Sampling fields for nitrate in late spring

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Abstract
Recent research has provided new information that can be used to address spatial variability in soil nitrate concentrations in Iowa cornfields in late spring. Following is a summary of observations made and some tips for sampling fields this spring. The tips focus on efficient sampling techniques for farmers having several fields that are managed similarly and separated by only a few miles. The information given herein expands on guidelines given in Iowa State University Extension publication Pm 1714, Nitrogen Fertilizer Recommendations for Corn in Iowa.

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Spatial variability is a problem in soil testing because mixing soil cores from high- and low-testing areas creates a soil sample that does not represent either area. This problem is not unique to soil nitrate tests, but the most effective strategies for minimizing the problem may be unique because (1) soil nitrate concentrations change rapidly with time, (2) soil nitrate testing must be done within a short period each year, and (3) spatial patterns in nitrate concentrations within fields tend to follow observable spatial patterns in soil color due to organic matter content.

Managing variability during soil testing requires recognition that spatial variability within a field occurs on many scales simultaneously. Large-scale variability often results when two or more fields with different management histories are combined. It also can be caused by differences in landscape position or other factors considered when soils are mapped. Variability on this scale can be managed by dividing the fields into two or more sampling units based on previous divisions between fields, soil map units, or groups of similar soil map units.

Small-scale variability can be caused by fertilizer bands, nitrogen (N) uptake by rows of small plants, decaying plant residues, nonuniform application of animal manure, and wheel tracks or small ridges that cause water to flow laterally a few inches before it moves into the soil. Variability on this scale can be managed by collecting the specified number of cores in the "sets-of-eight" pattern described in Pm 1714 [1]. Although this variability is not important to plants with large root systems, it can cause erratic results when too few cores are collected for each sample tested.

Intermediate-scale variability results from poorly adjusted fertilizer applicators, skips or overlaps by fertilizer applicators, old sites of manure piles or farmyards, and small fertilizer "spills" caused by leaks in hoses or other minor problems. Variability on this scale is most difficult to manage and may pose insurmountable sampling problems under some conditions. Improperly adjusted fertilizer applicators and grossly nonuniform applications of manure are common causes of insurmountable sampling problems.

The best strategy for managing intermediate-scale variability is to sample four to six test
areas per field and interpret the results based on trends observed. Each test area should be about an acre and selected because it is relatively uniform with respect to soil characteristics and seems to be representative of a major portion of the field. In some fields, for example, two test plots may be positioned on each of the two dominant soil map units within the field. In other fields, two samples may be on high and level ground, one on side hills ground, and one on low ground that is nearly level. Avoid

0. field edges and ends where fertilizer applicators may have skipped or overlapped,
1. locations where manure piles or barnyards may have been located in the past,
2. eroded knolls that are too small to be important,
3. depressions or waterways that are too small to be important,
4. small areas having unusually steep slope,
5. small areas at the base of a steep slope, and
6. small areas that had unusual weed pressure in the previous season.

Soil test results from a field or group of fields with similar soils should be expected to be similar or show trends with landscape positions or management history. A commonly observed trend, for example, is that nitrate concentrations tend to increase with soil organic matter content and tend to be low on ridges or steep slopes. Nitrate concentrations in depressions and waterways often are erratic. The finding of large variability without any discernible pattern usually indicates some management problem that needs to be corrected. Some fields, however, show so little variability that one or two good soil samples can characterize the whole field. The only way to learn about nitrate variability within a given group of fields is to sample several sites and look for trends in the results obtained.

The recommendation to test a few areas in each of a few fields and then look for trends does not rely on the common assumption that a soil test value always adequately describes the specific area sampled. Research shows this assumption can result in incorrect interpretations due to unrecognized spatial variability in soil nitrate concentrations and mixing of high-testing and low-testing cores while sampling. Interpretations based on trends in soil test values and on variability in soil test values are desirable because they provide information concerning the reliability of the sampling technique used in a specific field. Results from one year can be used to improve the sampling plan for that field in the next year. Farm-specific assessments of the variability in soil test values should be considered important whether the soil test is used to guide in-season fertilization or to get feedback concerning the nitrogen status of fields that were fertilized before or at planting.

Above: Aerial photograph of a cornfield showing nonuniform canopy color due to nonuniform application of anhydrous ammonia that was applied in early spring before planting. The photo was taken in late August, and the lighter-colored patches and strips reveal areas of nitrogen-deficient corn. Any reasonable method of soil sampling in late spring would have resulted in mixing of high- and low-testing cores to form a sample that does not
adequately represent the field. A management problem of this type should be suspected if soil nitrate concentrations from different test areas show high variability and no trends with landscape position or management history.

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