before the sample gets sent to the lab.

SOIL HEALTH TESTS

These can be valuable to assess management, but standardized methods may not yet be in place and calibration is lacking between test results and appropriate fertilizer requirements. Soil health testing is discussed in The Soil Scoop: *Evaluation of Soil Quality and Health*.

For more information:

MSU Extension publications at http://landresources.montana.edu/soilfertility/publications.html

Soil Sampling Strategies

Interpretation of Soil Test Reports for Agriculture

MSU Nutrient Management Module at http://landresources.montana.edu/nm/index.html

Soil Sampling and Laboratory Selection

The Soil Scoops at http://landresources.montana.edu/soilfertility/soilscoop.html

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