NEWS & VIEWS

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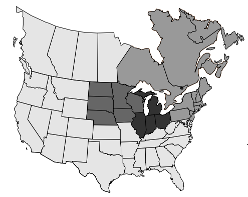

Multi-Region
July 1999

Maintaining High Soil Tests

A Strategy for Managing Risk during Low Crop Prices

LOW crop prices have led many farmers to find ways to cut costs and still maintain their production levels. In a 1998 survey of 2,317 Minnesota farms, fertilizer accounted for only 6.7 percent of average total cash expenses. Phosphorus (P) and potassium (K) fertilizer expenses were only a portion of this percentage, since nitrogen (N) and other nutrients were included. Many of these farms represented diversified operations, producing both livestock and crops. Thus, farms without livestock might be expected to have higher percentages of total costs attributable to fertilizer expenses. Even so, phosphate and potash represent a rather small percentage, while their benefits can be quite large. Before reducing P and K inputs, producers must first understand P and K management strategies and how best to use them. Managing soils at higher P and K levels has many benefits that should be considered.

It should be remembered that P and K fertility is controllable. This is important for farmers as they are bombarded each year by many unpredictable factors, such as insects, diseases, weeds, and weather. Managing soils at higher P and K fertility levels reduces the number of factors that may be cutting into production levels and profits and often helps a crop withstand (or resist) effects of other stresses.

On well-managed farms, high P and K soil test levels support optimum yields. If they are maintained, farmers have some flexibility to reduce fertilizer applications for one season without incurring a yield loss. Such a strategy may be used to manage limited cash resources more efficiently in a year of low crop prices. However, harvested portions of crops remove P and K from the field, lowering soil test levels. Farmers who do not apply P and K, or reduce applications to rates below crop removal, should monitor soil test levels closely to ensure that they do not drop to levels that cut into yields.

Farmers who have soils testing medium or below have less flexibility. Proper management of soils at these levels requires annual applications of fertilizer. Otherwise, they risk yield and profitability reductions...and have less flexibility to cut back on inputs in financially stressed times.

Identifying low testing areas is critical to increasing production. A 1997 survey of soil testing labs conducted by PPI is summarized in **Figures 1 and 2**. The percentage of soils testing medium or below is an indication of the percent of fields that are in the responsive range, that is, fields that need more P and K for optimum productivity. Summaries of soil tests from nearly 200,000 samples in Illinois, Indiana and Ohio, for example, show that 55 percent of samples tested medium or below in K (**Figure 1**). That means they are in the range where yield increases are expected from K fertilization. It also means that if K is not applied, a farmer misses opportunities for increased yields from inadequate K nutrition. These principles also hold true for soils testing medium or below in P.

During the last decade, PPI soil test summaries indicate that P and K soil tests are trending lower in some Midwestern states. One reason for this may be that the cropping systems have changed, and fertilizer practices have not been adjusted to account for increased nutrient removal. More fields are in a straight corn/soybean rotation, which means soybeans enter the rotation more often than in the past. Yet, it is still a common practice to apply P and K only ahead of the corn crop in the rotation. Soybeans remove large amounts of P and K, so P and K draw-down is more rapid than under less intensive rotations. If the nutrient management plan has not been

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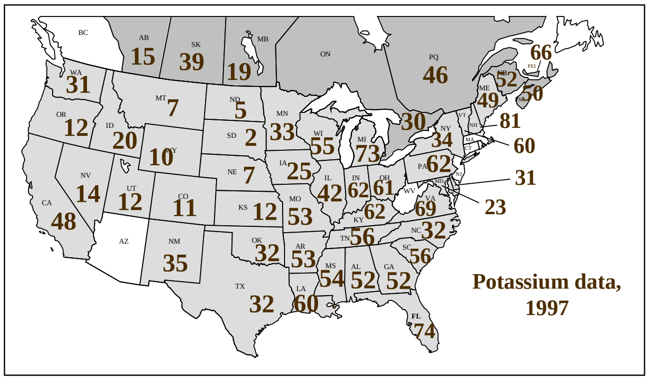

Figure 1. Potassium soil test summary – percent testing medium or lower.

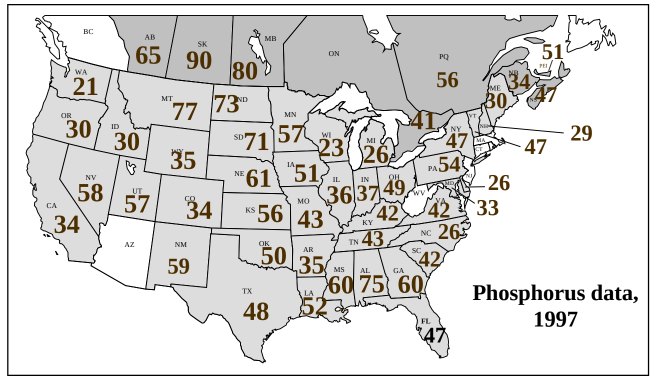

Figure 2. Phosphorus soil test summary – percent testing medium or lower.

adjusted to account for this increased removal, the result is a net decline in soil P and K levels. These considerations are also important for the Northcentral region, as more farmers are incorporating soybeans into their rotations in place of wheat.

To properly manage risk, farmers should understand that yield reductions are possible at various soil test levels when no fertilizer is applied. PPI assembled examples of calibration data from several states and crops. The assembled data appear in PKMAN software documentation, and examples are reproduced in **Tables 1 and 2**. These tables demonstrate that large reductions in yield are possible at lower soil test levels for the crops listed. Proper fertilization can boost yields to percentages approaching 100. This means that identifying lower testing areas and fertilizing them properly can produce substantial economic gains, both in the long and short term. Data were collected from land grant universities that conducted P and K fertility research across a large number of sites and years using broadcast P or K fertilizer applications. As such, they represent relative yields averaged over many conditions when either P or K was the primary limiting factor. Response at any given site and year can be either greater or less than these long term averages, depending on local conditions and how many yield-limiting factors are present. With these limitations in mind, farmers lacking local P and K response data can use these tables to begin quantifying risks and benefits of P and K management.

Table 1. Phosphorus calibration examples (Bray P-1, except where noted).

Soil test level, ppm[1]	Average Relative Yield, %									
	Corn Iowa	Corn Missouri	Corn Illinois	Corn Ontario*†	Soybean Illinois	Soybean Ontario*†	Spring wheat S. Dakota	Spring wheat N. Great Plains*	Winter wheat Kansas (Bray)	Winter wheat Kansas (Olsen)+
2.5	66.5	31.0	42.0	81.8	42.0	74.8	75.2	61.2	35.0	41.0
5.0	77.3	40.0	54.8	85.9	54.8	87.3	79.5	78.0	56.4	68.0
7.5	86.7	48.5	69.3	89.1	69.3	93.6	83.1	85.9	73.6	82.1
10.0	91.3	58.0	81.3	91.6	81.3	96.8	86.0	90.4	82.1	89.9
12.5	94.1	66.5	90.2	93.5	90.2	98.4	88.6	93.3	87.9	93.9
15.0	95.9	75.3	94.7	95.0	94.7	99.2	91.0	95.4	92.3	97.0
17.5	97.1	84.5	97.3	96.1	97.3	99.6	93.1	97.0	95.0	98.5
20.0	98.0	90.0	98.0	97.0	98.0	99.8	94.8	98.2	97.1	99.9
22.5	98.7	93.5	98.6	97.7	98.6	99.9	96.4	99.1	98.2	100.0
25.0	99.3	96.0	99.1	98.2	99.1	99.9	97.8	99.9	99.3	
27.5	99.6	98.0	99.5	98.6	99.5	100.0	98.8	100.0	100.0	
30.0	99.8	99.3	99.8	98.9	99.8	100.0	99.6			
32.5	99.9	99.9	100.0	99.2	100.0	100.0	99.9			
35.0	100.0	100.0		99.4		100.0	100.0			

†Note that Ontario soil test levels are expressed in milligrams per liter rather than ppm by weight.
*Olsen P; +Calculated from Bray P1 assuming Olsen P = 0.75 Bray P1.
Data: Potash & Phosphate Institute, PKMAN: A tool for personalizing P and K management. Version 1.0. Potash & Phosphate Institute, Norcross, GA.
[1]ppm=parts per million

Table 2. Potassium calibration examples (ammonium acetate).

Soil test level, ppm	Average Relative yield, %				
	Corn Missouri	Corn Illinois	Corn Ontario†	Soybean Illinois	Soybean Ontario†
60	62.0	52.5	89.7	59.5	87.5
70	69.8	66.0	92.1	66.0	90.5
80	76.3	74.5	94.0	73.5	92.1
90	82.0	82.0	95.4	79.6	93.7
100	86.8	87.2	96.4	85.2	95.0
110	91.0	91.9	97.3	90.2	96.0
120	96.0	95.0	97.9	94.6	96.9
130	97.0	97.1	98.4	97.1	97.5
140	98.3	98.4	98.8	98.4	98.0
150	99.6	99.3	99.0	99.3	98.4
160	100.0	99.9	99.3	99.9	98.7
170		100.0	99.4	100.0	99.0

†Note that Ontario soil test levels are expressed in milligrams per liter rather than ppm by weight.
Data: Potash & Phosphate Institute, PKMAN: A tool for personalizing P and K management. Version 1.0. Potash & Phosphate Institute, Norcross, GA.

Estimates of yield response should, where possible, be based on local data. Fertilizer response curves, showing the relationship between yield response and fertilizer inputs, should be matched as closely as possible to the specific situation of a given farm. With spatially geo-referenced soil sampling and yield monitors, farmers are collecting data that may allow them to begin to quantify such responses specific to their conditions. But it takes several years of records to develop these relationships. Most farmers have not yet reached that point, so we still depend on local university experiment station data for such response estimates. Dealers, consultants and farmers can work together to build a local data base if they are willing to share their information. That would speed the process to the benefit of all. In some cases, the dealer or consultant assembles the data and maintains the confidentiality of the farmers. This is not a new concept, but rather application of new tools to an old business practice that has worked successfully for many years. More progressive agronomists, consultants, and dealers have already implemented this approach and have used it successfully to modify fertilizer management practices in their regions.

Identifying Hidden Fertilizer Needs with More Intensive Sampling

Increased use of site-specific systems and variable-rate fertilizer application has resulted in increased soil sampling in recent years. While there are no official statistics collected on sample numbers, discussion with various laboratories across the Midwest indicates that there is a general increase in activity. Perhaps even more important, sampling intensity on fields is increasing. The most common density is about 2.5 acres per sample, with some going as low as one acre per sample. This has helped identify more low testing areas of the fields, increasing the potential market for P and K and potential profits for farmers.

A survey by one lab of 472 grid-sampled fields in Illinois, Indiana and Ohio, showed that 45 percent of the fields tested high or very high, thus falling in the category where yield response to annual broadcast fertilizer applications would not be expected. But 56 percent of the area within those fields tested medium or below, so that an additional 25 percent of the acreage actually falls in the range needing annual K application (56 percent of the samples in 45 percent of the fields = 25 percent of the total field area). Add that to the 55 percent of the fields falling in the medium or below category, and you could conclude that ***nearly 80 percent of the land area in these states may be sub-optimal in K soil test levels.*** That is probably an over statement, considering that a small portion of the fields averaging in the medium range will have areas in the high range. The point is, however, that there is substantial acreage in the mature market areas of the country that are identified as needing buildup fertilizer when intensive sampling patterns are used. That means farmers are missing the opportunity for increased yields and profits, and dealers are missing the opportunity for increased fertilizer markets.

Only through site-specific management will that increased market for fertilizer…and a higher yield opportunity for the farmer…be realized. Low-testing soil samples are not necessarily from farmers who don't fertilize. Fields with both low and high testing areas are likely to have a field-average soil test level that is too high to represent the needs of the lower testing areas…areas with high probabilities of yield response. Whole-field fertility management on such land leads to under-fertilization of the lower testing areas and over-fertilization of the high testing areas. In some cases, lower soil test levels, although still testing above medium, have been identified where higher than expected production has led to larger crop removal of nutrients. Proper fertilization is important for such areas to optimize their great production potential.

Identifying and quantifying the extent of responsive areas is an important outcome of site-specific management in times of low crop prices. In such areas, proper fertilization can lead to substantial returns from proper P and K fertilization. **Table 3** shows that greater investments in P on a responsive area increased net return and reduced production costs per bushel. This reflects the importance of proper P and K fertilization in improving production efficiency.

Non-Yield Income Associated with Fertilizer Use

When designing a nutrient management plan, we should recognize that benefits of P and K fertilization go beyond yield increases, as summarized on page 4:

P Benefits	K Benefits
• Increased nodulation	• Increased nodulation and development
• Better water use efficiency	• Increased ability to withstand stressed conditions
• Improved disease resistance	• Improved disease resistance
• Higher crop quality	• Higher crop quality
• Faster maturity	• Increased grain development
• Increased root growth	• Better nitrogen use efficiency

Table 3. Phosphate lowers the cost of production per bushel of corn on a soil testing low in P (Ohio).

P_2O_5 rate, lb/A	Corn grain yield, bu/A	Total yield income ($/A)	Additional harvest and drying costs from yield response to P ($/A)	Sampling, application, and P product costs ($/A)	Total cost per bushel, $/bu	Net profit, $/A
0	150	300	0.00	0.00	2.00	0.00
20	166	332	4.69	9.00	1.92	18.31
40	175	350	7.33	14.00	1.89	28.68
80	183	366	9.67	24.00	1.88	32.33
120	191	382	12.01	34.00	1.63	35.99

Base cost without P = $300/A. Corn sale price $2.00/bu.
Data: Potash & Phosphate Institute, 1988.

Often there are interactions among nutrients that further complicate the decision to cut back on P or K inputs. Phosphorus, for example, affects the dry down rate of corn, and both the yield response and the drying costs are affected by the N level available to the crop. In a Kansas study, the yield response to P was measured at 6 different N rates. **Figure 3** shows that:

- Net return to 40 lb P_2O_5/A was higher at higher N rates up to 120 lb/A

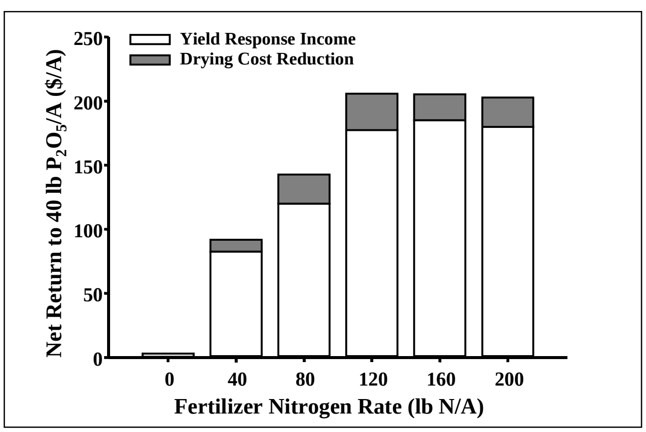

Figure 3. Phosphorus hastens maturity and lowers drying costs, adding to the return to P fertilization (Dhuyvetter and Schlegel. 1994. Better Crops 78:10-11).

- Drying costs were reduced as a result of P addition
- Reduction in drying cost was greater as N rates increased from 0 through 120 lb/A.

These data show that limiting estimates of return to yield response neglects other important economic benefits of P and K fertilization.

Summary

Managing soils at higher soil test P and K levels provides many benefits. In a typical corn/soybean rotation, P and K fertilizers are most often applied for both crops in the same year (usually ahead of the corn crop), so that each application is planned to meet the needs of the anticipated yield of both the corn and soybean crop. This approach saves on application costs, reduces traffic over the field, and fits with either 2-year or 4-year soil testing cycles. By maintaining soil tests in a high range, the actual time of application is less critical. With high fertility levels in place, skipping the P and K maintenance application in a given year is sometimes possible as long as it is made up in the next year. This provides the farmer some flexibility to help adjust to economic pressures or weather problems. If soil test levels are not in the high range, this flexibility is lost, and farmers that attempt to cut back on their P and K use run a greater risk of losses in productivity. Identifying and fertilizing lower testing areas within a field allow producers to increase production and decrease unit costs. Efficient management is the goal of farmers in times of low crop prices, and P and K are an important part of achieving that goal. ■

InfoAg99 Conference

InfoAg99 Scheduled August 9, 10, and 11

PPI/PPIC/FAR, and Purdue University are organizers of InfoAg99, the fourth in the series of Information Agriculture Conferences, set for August 9-11, 1999, on the Purdue campus, West Lafayette, Indiana. The 1999 program will focus on using site-specific technology and electronic communications systems in the development and implementation of nutrient management plans. Hands-on training with special software tools will be included. Watch for details on the website at:

http://www.ppi-far.org/infoag99

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