iGrow Soybean

BEST MANAGEMENT PRACTICES

Chapter 20:
Soil Sampling for Precision Phosphorus Soybean Management

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Precision farming attempts to increase profitability by better matching solutions to problems. Precision farming information can be collected using number of approaches that include adopting improved soil sampling techniques, routine scouting of your field, conducting on-farm research designed to identify your yield-limiting factors, and using a combine equipped with a yield monitor to harvest your field.

We believe that precision farming starts by determining what is limiting your yield. Precision farming may or may not result in variable rate fertilizer applications. The purpose of this chapter is to provide guidance on how to use precision soil sampling for improved P management. Fields with Bray-1 P concentrations ranging from 10 to 20 ppm may produce the greatest economic return from precision P management. Olsen P values will be slightly lower. Bray P is recommended for fields with an acid PH while Olsen P is recommended for fields with a basic PH. Additional information on P management is in Chapter 25.

Precision soil sampling approaches

Precision farming will not increase soybean yields in all fields. In South Dakota soybean production, the nutrients that routinely limit yield are Fe and P. Information on managing Fe deficiencies are provided in Chapters 19 and 26.

To better understand P management, it is important to understand that P and N have fundamental differences. These differences provide opportunities to increase corn and soybean profitability. One difference between these nutrients is that P stays where it is placed and generally does not leach, whereas nitrate is subject to leaching in the soil profile. A second difference is that soybeans have the capacity to convert atmospheric N2 to plant N (N fixation). Due to this capacity, N-based fertilizers generally are not applied to soybean fields.

We believe that the greatest opportunity to increase profitability with precision P management is when the whole field soil Bray-1 P concentrations range from 14 to 22 ppm. This opportunity exists because research shows that 60% to 70% of a field has a soil test value lower than the soil test value in the composite sample (Chapter 25). If the field composite P concentration is lower than 14 ppm, the entire field will receive some P fertilizer when seeded to corn and the percentage of the field not requiring P is relatively small. If the Bray-1 composite soil test value is greater than 22 ppm, it is likely that the percentage of the field requiring P for soybean production is relatively small. The higher the soil test value, the lower the percentage of the field requiring P.

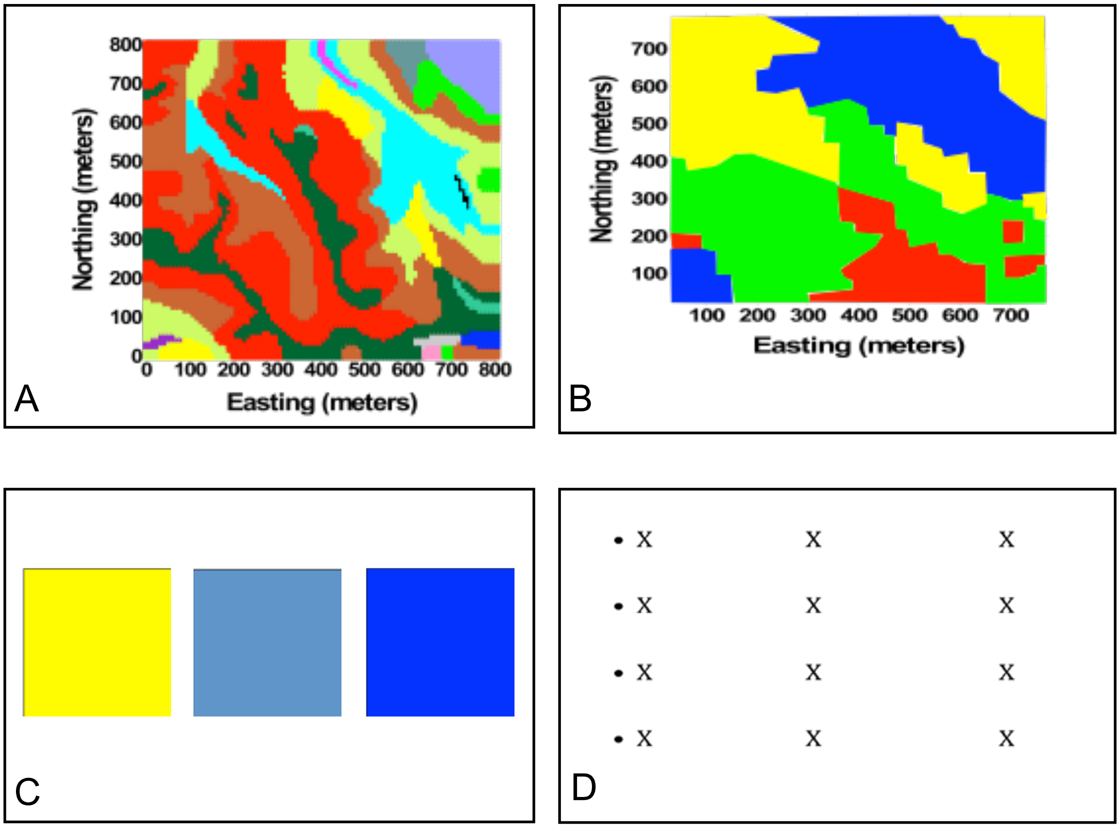

Figure 20.1. Sampling zones based on soil type (A), management zone (B), grid cell (C), and grid point (D). At each sampling location, 10 to 15 soil samples from the zone should be composited into one sample. This sample should be mixed, subsampled, and sent to an appropriate laboratory for analysis (Chapter 18). (Clay et al., 2002)

Precision P management can be implemented using many different sampling schemes (Fig. 20.1). Whole field sampling may be appropriate when yield is consistent over the entire area, or if little or few differences occur in soil properties. However, more information can be gained if precision sampling techniques are employed. Different strategies can be implemented depending on the amount of field variation present, amount of labor available, or other factors.

In grid-cell sampling, the field is split into zones where a single composite soil sample is collected for each zone. This composite sample represents the entire zone. Zones generally are rectangular in shape and the sample is collected randomly from the entire area. If the field contains old homesteads or animal confinement areas, these zones should be separated from the rest of the field. The zones can be any size and they can be different for different parts of the field. This technique is easy to implement, well suited for today's equipment, and does not require extensive training to develop a variable rate fertilizer application map.

One of the most commonly used techniques for collecting precision soil nutrient information is grid point sampling. In this technique, samples are collected at specified grid points. The grid points should be offset and their locations should be marked with a differentially corrected GPS. If samples are collected on a 100 x 100 ft grid (30 x 30 m), then approximately 676 samples are collected from a 160-acre field (65 ha).

Grid point sampling has been very useful in fields where prior management has changed the soil nutrient levels and in fields where several smaller fields have been merged into a larger field. At each grid point, "Good" sampling protocol should be followed (Chapter 18). While providing high resolution to the samples, drawbacks to this sampling scheme are labor and analysis costs. A 200 x 200 ft grid design (60 x 60 m) results in about 175 samples in a 160/A field, requiring less time and less analysis, but also less spatial resolution.

Table 20.1. Sampling approach and the skill required to implement them.

Sampling Approach	Protocols	Skill Sampling	Required Interpretation	Reduction in Fertilizer Errors
Whole field sampling	Follow "good" protocols for collecting samples (Chapter 18). Do not collect composite samples from entrances or old homesteads.	Moderate to high	Low	Low to moderate
Grid cell	Samples are randomly collected from predetermined cells.	Low	Low	Moderate to high
Grid point	Use an offset pattern to collect 10 to 15 cores located 8 to 10 feet (2.5 to 3m) from the grid point center. The location of this point should be determined with GPS.	Low	High	Moderate to high
Soil type	Composite soil samples collected from NRCS defined soil map.	Moderate to high	Moderate	Low to moderate
Management zone	Soil samples collected from management zones.	Moderate	High	Moderate to high
Sampling old homesteads separately from the rest of the field	Locate old homesteads on old USDA-NRCS photos and sample the homesteads separately fromt he rest of the field.	Moderate	Low	Moderate to high

In soil type-based sampling, soil samples are collected from each soil. Most published soil surveys are Order 2 soil surveys. In many fields, Order 2 soil surveys-based sampling has not reduced fertilizer application errors. Order 2 soil surveys may be improved by using experiences, visual observations, and analysis from soil samples (Fleming et al., 1999; Mount, 2001).

Management zone sampling is an approach where the field is split into zones based on soil and crop variability. This approach has value if the different data layers show consistent patterns. Management zones can be developed based on apparent electrical conductivity, yield monitor data sets, remote sensing, historic records, field scouting, and personal preferences. In this approach, computer classification of the various data layers is used to identify management zones. Geographic information systems software (GIS) is routinely used to process the data. Free software for conducting this analysis is available at http://www.umac.org/, and http://www.ars.usda.gov/is/ar/archive/aug03/zones0803.htm.

Once a zone is identified, a single composite sample, containing 15 to 20 individual cores per sampling area, should be collected. Good sampling protocols should be followed when collecting this sample (Chapter 18). This approach is not recommended for fields with recent manure application histories.

The first step in precision soil sampling

There are numerous soil nutrient maps that demonstrate that events that occurred over 50 years ago still impact soil nutrient levels today (Fig. 20.2). Site-specific sampling will help locate these areas. Accounting for this variability is critical for developing accurate recommendations today. For example, including a subsample from an old homestead in a whole field sample increases the soil test value and reduces the fertilizer recommendation. Old homesteads are routinely located near field entrances.

The second step in precision soil sampling

Start your program in fields with the greatest potential to produce an economic response. Three candidates that have the "good" likelihood of producing an economic returned include: 1) CRP land being converted back to crop production; 2) newly tile-drained fields; and 3) fields with a Bray-1 soil test P value ranging from 13 to 22 ppm. These topics are discussed in Chapter 26.

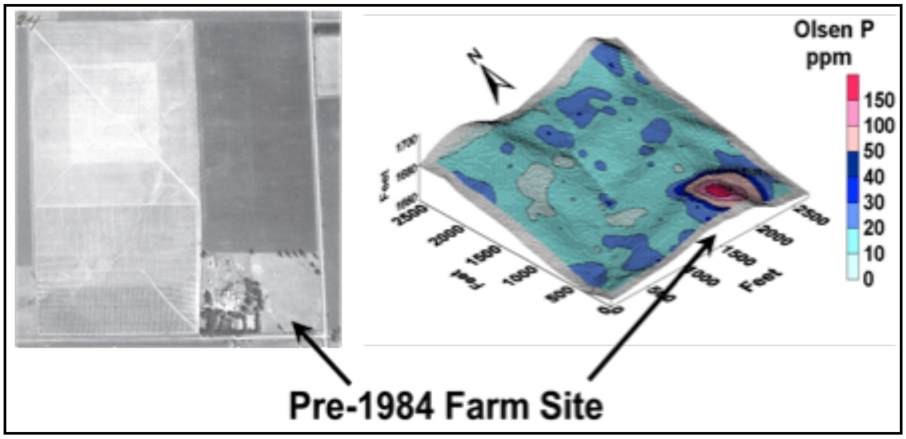

Figure 20.2. Black and white photograph collected in 1956, soil P map collected in 2001, and near infrared image (NIR) collected in 2001. (Clay et al., 2002)

Selecting a sampling protocol

A one-size-fits-all sampling protocol is not available or recommended. To maximize the return of your investment, a different sampling protocol may be selected for each field. Information that you can use to make this decision is cost, amount of yield variability, expected return, and prior management (Table 20.1). A return on your precision farming investment is not guaranteed. The different soil sampling approaches have different investment requirements. Higher skill level means higher costs.

Understanding the causes of your yield variability

Soybean yield variability is caused by many factors (Fig. 20.3). In many fields, the dominant limiting factor is water. Summit/shoulder areas can have yields reduced 50% to 60% by water stress. Water stress can impact the plants' ability to control other pests. Recent research conducted in corn showed that water stressed corn plants down-regulated their ability to utilize nutrients and control pests. Research is being conducted to develop management practices for drought conditions. Currently our recommendation for these areas is careful management and proactive treatments.

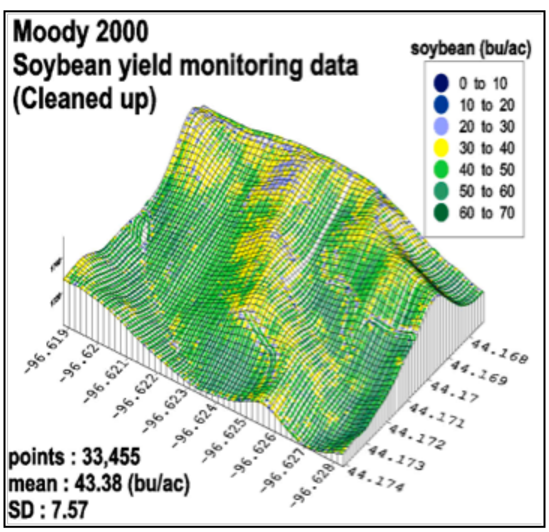

Figure 20.3. Soybean yield variability in a field located in east central South Dakota. (D.E. Clay, SDSU, 2013)

Assessing your fertility program

A detailed program for assessing your soil fertility program is provided in Chapter 17. Soil nutrient contour maps can be used to track the effectiveness of your fertility program. A goal of your P program might be to gradually increase the P level in deficient areas and lower the P concentration in very high P areas. To make this assessment, areas with low and high nutrient concentrations should be sampled every two to four years.

Storing data

Precision farming helps convert current and historic information into increased profits. This information may have been collected over many years by many people. To make sense of this information, the yield data and associated cultural practices must be available. This is a very difficult problem that we have been concerned about for many years. Several possible choices are available:

- Store hard copies of all data.
- Save hard copies of critical information and summary reports.
- Use a data management company.
- Routinely update data to current data storage formats.

In summary, fields are a mosaic of habitats, each having unique characteristics that influence soil properties and crop yields. The effectiveness of matching solutions to problems rests on the ability to identify problems, characterize the site, and develop appropriate solutions. To conduct an assessment of a field's fertility program, regular soil samples should be collected from targeted locations. This information needs to be stored for future use. Precision soil sampling can be used for many purposes including improving your understanding of your field and increasing profits. Precision farming by itself does not guarantee a return for your investment. Your return depends on how you use the information gathered through precision farming.

References and additional information

Chang, J., D.E. Clay, C.G. Carson, S.A. Clay, D.D. Malo, R. Berg, and W. Wiebold. 2004. The influence of different approaches for defining nutrient management zone boundaries on N and P recommendations. Agron. J. 95:1550-1559.

Clay, D.E., N.R. Kitchen, C.G. Carlson, J.L. Kleinjan, and W.A. Tjentland. 2002. Collecting representative soil samples for N and P fertilizer recommendations. MMSG-38. In Site-Specific Management Guidelines. Potash and Phosphate Institute. Available online at http://www.ipni.net/ssmg

Ferguson, R.B., and G.W. Hergert. 2009 Soil sampling for precision agriculture. EC154. University of Nebraska Cooperative Extension. Lincoln, NE. Available at http://ianrpubs.unl.edu/epublic/live/ec154/build/ec154.pdf

Fleming, K.L., D.G. Westfall, and D.W. Wiens. 1999. Field testing of management zones for VRT. SSMG-21. In Site-Specific Management Guidelines. Potash and Phosphate Institute. Available online at http://www.ipni.net/ssmg

Franzen, D.W., and N.R. Kitchen. 1999. Developing management zones to target nitrogen applications. SSMG-5. In Site-Specific Management Guidelines. Potash and Phosphate Institute. Available online at http://www.ipni.net/ssmg

Fridgen, J.J. 2000. Development and evaluation of unsupervised clustering software for sub-field delineation of agricultural fields. MS Thesis. University of Missouri, Columbia, MO.

Gerwing, J., and R. Gelderman. 2005. Fertilizer recommendations guide. EC750, South Dakota State University, SDSU Extension, Brookings, SD.

Mount, H.R. 2001. Obtaining soil information needed for site-specific management decisions. SSMG-35. In Site-Specific Management Guidelines. Potash and Phosphate Institute. Available online at http://www.ipni.net/ssmg

Psost, D., W. Casady, and K. Shannon. 1999. Global positioning systems. SSMG-6. In Site-Specific Management Guidelines. Potash and Phosphate Institute. Available online at http://www.ipni.net/ssmg

Reetz, H.F., Jr., and J.D. Westervelt. 1999. Geographic information systems (GIS) in site-specific systems. SSMG-29. In Site-Specific Management Guidelines. Potash and Phosphate Institute. Available online at http://www.ipni.net/ssmg

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Clay, D.E., C.G. Carlson, J. Chang, and C.L. Reese. 2013. Soil sampling for precision phosphorus soybean management. In Clay, D.E., C.G. Carlson, S.A. Clay, L. Wagner, D. Deneke, and C. Hay (eds). iGrow Soybeans: Best Management Practices for Soybean Production. South Dakota State University, SDSU Extension, Brookings, SD.