Soil Test Level Variability in Southern Minnesota

By Tom McGraw

How variable is the fertility of Corn Belt fields? This is a critical question as we continue to push crop production efficiency to the limit. In the following article, the owner of a successful crop consulting business in Minnesota shares his data on the extent of soil test variability within fields. The grid sampling results will be shocking to some and perhaps expected by others.

AS VARIABLE RATE FERTILIZATION, site-specific farming, farming by the foot and similar concepts become better known, the extent of soil test variability will become a major issue. If soil test variability is high, is that variability due to differences between soil types or are there differences within soil types that are large enough to allow differentiation of management inputs, including fertilizer?

Minnesota Studies

To better answer questions regarding soil variability, Minnesota Crop Monitors assembled data from approximately 50,000 acres of grid soil sampling carried out in the Fall of 1993 in west central, south central and extreme southern Minnesota. Grids were approximately 4.4 acres each; 7 to 10 cores per sample were taken in a radius of 20 to 30 feet from the center point of the grid. Using an open-faced hand probe, cores were taken to a depth of approximately 6 inches. Samples were analyzed for available phosphorus (P), exchangeable potassium (K) and available zinc (Zn) at Minnesota Valley Testing Laboratories, New Ulm, MN.

Data were assembled from four geographical areas from the three regions mentioned above. Fields were subdivided into three sizes: 35 to 80 acres, 80 to 160 acres, and greater than 160 acres. There were 392 fields in the study. More than 10,000 soil samples were taken.

The Results

The study showed there was little or no difference in the variability of nutrient levels in the different geographical regions. Therefore, results for all three are combined and summarized in **Table 1**.

Table 1. Soil test variability in western and southern Minnesota fields.

Soil test	Acres in field			
	35-80	80-160	>160	All fields
	% of fields with 4 or 5 soil test classes[1]			
P	75	89	96	86
K	48	62	78	61
Zn	63	77	91	75

[1] Soil test classes were VL, L, M, H and VH.

Variability was extreme for all three nutrients. There was more variability of P than K, but that was expected from previous soil test history in southern Minnesota. No correlation existed between P and Zn availability which had been surmised in the past. Overall relative Zn levels were generally higher than P levels.

The variability of soil test levels increased with field size as shown in **Table 1**, but not to the extent expected. Very

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large fields in the study naturally had more diverse history of past farming practices and generally included a wider variety of soil types.

Overlaying the grid results on a soil survey map showed that most of the time there was no correlation between soil test level and soil mapping unit. Field histories that include small pastures, manure application close to the farmstead, and modified drainage patterns contributed more to soil test variability than that related to soil type differences.

A fairly typical set of data in a geographical subset is presented in **Figure 1**. The top two graphs show the spread of nutrient classes in the smaller fields and the distribution of tests among classes. Even in the 35 to 80 acre group, it is readily apparent that over 85 percent of the fields would require considerably different rates of fertilizer P if the data set represented one field. Obviously, submitting one sample for analysis would produce an inaccurate picture of actual field conditions...even if great care were taken in collecting the sample.

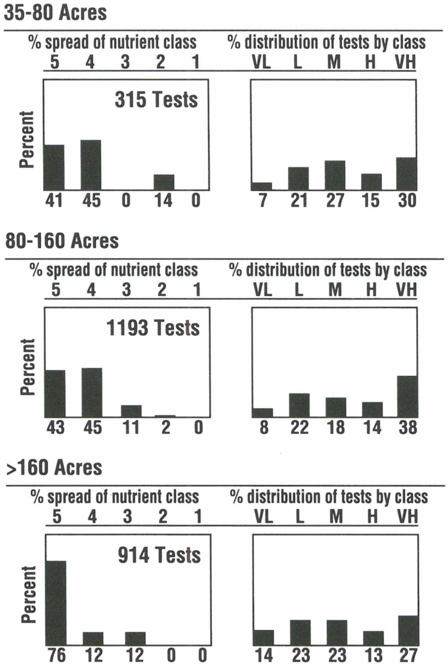

Figure 1. Soil test P variability in the Renville county region of southern Minnesota.

A quick glance at **Figure 1** shows that the distribution of soil test values, no matter the size of the field, assumes the same variable pattern, with the very high (VH) class having the highest frequency in every instance. The VH category is open ended. The large numbers of old barnyards, building sites, or old areas of manure application that are now farmed contribute to the large number of soil samples in this category. Furthermore, whether the soil test values in the VH class from grid sampling are averaged or the actual soil samples from these areas are mixed and then analyzed, the ultra high samples skew the average soil test value for the field. The result is a fertilizer recommendation far below that actually needed for optimum yields.

A computer program has been written to allow comparisons of crop response and rate of return using the average test level in a field or with application of nutrients based on the information provided by the grid soil sampling system. In a random check of 50 fields from the study, no economic gain was realized on two, but the other 48 showed economic gains ranging from \$2 to \$40/A. The comparison can be adjusted to reflect the expected yield, expected price per bushel, and the cost of fertilizer for corn and soybeans. When such comparisons were made, net return above additional costs of extra testing, mapping and spreading of the 48 fields averaged between \$10 and \$20/A, from the poorest to best case scenarios of yield and price, for southern Minnesota.

Summary

Several conclusions were drawn from this study. First, variation in nutrient levels in southern Minnesota fields is much greater than previously expected. Second, there can be significant economic yield increases by applying additional needed nutrients to the low and very low testing areas and conserving nutrient applications on very high testing areas. ■