Soil Test Summaries: Phosphorus, Potassium and pH

SOIL TESTING provides a road map . . . of where we have been and where we are headed in terms of maintaining the productive capability of our soils. The information in this article is an update of the percentage of soils in the U.S. and Canada that would routinely receive recommendations for supplemental phosphorus (P), potassium (K) and lime.

Soil testing data from commercial and public laboratories across the U.S. and Canada indicate that a significant percentage of soils are medium or lower in available P and/or K or have pH values of 6.0 or less. These data emphasize the importance of paying close attention to soil nutrient availability levels in order to maintain productive capability and farm profitability while providing environmental protection.

Phosphorus and Potassium

High P and K soil test values are important in providing plants with nutrients needed to take advantage of optimum growing conditions and best management practices (BMPs). High soil levels of available P and K provide greater flexibility in adoption of reduced tillage cropping systems, plus more options in fertilizer placement, time of application, nutrient application rates, and frequency of soil sampling.

As important as they are, however, high P and K soil test values alone do not account for all the factors influencing the need for supplemental nutrient applications. Increased use of heavy residue conservation tillage cropping systems has expanded the need for starter applications of P and K, even under soil P and K fertility. High residue cropping systems tend to depress soil temperatures and increase soil moisture. Those factors combined with the possibility of increased soil compaction lower plants' ability to absorb nutrients early in the growing season and emphasize the importance of starter applications of P, K and other nutrients. It is important to remember, too, that mainte-

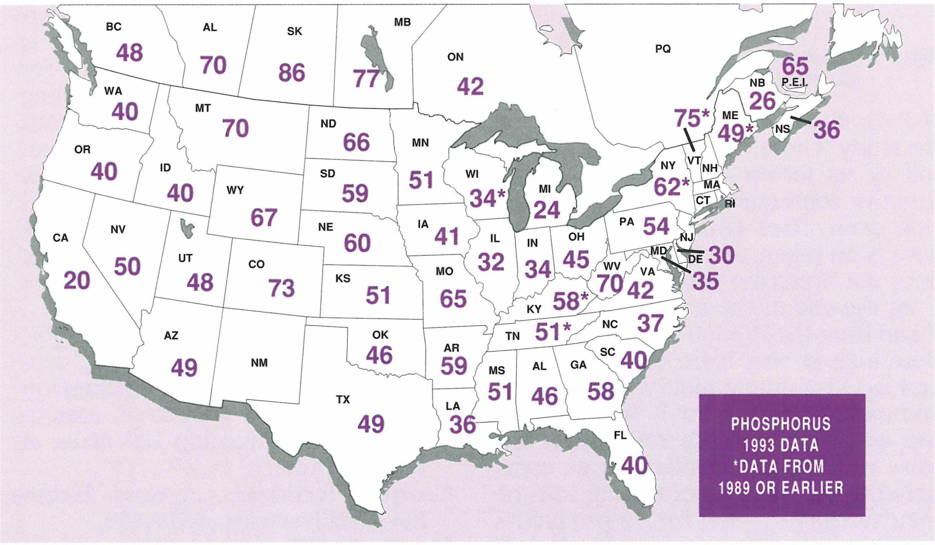

Figure 1. Phosphorus soil test summary–percent testing medium or lower.

nance of high soil test levels by replacement of nutrients removed in the preceding crop is an investment in maintaining the productive capability of the soil.

The categories of medium or lower for P and K soil tests were chosen as an indication of the percentage of soils that would likely receive a recommendation for supplemental P and K for crop production. See **Figures 1 and 2**. These state- and province-wide summaries are useful in providing some idea of crop production needs for P and K. But, the values could be misleading in the sense that differences among areas within states or provinces are ignored and the vital aspects of site specificity in crop management are not revealed.

Examples of variation in soil test summary values within states are demonstrated in **Figures 3, 4 and 5**. Minnesota data in **Figure 3** show the influence of differences in types of farming operations and soil conditions. For example, the percentage of soils testing medium or lower in P is much lower in the eastern two-thirds of Minnesota where animal production is more commonly a part of farming operations. Return of P to the soil through manure applications has probably influenced those P soil test summaries compared to values in other areas of the state.

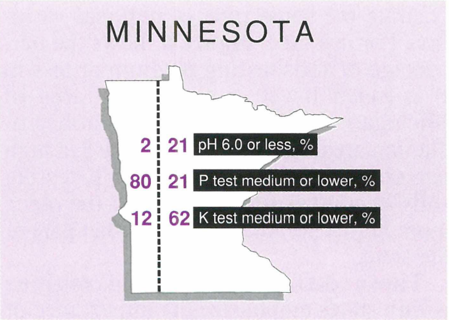

Figure 3. Percent of soils testing medium or lower in P and K, pH 6.0 or less, in eastern and western Minnesota.

The percentage of soils testing medium or lower in K in eastern Minnesota is much higher than in the western one-third where younger, less weathered soils dominate. Similarly, the intensive cropping systems of the western one-third of the state are associated with a much lower average P availability as indicated by the map. Higher soil pH values in the area affected by samples from the Red River Valley are indicated by the low percentage of soils below pH 6.

Summaries of P and K soil tests from Michigan, Illinois, Indiana and Ohio dem-

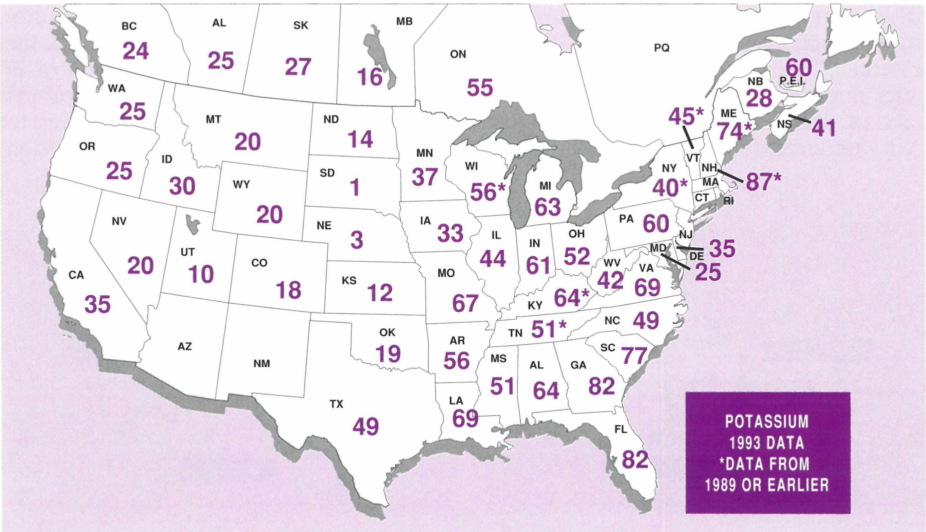

Figure 2. Potassium soil test summary–percent testing medium or lower.

onstrate the same type of regional variation. For instance, **Figure 4** shows the percentage of soils testing medium or less in P is much lower in the thumb area of Michigan, a highly intensified crop production area. Similarly, in **Figure 5**, a high percentage of medium or lower K testing soils in southern Illinois reflect the older, more highly weathered soils in that part of the state.

These differences among regions within states emphasize the importance of more and more area specific and site specific assessment of soil fertility needs. County-by-county soil test information would be even more helpful in assessing nutrient availability status of soils and could help focus attention on the importance of variations in soil fertility within individual fields.

In the future, research and education will focus even more dramatically on the importance of modifying nutrient management according to needs within individual fields determined either by grid sampling or sampling by soil type and modification of nutrient applications to fit those more precise needs.

Soil Acidity

Liming to neutralize soil acidity has long been recognized as one of the foundations of crop production. Increasing soil pH by liming provides a means of improving atmospheric nitrogen (N) fixation by legumes, improves the availability of other nutrients such as P, lowers the toxicity of aluminum (Al) and manganese (Mn) under extremely acid conditions, provides additional amounts of essential calcium (Ca) and magnesium (Mg) and enhances the activity of several classes of herbicides.

Soil test summary information for pH is shown in **Figure 6**. A pH of 6.0 was selected as a breaking point for this summary because soil pH above 6.0 is desirable for most cropping systems. Historically, soil pH values have tended to be more acid where rainfall is higher and where large amounts of vegetation have helped to acidify the soil. Those conditions have been associated with areas east of the Mississippi River in the U.S. and in the eastern Canadian provinces. But, continued research has revealed that soil acidity problems are not limited to those areas. Intensive cropping and the addition of N to the soil as commercial fertilizer, legume residues, manure or sewage sludge tend to produce soil acidity. The effect of N on soil acidity occurs through the nitrification process in the conversion of ammonium N to nitrite and eventually to nitrate. This process, mediated by soil bacteria, occurs irrespective of the source of the ammonium N. Inattention to soil acidity can lead to significant problems, severe restriction of crop yields and lowered profitability.

With the continued adoption of conservation tillage systems, it is increasingly important to pay attention to soil acidity and to the distribution of nutrients in the soil profile. Minimal incorporation of N can result in spectacular drops in soil pH near the soil surface. Special sampling to about 2 to 4 inches for pH determination

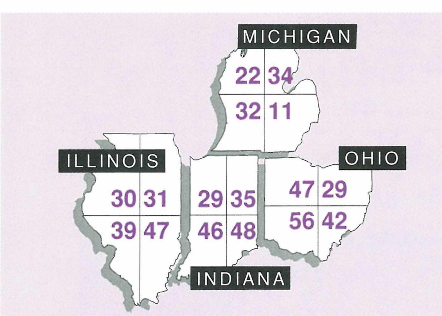

Figure 4. Percent of soils testing medium or lower in P varies by regions in states.

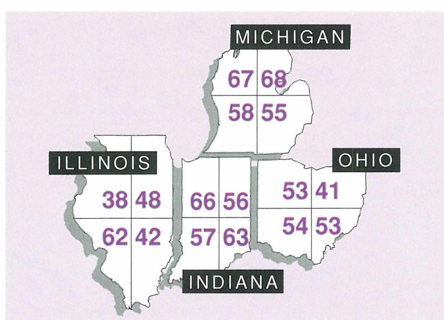

Figure 5. Percent of soils testing medium or lower in K varies by regions in states.

helps monitor these changes and can alert farmers to lime needs that may not be indicated by a deeper sample.

Determination of available P and K on shallow samples can also help evaluate nutrient stratification which can occur from long-term conservation tillage with minimal opportunity for nutrient incorporation. Surface stratification of P and K may alert growers to special needs for deep placement of nutrients to offset these positional accumulations. Nutrient stratification may be of lesser importance if subsoil nutrient levels are adequate and if crops are grown under normally adequate moisture conditions. However, under water-limiting conditions in the dryer areas of the U.S. and Canada, nutrient stratification may hinder nutrient uptake because of limited amounts of moisture in surface soils.

Interpretation of surface soil nutrient availabilities can also mask problems that exist in some areas with low subsoil availability of nutrients which can severely limit crop production. Surface accumulations of K in several important cotton producing areas of the U.S. have masked nutritional problems associated with low subsoil K availability and high K demand late in the growing season. Potassium fertilization, even on these nominally high-testing soils, has resulted in highly profitable yield increases and significant improvement in fiber quality.

Similarly, university research has demonstrated an increased need for supplemental K by corn produced under conservation tillage systems even with medium or higher surface soil K tests. Differences among corn hybrids and their response to supplemental K under these conditions may reflect differences in rooting patterns and root-to-shoot ratios. While more remains to be learned in this area, the indication of greater need for attention to K nutrition under conservation tillage is clear.

Summing it Up

Soil sampling, soil analysis and application of soil test results to individual crop management systems continue to develop into a very site-specific aspect of management. Soil testing is one of the important tools in a nutrient management system of BMPs that can continue to provide profitable crop production with positive environmental effects. ■

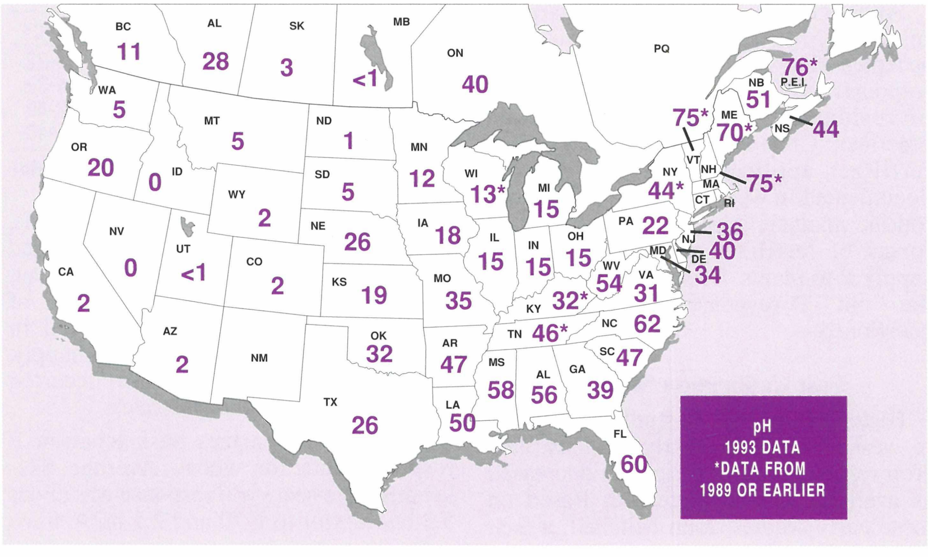

Figure 6. Soil test summary for pH–percent testing 6.0 or less.