NEBRASKA

Aerial Photography as an Aid in Soil Sampling

By Tracy M. Blackmer and James S. Schepers

The technology to vary fertilizer application has progressed faster than the means of obtaining an accurate prescription map economically. Economic methods that can help group regions of similar soils and direct more efficient or "smart" soil sampling strategies will increase adoption of variable-rate application technology (VRAT).

Nebraska research is showing how remote sensing tools such as aerial photography can increase the accuracy and cost effectiveness of soil sampling approaches for variable-rate fertilization. The study also shows how a composite soil sample from a variable area can underestimate phosphorus (P) fertilizer needs.

At the University of Nebraska VRAT site located near Shelton, the concept of using remote sensing to help guide better sampling practices is being evaluated. The site is a 160 acre pivot-irrigated continuous corn field that is made up of silt loam soils in the Central Platte River Valley. From this field, grid soil samples were collected on an alternate 40 by 80 ft. grid in zero to 8 in. and 8 to 36 in. increments. More than 2,000 soil samples were used to accurately map the fertility of the field.

Organic Matter

Soil organic matter was measured on the samples because it is part of the algorithm for calculating nitrogen (N) requirements and because organic matter is a good indicator of variability in many other soil parameters. The organic matter levels of the samples ranged from 1 to 5 percent and once mapped revealed a substantial spatial pattern (**Figure 1, left**).

Phosphorus

Bray P-1 soil test levels were also extremely variable, ranging from one part per million (ppm) to over 350 ppm. The average P soil test for the field was over 15 ppm and would have resulted in a zero P fertilizer recommendation using standard university guidelines in Nebraska. However, approximately 75 percent of the field tested 15 ppm or below (low or very low) and would have benefited from receiving P fertilizer. This field serves as an example of how mixing samples of low P with a few samples of very high P can result in a composite sample indicating adequate P.

The spatial pattern of soil test P was primarily associated with two factors . . . field history and soil organic matter level (**Figure 1, right**). The southwest portion of the field was influenced by an old homestead which had not had livestock present for over 30 years, but still had P levels as high as 376 ppm. In addition, the map illustrates the same spatial pattern observed in the organic matter map.

Aerial Photographs

Aerial photographs were obtained after ridge-till planting using regular 35 mm color film from an altitude of 5,000 feet. From these photographs, clear patterns of soil variability exist (**Figure 2**). The darker regions of the photograph match those regions higher in organic matter. Likewise, a similar relationship exists with soil organic matter and soil P. From this one field, it would seem that identification of areas low in P could be done by sampling a few areas of the field that are lighter in the photograph. Using a photograph to guide soil sampling for P in this field increases the chances of successfully finding deficient portions of the field with reduced soil sampling. However, if we were to apply different amounts of P to the field, this relationship would no longer be valid.

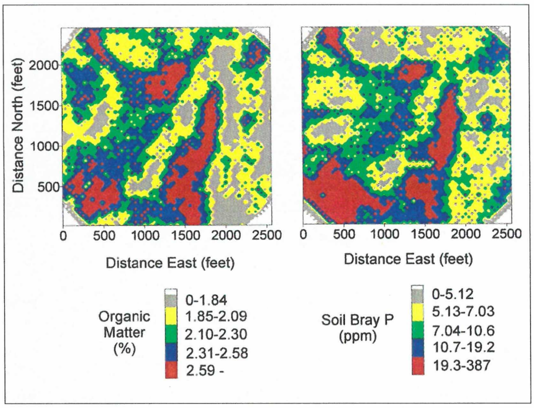

Figure 1. Over 2,000 soil samples were used to generate these maps of the levels of soil organic matter and soil test P in this quarter section in Nebraska.

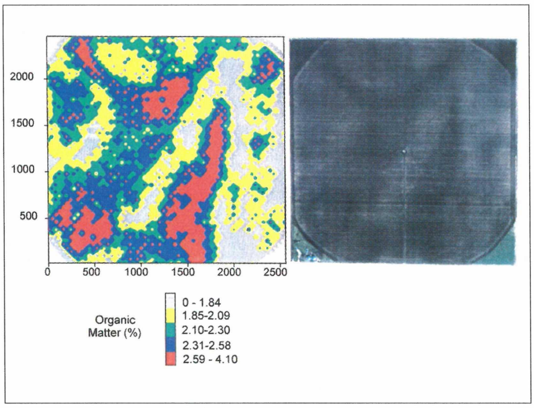

Figure 2. Note the similarity in spatial pattern of soil organic matter level and the spatial pattern of soil color from an aerial photograph.

For the organic matter, it is possible to digitize the color photograph and collect a few samples from each brightness category and use those to generate an estimated organic matter map. One obstacle with generating an estimated organic matter map is the planter pattern in the image. Side-by-side passes through the field (east-west direction) vary in brightness almost as much as the color of the general regions changing in organic matter content.

Our recommendation is that pictures of bare soil color should not be taken immediately after tillage because soil moisture content has a strong influence on color. We feel it is better to wait until after the first rain because that permits the rain to stabilize the soil surface (wash the soil off the residues and allows the soil particles to form a blended color). The soil needs to dry a little after precipitation before taking the picture because some drying will embellish the contrast (the low areas will remain wetter longer and low organic matter areas will dry quicker).

In **Figure 2**, the image was taken the day after planting. The tillage system was ridge-till (12-row). The direction of planting affected residue orientation, which in turn influences reflectance patterns. The thing to note is that with ridge-tillage, the planter is only shaving off the top of the ridge, but the shape of the ridge affects

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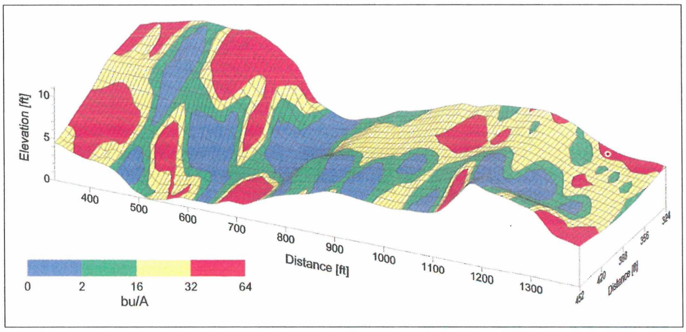

FIGURE 4. Topography and spatial distribution of ΔYield within a 4-acre portion of a corn field. (Londesboro, Ontario)

to capture the variability in topography. On-the-go yield monitors with GPS generate yield maps of both check strips and areas fertilized to current recommended levels, from which ΔYield maps are derived. Relationships among landscape/soil attributes and ΔYield maps will be used to develop site-specific management maps for fertilizer N.

The next step in the project is to evaluate the management maps by comparing yields from strips receiving variably applied N fertilizer based on the management map to yields from strips fertilized at a constant recommended rate. Economic analysis of the two systems will be conducted to evaluate the potential savings and net cost/benefit associated with the variable rate system. At selected sites, more detailed studies will be conducted to examine cumulative long-term effects of site-specific N management on soil fertility, movement of fertilizer into the groundwater, and crop N uptake.

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Aerial Photography...

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how much bare soil is exposed. The more soil that is removed (i.e. deeper), the wetter the soil and the darker the color. Row-to-row variation can be substantial depending on uniformity of the ridge forming process the previous year and ridge modification caused by harvesting equipment.

By waiting until after the first rain, the soil water content has a chance to stabilize and then be rather uniformly re-wetted. When soil is saturated, color differences are not as great as after a little drying.

Overall, we can use aerial photographs to help identify areas of a field that are likely to vary in certain soil properties. Caution should be employed to ensure that past management of the field or other factors have not negated the intended relationship. But if these relationships exist in other fields, it has the potential to provide a high resolution information layer at a potentially affordable price.

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