Nutrient Management with Intensive Soil Sampling and Differential Fertilizer Spreading

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Managing plant nutrients within field boundaries is gaining interest as a result of growing environmental concerns about water quality, narrow profit margins for farms and new fertilizer equipment which can adjust fertilizer rates on-the-go within a field.

MOST FARMERS recognize variations in soil texture, color and/or productivity within fields. Soil type variations affect crop productivity and the amount of nutrients removed from each area of the field. In addition to natural differences in soil fertility, soil nutrient availability may vary within fields as a result of manure applications that covered parts of the field or concentrated in specific areas. The shape of the field, including contour strips and uncrossable waterways, can also impede uniform fertilizer applications.

Illinois soil test sampling procedures call for one soil sample to represent an area no larger than 2.5 acres, and suggest that areas within a field of varying soil types or representing different past management histories be sampled separately. However, the results are then averaged and one fertilizer grade is prepared and spread over one or several similar fields. The net result is that some areas within a field receive more nutrients than are required for optimum crop yields, while in other areas nutrients may remain limiting to crop production. Neither situation is economically or environmentally desirable.

Scientists who map soils have long recognized that soils vary spatially across a landscape. Only recently has it been possible to describe this spatial variation numerically through the use of an emerging field of study called geostatistics. The

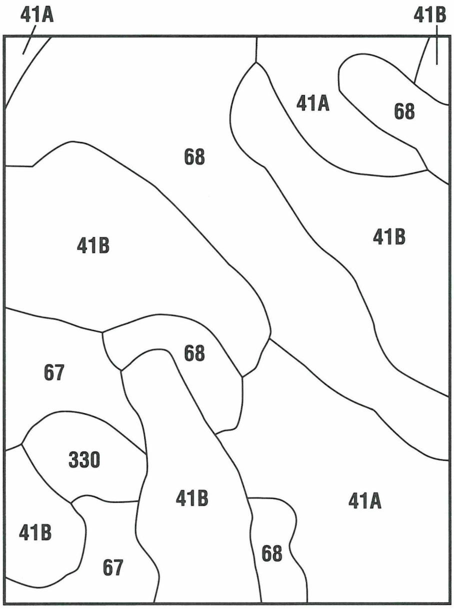

Figure 1. Soils map for one field site.

LaSalle County, IL; 32 acres; scale 300 ft/in.

Soil Summary

	Soil Type	Acres	--- Yield --- Corn	Beans
41A	Muscatine silt loam, 0-2% slope	6.6	167	51
41B	Muscatine silt loam, 2-4% slope	12.1	165	50
67	Harpster silty clay loam	2.6	136	44
68	Sable silty clay loam	9.7	156	51
330	Peotone silty clay loam	1.0	123	42
			159	50

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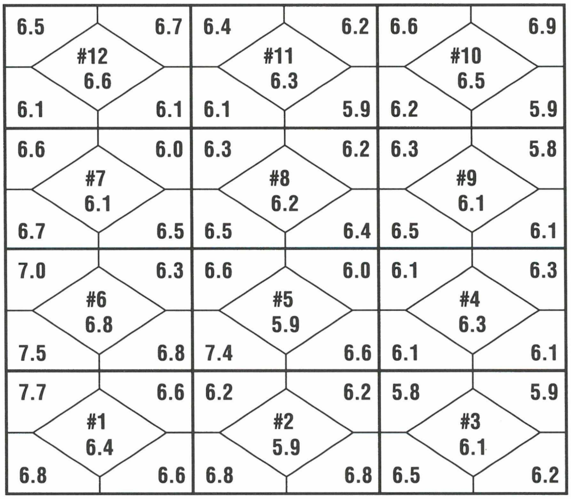

Figure 2. Soil pH distribution, 2.5 acre and 0.6 acre grids. The larger rectangular areas represent 2.5 acre grids in a field, each identified by a number in the center and a soil test value. The other numbers within each rectangle are values for four 0.6 acre grids.

Weighted Field Average = 6.3 for 2.5 acre grids, 6.4 for 0.6 acre grids

Recommendation:		For 2.5 A grids	For 0.6 A grids
> 6.7	Avoid Limestone	2.7 acres	5.9 acres
6.3-6.7	No Limestone Needed	13.2 acres	12.6 acres
5.9-6.2	2 tons/acre	16.1 acres	12.1 acres
5.6-5.8	3 tons/acre	0.0 acres	1.3 acres

challenge we face is how to use geostatistics to help generate soil test nutrient availability maps that can be used with confidence as a correct representation of actual field conditions. We need to know what geostatistical procedures are best suited for creating nutrient management maps. A second need is to evaluate whether managing nutrients within a field is cost effective and environmentally sound.

Illinois Studies

Eight sites in a corn/soybean rotation were selected for study. Field soil sampling was conducted on 2.5 and 0.6 acre bases in a fixed grid at each site. At grid intersection points, 8 cores located within a 10 foot radius were composited to represent the sample point. Kriging was conducted on the 2.5 and 0.6 acre grid sets as well as the combination of the two sets (i.e. five points for each 2.5 acre area). Soil test analyses were performed on each sample including phosphorus (P), potassium (K), pH and organic matter.

Soil test data are being used to create single nutrient maps. The individual nutrient information will be used to develop fertilizer management maps. Each cooperating farmer is also equipped with yield monitoring equipment. Detailed yield maps have been constructed for each site.

Results

This study has demonstrated that grid size can, but does not always, make a substantial difference in soil test results. One site of 32 acres, shown in **Figure 1**, consisted of Muscatine silt loam 0-2 percent slope (6.6 acres), Muscatine silt loam 2-4 percent slope (12.1 acres), Harp-

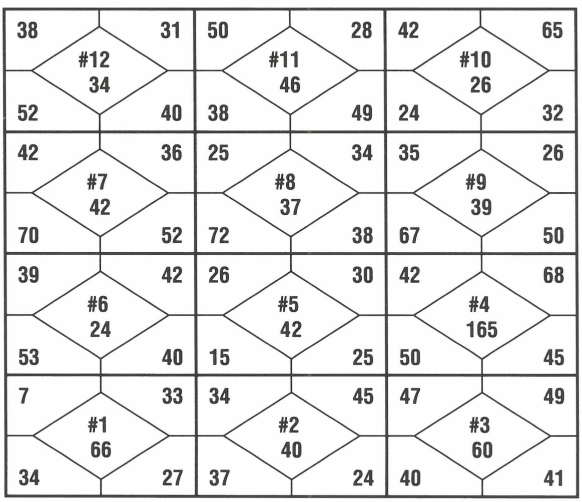

Figure 3. Soil P distribution, 2.5 and 0.6 acre grids.

Weighted Field Average = 52 for 2.5 acre grids, 40 for 0.6 acre grids

Recommendation:		For 2.5 A grids	For 0.6 A grids
> 99	Excessive	2.7 acres	0 acres
60-99	Maintenance	5.3 acres	3.3 acres
36-59	Build-up	16.1 acres	16.7 acres
< 36	Low	7.9 acres	12.0 acres

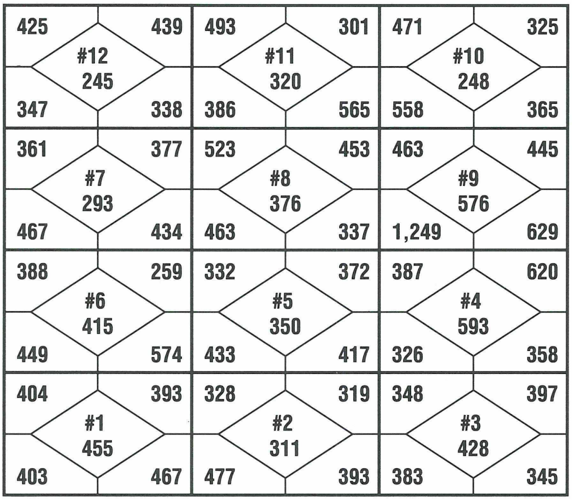

Figure 4. Soil K distribution, 2.5 acre and 0.6 acre grids.

Weighted Field Average = 385 for 2.5 acre grids, 433 for 0.6 acre grids

Recommendation:		For 2.5 A grids	For 0.6 A grids
> 499	Excessive	5.4 acres	4.7 acres
400-499	Maintenance	7.9 acres	11.2 acres
240-399	Build-up	18.6 acres	16.1 acres
< 240	Low	0.0 acres	0.0 acres

ster silty clay loam (2.6 acres), Sable silty clay loam (9.7 acres), and Peotone silty clay loam (1.0 acre).

Soil pH. Figure 2 shows how pH values for the 0.6 acre grids compare to that for a 2.5 acre grid. In most cases, the mean of the four 0.6 acre grids is similar to the value for the 2.5 acre grid, but there are exceptions. For example, 2.5 acre grid #5 provided a pH estimate of 5.9 while the four 0.6 acre grids within it had pH values ranging from 6.0 to 7.4 and a mean pH estimate of 6.7. Recognition and mapping of such small-scale variation offers the potential for increased productivity and profit via site-specific application. It is also of interest to note that the weighted field averages are similar (6.3 vs. 6.4). The additional soil sampling would not have changed liming recommendations if the field is treated as a unit.

Soil P. Soil analysis for P demonstrated similar small-scale variability. Differences between the 2.5 and 0.6 acre grid sampling systems were larger than those for soil pH. For example, 2.5 acre grid #1 (**Figure 3**) had a soil P value of 66 while the four 0.6 acre grids within 2.5 acre grid #1 had soil P values of 34, 27, 7 and 33. Even more striking is 2.5 acre grid #4 which had a soil P value of 165. It was two to three orders of magnitude greater than the four 0.6 acre grids within that portion of the field. The field averages are not similar (52 vs. 40), and this difference is very much due to the soil P value of 165 reported for 2.5 acre grid #4. If grid #4 is deleted, the 2.5 acre grid systems provide a weighted field average similar to that of the 0.6 acre grid system (41 vs. 40).

Soil K. Soil analysis for K demonstrated small-scale variability and an increase (433 vs. 385) in the weighted field K average when 2.5 acre grids and 0.6 acre grids were compared (**Figure 4**). This increase was largely due to an exceptionally high cell in one 0.6 acre grid, which had a soil K test value of 1,249. This was at least twice as high as any other cell in the field and over twice as high as 2.5 acre grid #9, which represents the same part of the field. If that large value is excluded, the weighted field averages are much closer (385 vs. 416) although they fall in different recommendation categories. The soil K value of 385 from the 2.5 acre grids would have resulted in a recommendation for a build-up program while the soil value of 416 from the 0.6 acre grids would have resulted in a recommendation for only a maintenance K application.

Summary

These results should not be interpreted to discredit current soil sampling techniques. They do indicate that more intensive soil sampling provides a different picture of a field than do conventional sampling procedures. More work remains to be done in using intensive grid sampling for more efficient mapping, improved fertilizer recommendations and increased profitability, but the potential certainly appears to be present and reasonable. ■