Soil Sampling Guidelines for Immobile Plant Nutrients

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Crop nutrient recommendations are derived from laboratory tests performed on representative soil samples. The objectives of soil testing are:

1) Provide an index of nutrient availability for crop growth
2) Predict the probability of a profitable response to the application of lime and fertilizers
3) Provide a basis for lime and fertilizer recommendations
4) Monitor the nutrient status of fields/subfields over time

Obtaining soil samples that represent a field or subfield in question is vital for achieving the objectives stated above. Thorough sampling is critical to the accuracy of soil test results. Soil samples submitted to the laboratory represents an extremely small portion of the total soil. For example, a one half pound sample obtained from one acre is only .000025 percent of the total amount of soil in an acre furrow slice. Consequently, soil sampling represents a large potential source of error associated with soil testing regardless of the sampling methods used. Inherent soil properties, due to soil forming processes, are known to influence nutrient availability directly and indirectly due to the soil's impact on crop yield and nutrient removal. On this basis, traditional guidelines for obtaining representative soil samples consisted of dividing a field into areas of similar soil types/topography and management and randomly taking subsamples to be mixed to create a composite or bulk sample for laboratory submission.

Site specific technology such as incorporating the use of GPS, geostatistical mapping software, aerial and satellite photography, and yield monitors and computer assisted guidance systems enabled crop advisors to observe the high degree of nutrient and yield variability present in most fields. The variability is present even within fields that are visually uniform. The technology revealed patterns of soil test variability that seldom reflect the patterns found in order 2 soil survey maps. In fact, nutrient management planners and researchers discovered as much nutrient variability within soil map units as between soil map units. Researchers sampling along transects found that soil test values can change significantly in just a few feet. In fields with a long history of fertilizer and/or manure applications, soil Phosphorus (P), Potassium (K), and pH tests variation are often influenced more by past management than inherent soil properties.

The high spatial variability of immobile nutrients lacking correlation with soil map units and the introduction of GPS guided, precision application technology led to sampling strategies based on intensive grids that ignored soil map units and topography. Additionally, methods have been developed for sampling within the grids but will not be discussed here. The consensus is that intensive grid sampling represents the variation in soil fertility better than traditional methods. One key reason is there are significantly more samples obtained with grid methods than with traditional sampling methods. The ideal cell size can be debated but researchers have concluded that cell sizes larger than 4 acres fail to describe the high variability commonly found in most fields and 1 acre grids are best for computer assisted variable rate fertilizer application.

The typical grid size is about 2.5 to 3.3 acres. Applying fertilizer and manure more precisely can be beneficial for the producer and the environment. However, the increased sampling and application costs must be offset by lower fertilizer costs and/or improved productivity. Grid sampling methods would be expected to be the favored method when:

- Immobile nutrients are the primary concern
- Soil test levels are expected to range from very low to very high
- The field has a history of manure application(s)
- Small fields have been merged into larger fields
- Field history is not known.
- Identify if areas of the field can be prescriptively fertilized

Results from precision fertilizer applications have been reported to "even" out the soil test variability for P and K in most fields but reports have been mixed as to the profitability of variable rate fertilizer applications. In some cases, the increased profits due to yield increases and/or fertilizer savings have exceeded the extra costs for sampling and application and in some cases it has not.

In an effort to reduce soil sampling costs while retaining a reasonable ability to detect soil test variability, soil sampling by management zones has been offered as an alternative. The premise for management zone sampling is fields can be divided into zones that contain similar characteristics such as soils, yield levels, past management histories that will allow areas larger than 2.5 acre grids to be sampled. The success of sampling by management zones requires the easy identification of the nutrient variability by using several sources of information to delineate the zones. Soil survey maps, yield monitor maps, electrical conductivity, aerial photos, satellite imagery, and farmer knowledge have been used as sources/layers of information. Although, there are no specific criteria developed to identify management zones, the soil test variability within the zones should be less than between the zones. Management zones larger than 10 acres should be avoided and at least 15-20 subsamples should be bulked into the composite/bulk sample. More frequent soil sampling of the zones (e.g. every 2 years or annually) has been recommended for management zone sampling. Soil management zones based solely on soil map units in order 2 soil surveys are not adequate. Management zone sampling would be favored when:

- Multiple sources of data layers are available and show consistency from one to the other
- There has been limited fertilizer or manure applied
- Information is available relative to crop history, land use, and past management

Often it is debated as to which method is considered "better". Field testing at Iowa State University by Mallarino and Wittry determined that no single method is superior to the other on all fields. Ultimately cost effectiveness is the key to farmer acceptability with either method.

In summary, there are advantages and disadvantages to grid and soil management zone soil sampling strategies for immobile nutrients such as P, K, and pH. Different procedures are required for mobile nutrients such as nitrates. Producers electing to use grids sizes or management zones larger than 5 acres should obtain at least 15-20 subsamples. Management zones larger than 10 acres are discouraged. NRCS will accept either zone sampling or grid methods to support nutrient management plans. Management zones established solely on order 2 soil survey maps will not be considered acceptable. Sampling should be conducted at the same time of year. Due to the temporal nature of potassium soil tests, it is recommended that sampling be conducted in late summer to early fall. Finally regardless of the sampling method used, elevated pH levels often occur within approximately 150 feet of a gravel road where crushed limestone is used to surface the road.

Special Considerations when Soil Sampling

Deep Banding P and K in strip tillage.

Soil sampling for P and K can be problematic when deep banded with strip-till regardless of soil sampling strategy (grid vs. zone). Phosphorus and Potassium are often deep banded in strip-tillage using Real Time Kinematic satellite guidance. Crops do not use all of the P and K applied in deep bands resulting in higher concentrations within the bands than between the bands. The ratio of subsamples that are obtained from the band to samples between the bands is critical in order to characterize the P and K status of deep banded, strip-till fields. Fernandez and Schaefer determined that at least 2-3 samples must be obtained between the bands for every sample obtained within the band for RTK deep band P and K applications in strip-tillage.

Pastures

Pastures are difficult to sample due to the prevalence of very high testing portions of fields. The high testing portions of pastures are around watering sources, temporary feeding areas, and shade. Taking just a few subsamples from these areas will greatly skew the sample. Sampling within 100 feet of these areas should be avoided or sampled separately. Additionally, at least 20 subsamples should be obtained for the bulk sample. The quality of the soil sample would likely be improved if 30-40 subsamples were used for the bulk sample. The larger number of subsamples required is not only due to nutrient gradients due to sites described above but also due to manure and urine deposition. Continuously grazed pastures result in less than 2% of the pasture area being affected by manure deposition and therefore easier to avoid during sampling. By contrast, high stocking densities result in a much higher percentage of the soil being affected by manure deposition. Sampling at spaced intervals is advised in these cases.

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