

## Soil Test Levels in North America

By P.E. Fixen

With the cooperation of numerous public and private soil testing laboratories, PPI periodically summarizes soil test levels for phosphorus (P), potassium (K), and pH in North America. This 2005 summary is the ninth completed by the Institute.

**T**he 2005 summary includes results of tests performed by more than 70 public and private labs on approximately 3.4 million soil samples collected in the fall of 2004 and spring of 2005. Great appreciation is extended to all the labs cooperating. They were asked to do considerably more work than in the past and it has resulted in what is likely the most comprehensive evaluation of the status of soil fertility in North America ever conducted.

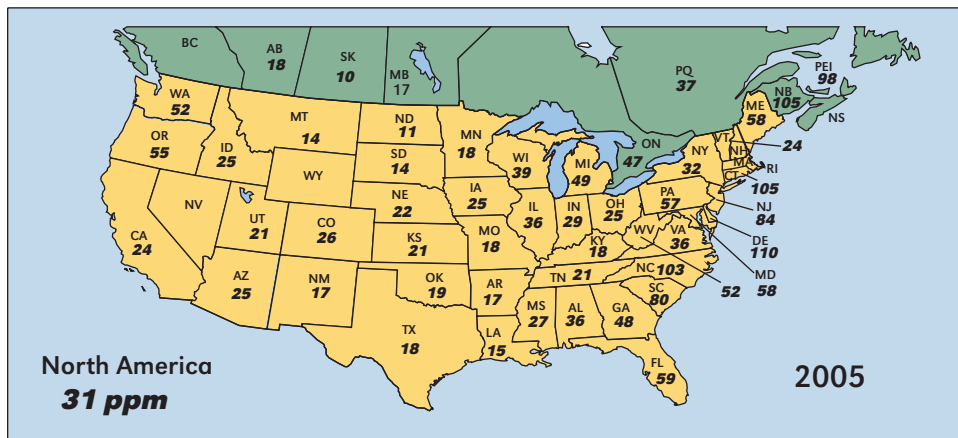
Past summaries reported the percent of samples testing medium or below in P or K or that had pH values less than or equal to 6.0. In general, these were soil test categories where most agronomists would predict a significant yield response in the year of application to P, K, or lime. However, the agronomic definition of medium varies due to differences in philosophical approaches and research results. In other words, the numerical soil test level separating medium and high categories varies substantially. To avoid the confounding which results from geographic and temporal variation in laboratory or state/province definition of medium and actual changes in soil fertility levels, percent medium or below was not estimated in the 2005 summary process. Starting with the 2001 summary, medians will be used to track changes over time in soil fertility levels. The median is the level occurring in the middle when values are arranged in order of magnitude.

Several changes in summary procedures from the past have contributed to a significant improvement in the quality of

the 2005 summary. These include an increase in total number of samples, more complete frequency distributions across North America, and the replacement of "medium" with median levels. Despite these improvements, several weaknesses continue in the summary process:

- Quantity of samples remains low in several states and provinces.
- Some samples may have originated outside the state or province indicated.
- Some areas of each state or province are likely under or over-represented.
- It is likely that the better managers soil test and that their soil tests may not be representative of those that do not soil test.
- Due to the requirement of nutrient management plans for many livestock operations, the percent of samples in the summary from manured fields could be higher than in the past for some regions and inflate soil test levels, especially for P.
- Although an attempt was made to define agronomic equivalency for each of the soil test categories among the various procedures, it is likely that error was introduced in this process.

Critical to appropriate use of this information is recognition that nutrient management should occur on a site-specific basis where the needs of individual fields, and in many cases areas within fields, are recognized. **Therefore, a general soil test summary like this one has no value in on-farm nutrient management.** Its value lies in calling attention to broad nutrient needs



and challenges and in motivating educational and action programs.

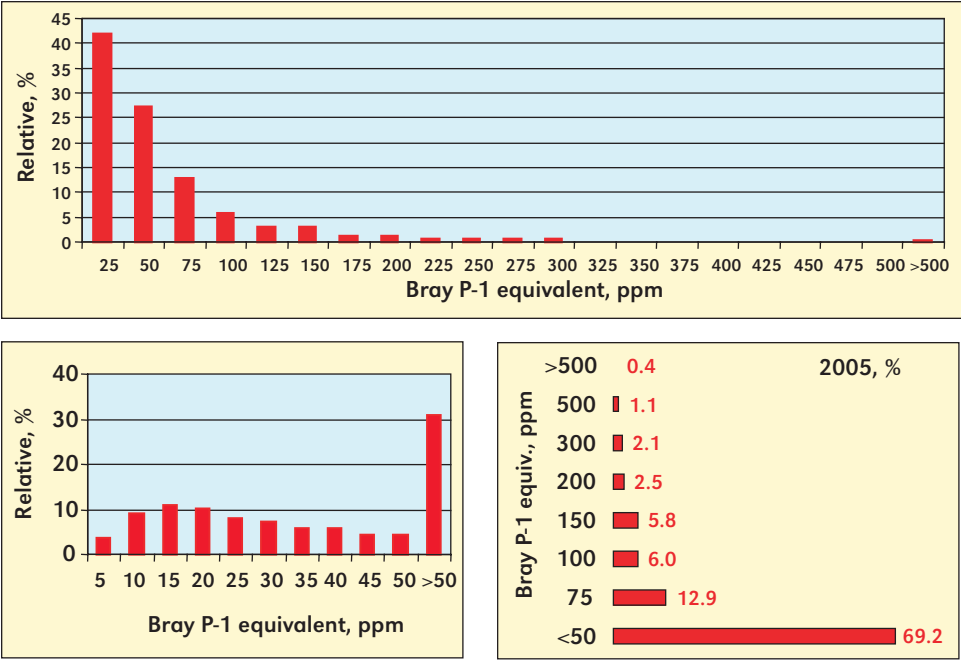
There are many benefits of high P and K soil test levels. High tests are important in providing plants with needed nutrients to take advantage of optimum growing conditions and reduce the negative effects of stressful conditions. They provide protection against deficiencies induced by nutrient stratification in reduced tillage systems plus offer more options in fertilizer placement, time of application, nutrient application rates, and frequency of soil sampling. High and very high field average soil test levels offer insurance against profit-robbing deficiencies occurring in low testing parts of variable fields. Considering the high frequency of extreme within-field variability revealed by intensive sampling, this factor alone in many cases justifies building soil test levels to at least the high category.

It is important to recognize that these nutrients should be protected from loss to avoid environmental degradation. This can be accomplished through proper management. It should not be assumed that because a soil area or field is high in fertility that it represents a threat to water quality or because it is low in fertility that it offers no threat to water quality. Management relative to watershed characteristics makes the difference.

Critical Bray P-1 equivalent levels for the soils and cropping systems of the Great Plains and western Corn Belt are usually assumed to be around 20 parts per million (ppm) and to increase to 25 or 30 ppm for the eastern U.S. Recent research indicates that critical levels may be higher for high yield management systems. Certain crops, such as potatoes on some soils, will require much higher soil P levels—research shows response in the 100 ppm range. Bottom line...critical levels are site-specific.

**Critical ammonium acetate K equivalent levels vary markedly across North America.** For the relatively high cation exchange capacity (CEC) soils of western and central North America, calibration research usually indicates critical levels in the 140 to 200 ppm range. Critical levels are usually lower in eastern North America and on low CEC soils may drop to 80 ppm. As with P, specific crops and management systems may have different critical K levels than those indicated above.

**The median P level for North America is 31 ppm, with 42% testing less than 25 ppm, a middle-of-the-road critical level.** Phosphorus levels continue to vary markedly among states and provinces (**Figure 1**). The northern Great Plains has the lowest P levels with medians in the 10 to 18 ppm range, followed by the Midsouth and western states of the Corn Belt in the



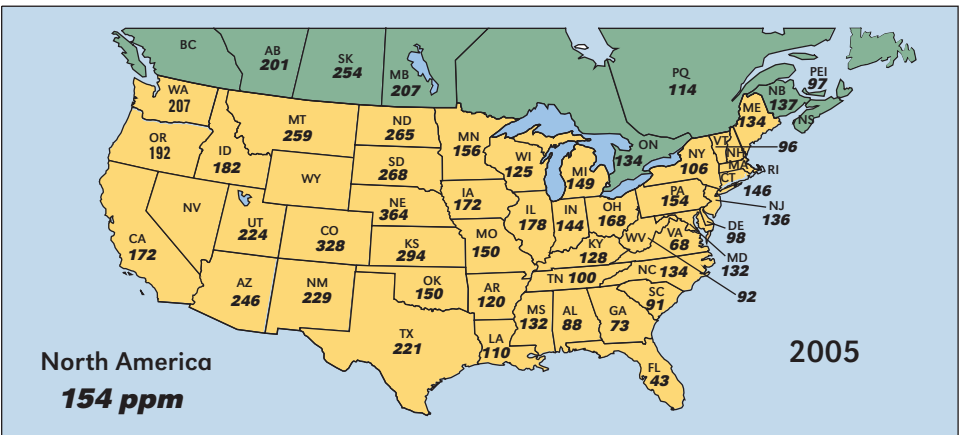
**Figure 2.** Relative frequencies for soil test P in North America.

15 to 27 ppm range. Soil P levels in eastern North America from Florida to the Maritime Provinces are generally much higher than for the rest of the region.

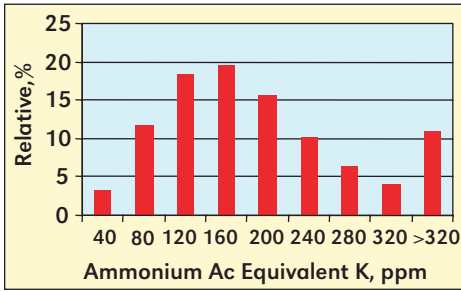
Relative frequencies for soil test P in North America are shown in **Figure 2**. Viewing North America as a single frequency distribution with uniform category widths of 25 ppm gives the typical skewed

distribution with a long tail to the right. These graphs show why an average is inappropriate for describing most soil P distributions...because it over-estimates the central tendency of the data. It also shows the dominance of the lower categories of soil P in North America.

**The median K level for North America is 154 ppm, with 33% of the samples test-**



**Figure 3.** Median ammonium acetate equivalent soil test K levels.



**Figure 4.** Soil test K frequency distribution for North America in 2005.

ing less than 120 ppm and 53% testing less than 160 ppm (Figures 3, 4). Median K levels in most of the states east of the Mississippi River and in the provinces of eastern Canada are at or below agronomic critical levels, indicating that 50% or more of the fields represented likely require annual K application to avoid yield losses. The higher K levels of the West reflect the less weathered status of western soils. However, in states such as California where 46% of the soils test <160 ppm, crop removal over several decades with limited nutrient addition has significantly reduced soil K levels.

**The median pH for the U.S. and Canada is 6.3, with 31% of the samples testing <6.0.** A pH of 6.0 is highlighted because a pH above 6.0 is desirable for most cropping systems. Median pH is lowest in the southeastern U.S. and generally

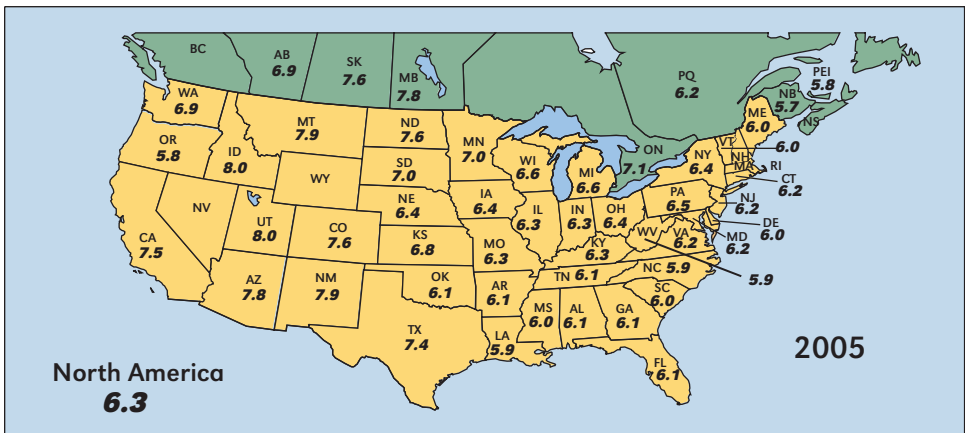
increases as you move north and west in North America (Figure 5). Historically, soil pH values have tended to be more acid where rainfall is higher and where large amounts of vegetation have helped to acidify the soil. Those conditions have been associated with areas east of the Mississippi River in the U.S. and in the eastern Canadian provinces. But, continued research has revealed that soil acidity problems are not limited to those areas.

## Conclusions

Both the P and K results illustrate the importance of regular field-specific soil testing. The wide-ranging distribution of soil test results in nearly all states and provinces points clearly to the need for soil testing to determine fertility needs of specific fields as a guide to fertilizer and manure application. **BC**

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*Note: More detailed information, including comparisons to the 2001 summary, plus magnesium and sulfur soil test information, is included in Technical Bulletin 2005-1 and the accompanying CD, available for purchase from PPI. For more details, see the item on page 24 or go to the website: >[www.ppi-ppic.org](http://www.ppi-ppic.org)<*



**Figure 5.** Median soil pH levels.