CURRENT PERCEPTIONS ON SOIL FERTILITY RECOMMENDATIONS AND STATUS OF SOIL FERTILITY IN ILLINOIS

F.G. Fernández, B.S. Farmaha, and E.D. Nafziger
University of Illinois, Urbana-Champaign

Abstract

While most soils in Illinois are generally recognized for their high productivity, regular application of phosphorus (P), potassium (K), and limestone are necessary to maintain their productivity. Determination of soil P, K, and pH levels through soil analysis is necessary to guide application of these nutrients and limestone. Due to recent high fertilizer prices there has been interest from producers to temporarily reduce or eliminate P and K applications without reducing crop yield. In an effort to more effectively teach concepts of fertility management, two surveys were conducted to determine the general fertility of soils in Illinois and to assess the perception of producers and others linked to crop production on the current soil fertility recommendations from the University. A soil fertility survey was conducted in 2007 and 2008 by collecting soil samples from the 0-8 and 8-18 cm depths at random corn (Zea mays L.) fields prior to crop harvest. Most of the 598 fields sampled in 52 counties were collected by volunteers conducting the annual European Corn Borer Survey that has taken place for more than 60 years in Illinois. Samples were analyzed for P, K, pH, calcium (Ca), magnesium (Mg), and organic matter (OM). Perception on current soil fertility recommendations was assessed during the Corn and Soybean Classic Conference series in which 833 responses from an audience of approximately 1,100 participants was obtained using the TurningPoint audience response system. The soil survey revealed that 17 and 43% of the fields were below the mean critical level of 19 mg P kg^{-1} and 140 mg K kg^{-1}, respectively. Fifty eight and 30% of the fields were above the mean soil test level of 33 mg P kg^{-1} and 190 mg K kg^{-1} at which additional fertilization is not recommended, respectively. Mean soil pH was adequate at 6.7. Mean Ca (2226 mg Ca kg^{-1}) and Mg (366 mg Mg kg^{-1}) levels indicate no need for application of these nutrients. Mean organic matter (OM) was 3.3%. Comparison with an earlier survey conducted approximately 40-years prior indicated that current P and pH levels are higher, but K levels are approximately the same. Phosphorus, K, and OM levels were stratified with surface to subsurface ratio of 2.4:1, 1.5:1, and 1.2:1, respectively. This stratification is an indication that most soils are under conservation or reduced tillage. The lack of stratification in pH possibly indicates that soil acidity in the plow layer can be corrected even when soils are not intensively tilled. Audience response indicated that more than 89% of producers conduct soil sampling for P, K, and pH analysis at least every 4 years and 55% indicated that current University recommendations are adequate for P and K. While audience response and fields sampled are not necessarily linked directly, the information from these two surveys illustrates the need for education on following recommendations and interpreting soil analysis. This information is being used by extension specialists and educators in Illinois to illustrate the benefit of using soil test information to manage nutrients in times of high fertilizer prices.

Introduction

Illinois has over 10 million hectares of cropland. A substantial portion of this area has some of the most productive soil in the world. Most of this land is dedicated to corn (*Zea mays* L.) and soybean [*Glycine max* (L.) Merr.] production. Flanking the impressive entrance of Davenport Hall, formerly known as the Agriculture Building, in the main campus of the University of Illinois there is a quote by A.D. Draper (University president from 1894 to 1904) proclaiming "The wealth of Illinois is in her soil and her strength lies in its intelligent development." Even though many soils in Illinois are highly productive, it is important to conduct regular soil sampling and analysis to determine the need for fertilizer additions in order to maintain their productivity. Illinois has a set of recommendations for P, K, and limestone applications to help guide producers on the fertilizer and lime inputs needed to maximize productivity of their crops. This recommendation system is also important to help protect resources and the environment from over- or under-application of fertilizers. Of special interest is over application of P because of its potential for environmental degradation. Fertilizers are becoming increasingly a more costly input in farming operations, and the profitability margins seem to continue to narrow. Thus, producers have to make certain to make the most informed decisions in order to maintain solvent. For these reasons, having a recommendation system for P, K, and limestone applications is of outmost importance.

Illinois soil P, K, and limestone recommendation system

Sound fertilizer recommendations for the application of P and K fertilizers in Illinois were developed by soil test data and yield response curves generated from fertilizer rate studies. The yield response curve can be divided into three major segments: 1) the critical level (CL) is defined as the point at which near maximum yields are achieve; 2) A test level at which additional application of P and K is very unlikely to produce an increase in yields; and 3) a maintenance level range which falls between the previous two points. Producers are encouraged to maintain test levels within the maintenance range by applying an amount of P and K equal to what is removed by the harvested portion of the crop. This strategy ensures adequate fertility to maximize productivity. When soil test levels are below the CL, additional fertilizer applications, beyond what the crop will remove from the harvested portion, are needed to build the soil test levels to at least that point. This is recommended to prevent yield loss due to inadequate nutrient availability. When soil test levels are above a point at which additional P and K applications are not likely to increase yield, it is recommended to stop additional applications to drawdown soil test levels to the maintenance range. This strategy is designed to improve the return on the fertilizer investment, and to prevent building soil test levels to a point that can pose environmental risks or adversely affect other nutrients in the system. The state is divided into three major P regions associated with the P-supplying power of the soil (Fernández and Hoeft, 2009). The critical soil test levels for P are 15, 20, and 23 mg kg^{-1} for the high-, medium-, and low-P supplying region, respectively. It is not recommended to apply additional P fertilizer when soil test levels are above 30, 33, 35 mg P kg^{-1} for the high-, medium-, and low-P supplying region, respectively. The state is divided into two major K-supplying power regions associated with the cation exchange capacity (CEC) of the soil. The low-K supplying power region has soils with CEC below 12 meq. $100g^{-1}$ and the high-K supplying power region has CEC values ≥12 meq. $100g^{-1}$. Some soils with high sand content also fall within the low CEC category. The critical soil K levels are 130 and 150 mg kg^{-1} for the low- and high-K supplying power region, respectively. It is not recommended to apply additional K when soil test levels are above 180 and 200 mg kg^{-1}, for the low- and high-K supplying power region, respectively. Soil pH for corn and soybean production is recommended to be maintained between 6.0 and 6.5. Additional limestone applications to raise pH above 6.5 are not recommended because the yield increase would not pay for the added cost of the material.

Justification for this study

The high price of fertilizers in recent years induced many producers to reduce or eliminate application of P and K in their farms. This strategy was used by many to reduce costs in the short-term and to allow time for the market to return back to more traditional prices. While some producers could afford to produce a few crops without replenishing what was removed and not see a yield decline, others were likely at soil test levels that would not allow them to reduce application rates without paying a yield-reduction penalty. In light of this situation, and seeing it as an excellent opportunity to educate producers on proper management of P and K fertilizer inputs, it was decided that a survey to determine the soil fertility status of soils in Illinois would be necessary. This survey would provide information to illustrate the importance of soil testing for P, K, and soil pH management, and it would provide useful information to extension specialists and other groups to address present-day challenges related to crop nutrient management. Along with this effort it was determined that there was a need to conduct an additional survey to know what the perception of end users was on current University recommendations for the state. These two surveys could provide a database foundation from which additional studies could be conceived to improve crop nutrient management in Illinois. On in an effort to determine the current fertility of the soils in Illinois a survey was conducted in the fall of 2007 and 2008. The survey was conducted mostly by

Approach

The soil survey was conducted by-in-large by volunteers conducting the annual European Corn Borer (ECB) Survey. This survey has taken place for more than 60 years in Illinois. Soil samples were taken from 598 randomly-selected fields in 52 of the 102 counties in Illinois during the fall of 2007 and 2008. Sample locations are shown in Figure 1. Samples were collected prior to harvest of the corn crop during September and October. This approach prevented sampling fields with very recent fertilizer applications. A 6-core (2 cm diameter) composite sample was taken from each field within a 3-meter diameter area that was georeferenced at the time of sampling. Each sample was divided into the 0-8 and 8-18 cm soil depth increment. Unfortunately, a few samples were collected to shallower depths or were not partitioned into the two depth increments; therefore, those samples could not be included in some of the datasets. Samples were air-dried and ground to pass through a 1-mm sieve. Samples were analyzed for Bray P_1; ammonium acetate-extractable K, calcium (Ca), and magnesium (Mg); pH (1:1v:v); and organic matter (OM) by loss of weight on ignition (LOI) at 360°C.

Soil classification information for each sample location was obtained from the USDA-NRCS Web Soil Survey database (2009). Historic information on number of cattle and swine production by county was obtained from the USDA-NASS Quick Stats database (2009).

An audience survey to determine perception on current soil fertility recommendations was conducted during the Corn and Soybean Classic Conference series (January, 2009) in which 833 responses from an audience of approximately 1,100 participants was obtained using the TurningPoint® (©2002-2008 Turning Technologies, LLC) audience response system. The survey questions and answer choices are listed in Table 1. Only the responses made by producers (340 responses) will be presented here. Prior approval on these questions was obtained from the Institutional Review Board for the protection of human subjects (IRB).

Results and Discussion

Soil fertility surveys typically gather information from soil samples submitted to testing labs.). While these studies provide relevant information, one of the potential biases with this approach is that since soil samples were submitted for analysis, the person submitting them likely is interested in maintaining adequate fertility in the field and understands the importance of regular assessment of soil fertility. One of the unique aspects of the survey presented here is that, since the soil survey was done in random fields selected for a purpose other than the evaluation of soil fertility (main focus was the ECB survey), the survey should provide an excellent source of unbiased information that more closely would represent the actual soil fertility status of Illinois. The only possible bias of this survey is that samples were collected only from fields with corn growing during the year of the survey.

Descriptive statistics of soil parameters for composite 0-18 cm soil samples across Illinois, at the different P-supplying power regions, and at the different K-supplying power regions based on CEC are shown in Tables 2, 3, and 4, respectively. Across the state there was a large range of values for the variables measured. Median and mean P values were above the levels at which no additional P fertilization is recommended (NA) across the state and clearly indicates P levels are high for crop production in Illinois. Similar results were observed when mean P levels were calculated for each P-supplying region (Table 3). Across the state, potassium median and mean values were within maintenance levels. Similar results were observed for the different K-supplying power region of the state, except for the low K-supplying region where the median and mean values were below the CL (Table 4). This would indicate that generally speaking the southern one-third portion of the state (Figure 1B) would benefit from a K-buildup management approach. It is important to point out, however, that it is possible these lower values could be an artifact of a lower sampling density (only 78 fields). The critical soil levels for Ca are between 200 and 400 mg Ca kg^{-1} and for Mg between30 and 100 mg Mg kg^{-1}. The survey data indicates that both nutrients appear to be in abundant supply and likely are not going to pose major concerns for corn and soybean production in the foreseeable future. In general, soil OM was slightly above 3% and pH values were centered at 6.7. The current recommendation is to maintain pH values between 6.0 and 6.5 for corn and soybean production. In soils where limestone applications are required to maintain adequate pH levels, increasing the pH above 6.5 is not recommended purely from an economical, not agronomical, standpoint. An average pH of 6.7 across the state indicates that producers are applying limestone to maintain adequate soil pH. Slightly lower K values for the low P-supplying power region (Table 3) are likely an artifact of the number of fields present in this region that are also within the low CEC soils requiring lower K test values to maximize productivity (Compare field A and B in Figure 1). Calcium, Mg and OM showed trends of increasing levels from the high- to the low-P regions (Table 3). This was expected since P-supplying regions were primarily determined by parent material and degree of weathering which also influences these other parameters. Soil pH was not influenced by P-supplying region and indicates that pH levels are being controlled by management rather than nature. As in the case of P-regions, K-supplying power regions were also determined by soil conditions (CEC of the soil). A trend for lower Ca, Mg, and OM mean values in the low- compared to the high-K supplying regions is indicative of native soil conditions (Table 4).

Mean and median P and K soil test levels for the different counties surveyed are showed in Figures 2 and 3, respectively. Except for Shelby and Tazewell County, all counties had mean and median P levels at or above the CL (Figure 2). Seventy eight percent of the counties had P mean levels above 35 mg P kg^{-1} test level at which no additional P applications are recommended for the low-P supplying region. On the other hand, for K only 18% of the surveyed counties had mean K levels above 200 mg K kg^{-1} test level at which additional K applications are not recommended and 7 counties (14%) were below the CL of 130 mg K kg^{-1} (Table 3). For P and K most often mean values were greater than median values indicating distribution of soil test levels squawked towards higher values.

The number of fields and percent of total surveyed fields below the recommended CL, above the level at which no additional fertilization—P and K— is recommended (NA), or at maintenance levels (between CL and NA) for the different phosphorus- and potassium-supplying power regions are shown in Table 5. The number of fields testing below the different CLs increased from the high- to the low-P supplying regions. Conversely, the number of fields that tested above NA increased from low- to high-P supplying regions. These results perhaps indicate that P supplying power in the high-P region is actually higher than what was suspected when the P-regions were delineated, and applications of P overtime have caused an increase in test levels. Also, it is possible that in the low-P regions, where higher test levels are required, not enough P fertilizer is being applied. The large majority of fields in the high- and medium-P regions are above NA, while a substantial number of fields are below CL for the high- and low-K regions. These results indicate the need to manage these nutrients separately. The data seems to indicate that in many cases there might not be need to make a combined P and K application. Generally speaking, these data would indicate a need to allocate some of the resources currently being used for P into K applications.

A similar soil fertility survey to the one conducted in this study was done between 1967 and 1969 in Illinois (Walker et al., 1968, 1969, 1970). While the sampling depth, time of collection, and locations may be different between the two surveys, a comparison of soil test values provides insight on the state-wide soil fertility changes that have occurred over approximately 40 years. Table 6 shows the results of the former and current survey. Phosphorus levels have increased over time. Soil pH is at better levels today than when the first survey was conducted. Early, 35% of the sites were at or below pH 6, whereas now only 15% of the sites are in that category. Currently 32% of the fields surveyed are testing above pH 7 compared to only 13% during the former survey. This would indicate that producers are overall applying good management practices to manage soil pH. In the earlier survey, 30% of the fields were below CL (≤15 mg kg^{-1}) for P compared to only 11% in the recent survey. While both surveys show slightly over 50% of fields near the critical levels to somewhat above maintenance (16-50 mg kg^{-1}), the new survey shows a greater percentage at the higher test range. In the recent survey, 19%

more fields were in the very high (>50 mg kg^{-1}) soil P level category compared to the earlier survey. The distribution of values for K is surprisingly similar between the two surveys. The recent survey shows slightly more fields at the higher end of the maintenance range or slightly above it.

The adoption of conservation tillage systems to help protect natural resources and to reduce farming costs can induce changes in nutrient distribution in the soil profile. Conservation tillage systems are characterized by minimal soil disturbance. Limited mobility of surface broadcast limestone and P and K fertilizers in combination with reduced mixing of the soil can create strong vertical stratification with highest pH levels and P and K concentrations occurring on the top surface layer of the soil compared to the soil layer underneath. Tables 7, 8, and 9 show soil test levels at the different soil depth increments and their corresponding surface to subsurface ratios across the state, for the different P-supplying regions, and for the different K-supplying regions, respectively. Both P and K were stratified, but P showed greater stratification with a 2.4:1 ratio compared to 1.5:1 for K (Table 7). Soil OM was also slightly stratified. On the other hand Ca, Mg, and pH were not stratified. These results likely indicate that most soils in Illinois are being managed under conservation tillage systems. It is important to point out that pH levels were not stratified. This likely indicates that limestone applications are being done regularly, allowing the material to reduce soil acidity at depth even when soils are not being mixed. Results across the state were not different than those observed by the different P- (Table 8) and K-supplying power regions (Table 9) except that the ration of stratification for P increased from the high- to the low-P supplying power region. This was expected because the high-P supplying soils have greater inherent P availability in the subsurface.

It is not clear which factor or factors have contributed to the high soil test levels, especially P, that were observed in this survey. It is possible that higher rates of application than those needed to maximize production have overtime built up test levels. Another possibility is that crops are continually removing nutrients from subsurface layers and depositing nutrients in the form of crop residue on the soil surface. Another possibility is that soil tests have build by frequent manure applications. However, a scatter plot showing the relationship of number of swine and cattle produced in the last 30 years and the mean soil P level by county showed no clear evidence to substantiate this possibility (Figure 4). Other such relationships were studied, but yielded similar results (Data not shown). Finally, another possibility is that soils built overtime by less than expected P and K removal rates during marginal-yielding years. Whatever, the factors may be, it is clear that many people are not following current university recommendations to manage their P and K. In general, P is being over-applied and K is being under applied. Both situations can lead to a reduction on investment, and in the case of P, to greater potential for environmental degradation.

In contrast to what was found through the soil survey, the audience survey showed most people agree that current P and K recommendations are adequate (55% of the responses) and most producers are testing their soils frequently (every 4 years) (Table 10). It is also interesting to notice that during the survey (P and K fertilizer prices were very high compared to the recent past) 53% of the producers agreed that they would reduce P and K application for the 2009 crop, but 38% would make no changes. This audience likely represents the more progressive sector of Illinois farmers, and while it is not possible to make inferences from this survey to understand the results from the soil survey, the surveys illustrate the need to continue to educate fertilizer users on the benefits of following sound crop-nutrient management practices.

References

USDA-NASS Quick Stats. 2009. http://www.nass.usda.gov/Data_and_Statistics/Quick_Stats/index.asp (verified October 15, 2009)

USDA-NRCS Web Soil Survey. 2009. http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm. (Verified October 15, 2009).

Walker, W.M, T.R. Peck, S.R. Aldrich, and W.R. OSchwald. 1970. Nutrient levels of corn and soybean fields remain high. *In* Illinois Research. Univ. Illinois Agric. Exp. Stn. 12:16-17.

Walker, W.M, T.R. Peck, S.R. Aldrich, and W.R. OSchwald. 1969. Illinois soils remain high in nutrients according to 1968 plant and soil analyses. *In* Illinois Research. Univ. Illinois Agric. Exp. Stn. 11:6-7.

Walker, W.M, T.R. Peck, S.R. Aldrich, and W.R. OSchwald. 1968. Nutrient levels in Illinois soils. *In* Illinois Research. Univ. Illinois Agric. Exp. Stn. 10:12-13.

Table 1. Survey questions and possible answers used during an audience survey to determine perception on current fertilizer recommendation in Illinois.

A) Which of the following describes your primary occupation? 1) Producer, 2) Ag input supplier (retailer), 3) Ag chemical company representative, 4) Seed company representative, 5) Consultant, 6) Other
B) (For producers) In your operation, how many acres are dedicated to corn AND soybean production? 1) <500; 2) 500-1,000; 3) 1,001-2,000; 4) 2,001-5,000; 5) >5,000
C) (For suppliers/reps/consultants) How many acres do you assist with or have influence with? 1) 1 – 1,000; 2) 1,001-10,000; 3)10,001-50,000; 4) 50,001-100,000; 5)>100,000
D) What do you think about the critical levels for P recommended for corn and soybean production in Illinois? 1) Too low; 2) About right; 3) Too high; 4) Don't know
E) What do you think about the critical levels for K recommended for corn and soybean production in Illinois? 1) Too low; 2) About right; 3) Too high; 4) Don't know
F) How often do you soil sample for P, K, and pH? 1) Every 2 years at least; 2) Every 4 years; 3) Every 5-10 years; 4) Never
G) Do you plan on applying less P and K for the 2009 growing season? 1) Yes, by quite a bit; 2) Yes, by a little; 3) No change; 4) I will be applying more P and K

Table 2. Descriptive statistics of parameters for the top 18 cm of soil across 547 fields in Illinois.

Variable	Minimum	Maximum	Median	Mean
Phosphorus (mg kg^{-1})	1	576	39	51
Potassium (mg kg^{-1})	31	794	152	172
Calcium (mg kg^{-1})	404	6485	2047	2226
Magnesium (mg kg^{-1})	37	1107	329	366
OM (%)	0.9	8.9	3.2	3.3
pH (%)	4.7	8.1	6.7	6.7

Table 3. Descriptive statistics of parameters for the top 18 cm of soil at the different phosphorus-supplying power regions of Illinois.

	High-P region (n= 202)				Medium-P region (n =168)				Low-P region (n =177)			
Variable	Minimum	Maximum	Median	Mean	Minimum	Maximum	Median	Mean	Minimum	Maximum	Median	Mean
Phosphorus (mg kg^{-1})	6	576	43	60	1	407	39	52	1	197	32	40
Potassium (mg kg^{-1})	43	639	152	179	49	701	165	178	31	794	146	158
Calcium (mg kg^{-1})	404	4653	1911	2056	711	5812	2074	2270	743	6485	2248	2380
Magnesium (mg kg^{-1})	37	857	273	298	59	1031	300	342	92	1107	471	467
OM (%)	0.9	6.6	2.7	2.8	1.2	6.2	3.4	3.4	1.7	8.9	3.6	3.8
pH (%)	4.7	8.0	6.8	6.8	5.2	8.0	6.5	6.6	5.1	8.1	6.8	6.8

Table 4. Descriptive statistics of parameters for the top 18 cm of soil at the different potassium-supplying power regions of Illinois based on cation exchange capacity (CEC).

	High-CEC region (n= 447)				Low-CEC region (n =78)				Low-CEC (sands) region (n =22)			
Variable	Minimum	Maximum	Median	Mean	Minimum	Maximum	Median	Mean	Minimum	Maximum	Median	Mean
Phosphorus (mg kg^{-1})	1	576	38	51	3	150	44	48	3	168	52	63
Potassium (mg kg^{-1})	43	794	158	179	31	310	119	127	71	377	173	188
Calcium (mg kg^{-1})	711	6485	2141	2344	743	4498	1563	1658	404	3941	1756	1859
Magnesium (mg kg^{-1})	37	1107	376	400	59	524	152	175	52	857	334	362
OM (%)	1.2	8.9	3.3	3.5	1.3	5.2	2.4	2.5	0.9	6.1	3.4	3.2
pH (%)	4.7	8.1	6.7	6.7	5.2	8.0	6.7	6.6	5.0	8.0	6.6	6.6

Table 5. Number of fields and percent of total surveyed fields below the recommended critical level (CL), above the level at which no additional fertilization is recommended (NA), or at maintenance levels (between CL and NA) for the different phosphorus-supplying power regions and potassium-supplying power regions based on cation exchange capacity (CEC).

		CL	NA	Below CL		Maintenance		Above NA	
Region	n	mg kg^{-1}	mg kg^{-1}	Fields	%	Fields	%	Fields	%
Phosphorus									
High	202	15	30	14	7	40	20	148	73
medium	168	20	33	26	16	41	24	101	60
low	177	23	35	60	34	41	23	76	43
Potassium									
High CEC	447	150	200	195	44	126	28	126	28
Low CEC	78	130	180	47	60	20	26	11	14
Low CEC (Sands)	22	130	180	7	32	4	18	11	50

Table 6. Comparison of frequency distribution of soil test values for two soil surveys conducted from 1967 to 1969 and from 2007 to 2008 in Illinois.

pH range	1967-69	2007-08	P test range	1967-69	2007-08	K test range	1967-69	2007-08
	%*	%	mg kg^{-1}	%	%	mg kg^{-1}	%	%
≤4.5	0.1	0	≤5	3	1	≤60	3	3
4.6-5.0	2	0.4	6-10	11	4	61-90	12	8
5.1-5.5	12	3	11-15	16	6	91-120	18	19
5.6-6.0	21	12	16-20	15	7	121-150	23	18
6.1-6.5	31	24	21-25	12	10	151-250	30	40
6.6-7.0	22	28	26-50	26	35	251-400	9	9
7.1-7.5	10	23	51-100	12	26	401-550	3	2
>7.5	3	9	>100	5	10	>550	3	1

*Percent relates to the percent of the total number of fields surveyed in each survey that fall within the prescribed pH, phosphorus (P) and potassium (K) ranges.

1967-1969 survey had 1,384 samples collected from corn and soybean fields during the growing season from the 0-15 cm soil depth increment.

2007-2008 survey had 547 samples collected from corn fields in the fall prior to harvest from the 0-18 cm soil depth increment.

Table 7. Soil parameters at different depths and surface (0-8 cm) to subsurface (8-18 cm) ratio across Illinois.

Soil depth parameter	P	K	Ca	Mg	pH	OM
State (n=547)	------------------------mg kg^{-1}-------------------------				------------%------------	
0-8cm	64a	206a	2173	357	6.8a*	3.5a
8-18cm	40b	144b	2259	372	6.7b	3.1b
Ratio	2.4	1.5	1.0	1.0	1.0	1.2

Values followed by the same letter within column are not different by Mann-Whitney Rank Sum Test (p>0.001). * indicate p<0.1.

Table 8. Soil parameters at different depths and surface (0-8 cm) to subsurface (8-18 cm) ratio for the different soil phosphorus-supplying power regions of Illinois.

Soil depth parameter	P	K	Ca	Mg	pH	OM
	-------------------- mg kg^{-1} --------------------				---------- % ----------	
High P region (n=202)						
0-8cm	71a*	214a	2027	297	6.9	3.0a
8-18cm	51b	152b	2078	299	6.7	2.7b
Surface:subsurface ratio	2.1	1.5	1.0	1.0	1.0	1.2
Medium P region (n=168)						
0-8cm	65a	213a	2193	329	6.6	3.6a
8-18cm	38b	146b	2304	346	6.6	3.2b
Surface:subsurface ratio	2.5	1.5	1.0	1.0	1.0	1.2
Low P region (n=177)						
0-8cm	56a	190a	2320	451	6.8	4.1a
8-18cm	28b	133b	2424	479	6.8	3.6b
Surface:subsurface ratio	2.8	1.5	1.0	1.0	1.0	1.2

Values followed by the same letter within column and P region are not different by Mann-Whitney Rank Sum Test (p>0.001).

Table 9. Soil parameters at different depths and surface (0-8 cm) to subsurface (8-18 cm) ratio for the different potassium-supplying power regions of Illinois based on cation exchange capacity (CEC).

Soil depth parameter	P	K	Ca	Mg	pH	OM
	---------------------- mg kg^{-1}			---------------------	---------- %	----------
High CEC region (n=447)						
0-8cm	63a	213a	2288	390	6.8a*	3.7a
8-18cm	40b	151b	2378	406	6.7b	3.3b
Surface:subsurface ratio	2.4	1.5	1.0	1.0	1.0	1.1
Low CEC region(n=78)						
0-8cm	66a	163a	1624	170	6.7	2.8a
8-18cm	35b	100b	1684	178	6.6	2.2b
Surface:subsurface ratio	2.7	1.7	1.0	1.0	1.0	1.4
Low CEC region (sands) (n=22)						
0-8cm	77a**	227a**	1795	350	6.5	3.3
8-18cm	52b	159b	1908	370	6.6	3.0
Surface:subsurface ratio	1.9	1.5	1.0	1.0	1.0	1.1

Values followed by the same letter within column and CEC region are not different by Mann-Whitney Rank Sum Test ($p>0.001$). *, ** indicate $p<0.1$ and $p<0.05$, respectively.

Table 10. Producer's response to survey questions.

	All producers	Response by farm size range (acres)				
		<500	500 – 1,000	1,000 – 2,000	2,000 – 5,000	>5,000
Categories	n=340	n=45	n=84	n=116	n=66	n=16
	% of responses					
P recommendations						
Too low	11	11	7	12	15	25
About right	55	60	61	54	47	63
Too high	8	4	8	9	12	0
Don't know	17	22	15	18	17	6
No response	8	2	8	7	9	6
K recommendations						
Too low	16	18	14	16	17	38
About right	55	53	60	59	50	44
Too high	9	9	11	7	12	0
Don't know	12	13	8	11	12	13
No response	8	7	7	6	9	6
Soil test frequency						
Every 2 years at least	10	18	11	5	8	0
Every 4 years	79	67	81	84	74	75
Every 5-10 years	7	9	6	5	15	19
Never.	0	2	0	0	2	0
No response	4	4	2	5	2	6
Apply less P and K in 2009?						
Yes, by quite a bit	19	16	19	18	29	19
Yes, by a little	34	20	37	35	41	38
No change	38	56	35	39	27	38
Applying more	1	7	1	0	0	0
No response	8	2	8	8	3	6

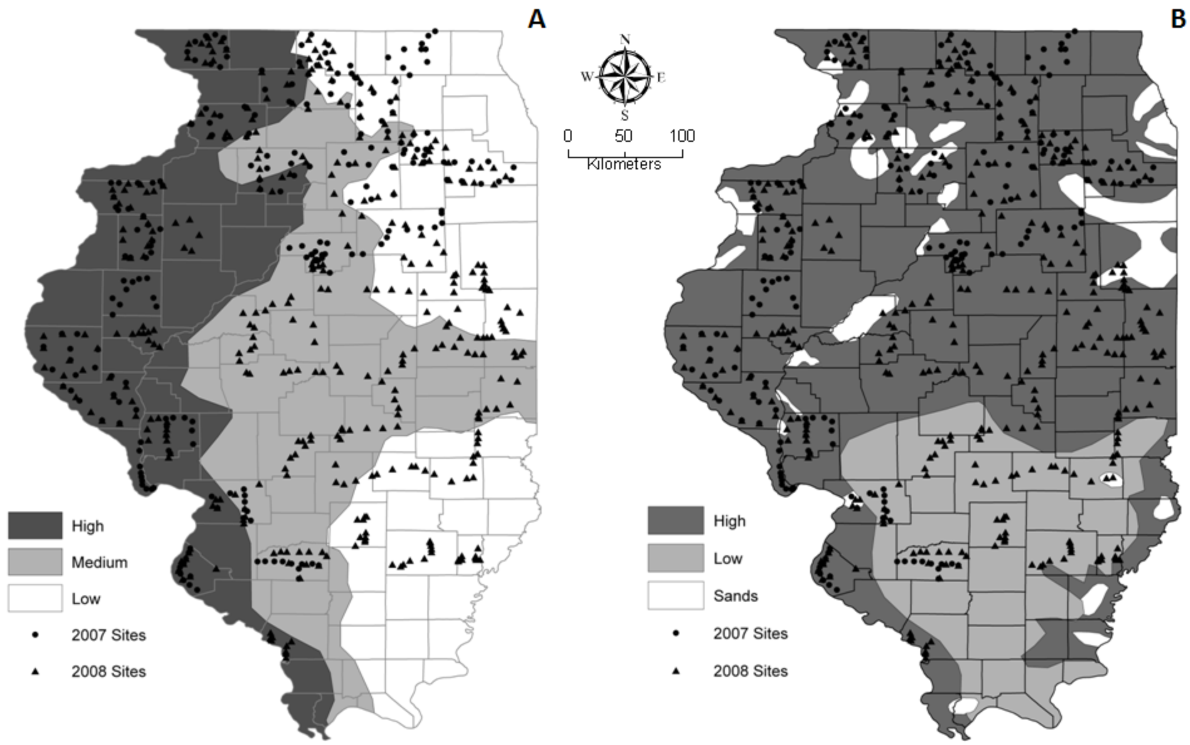

Figure 1. Illinois county map with location of fields surveyed in 2007 and 2008 and the corresponding phosphorus-supplying power regions (A) and potassium-supplying power regions based on cation exchange capacity (B).

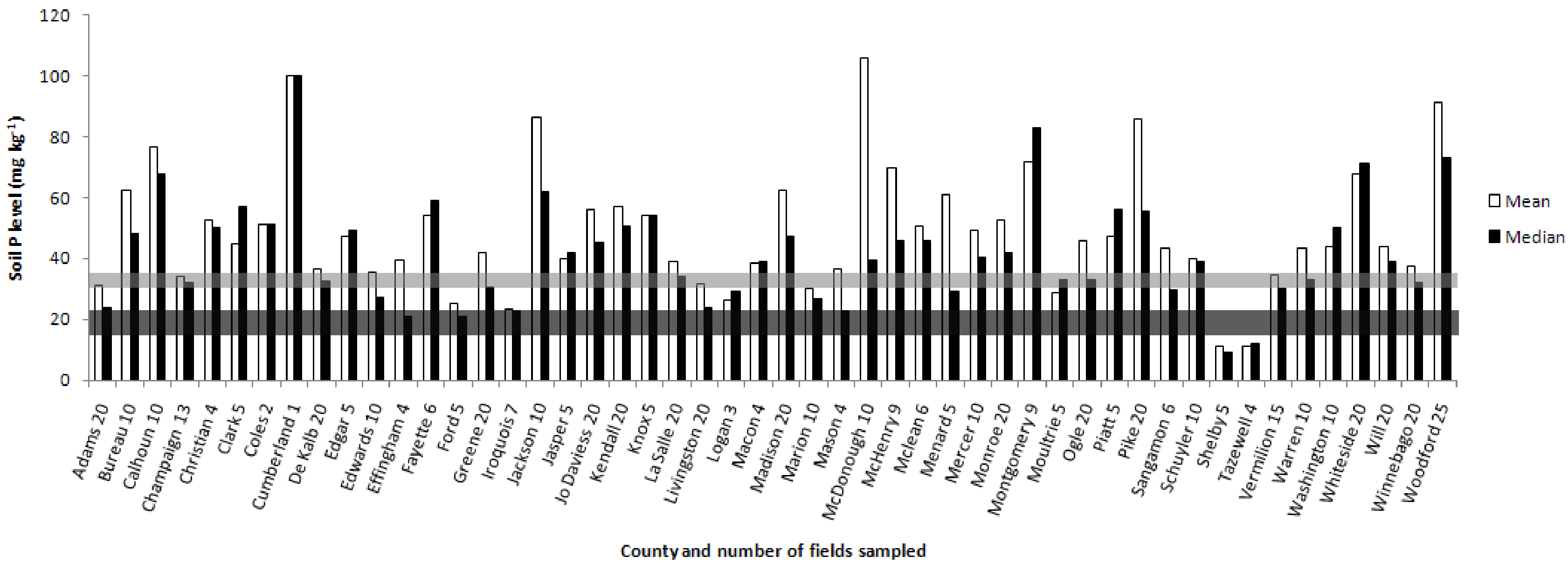

Figure 2. Mean and median phosphorus soil test levels for the different counties surveyed. Dark-gray and light-gray bands represent the range of values across the different phosphorus-supplying power regions of Illinois for critical levels and levels at which additional application of phosphorus is not recommended, respectively.

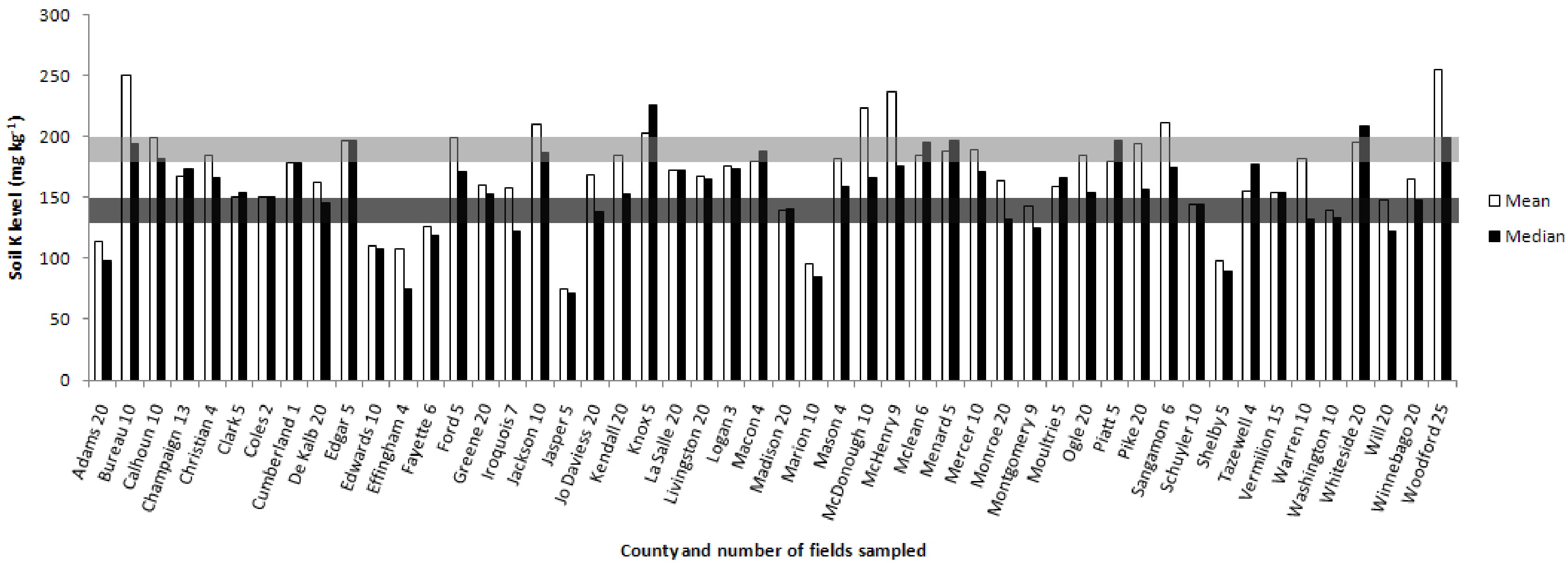

Figure 3. Mean and median potassium soil test levels for the different counties surveyed. Dark-gray and light-gray bands represent the range of values across the different potassium-supplying power regions of Illinois based on cation exchange capacity (CEC) for critical levels and levels at which additional application of potassium is not recommended, respectively.

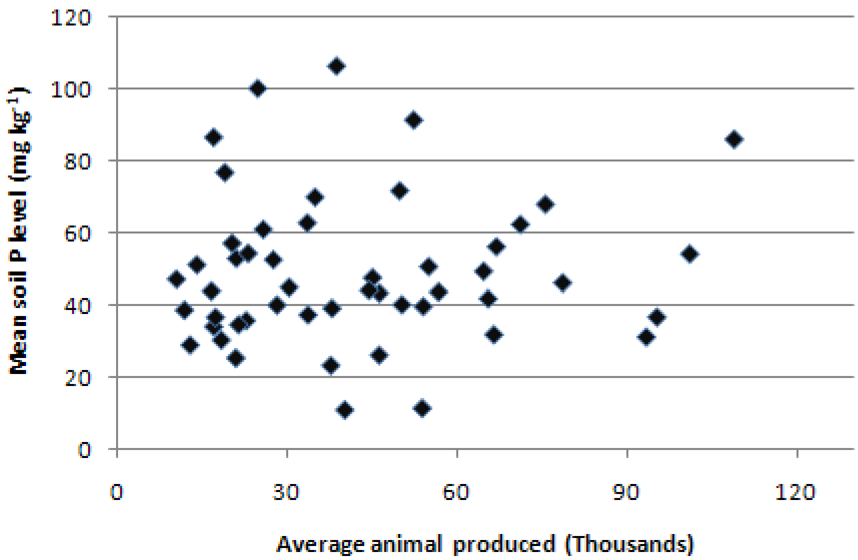

Figure 4. Relationship between average animal produced (Swine and cattle) between 1978 and 2008 and mean soil test phosphorus levels at the 0-18 cm depth increment for 50 counties.

PROCEEDINGS OF THE

THIRTY-NINTH
NORTH CENTRAL
EXTENSION-INDUSTRY
SOIL FERTILITY CONFERENCE

Volume 25

November 18-19, 2009
Holiday Inn Airport
Des Moines, IA

Program Chair:

John Lamb
University of Minnesota
St. Paul, MN 55108
(612) 625-1772
JohnLamb@umn.ed

Published by:

International Plant Nutrition Institute
2301 Research Park Way, Suite 126
Brookings, SD 57006
(605) 692-6280
Web page: www.IPNI.net