



# CCA ADVANTAGE

The Voice of the Certified Crop Adviser Program  
[www.agronomy.org/cca](http://www.agronomy.org/cca)

## Trends in Custom Application ... Auto Guidance Will Give an Additional Boost

By Bob Wanzel  
Senior Editor, *AgProfessional magazine*

**D**uring this election year, hardly a day goes by without the national media releasing a new poll discussing voter opinions and intentions.

CCA Advantage is not to be outdone as we conducted our own informal poll on the state of custom application business as perceived by several Certified Crop Advisers.

Two basic premises drove our questioning: How have the trends toward larger-sized farms and biotech products affected custom application ... and how many farmers are now applying themselves?

"Our growers tend to do their own spraying for the first application of glyphosate, but they ask us to do the second application," says **Troy Greenfield**, CCA from Chandler Co-op near Marshall, MN. Greenfield adds that even though his customers are buying more pull-type sprayers, his application business has not fallen off. "I get worried when growers decide on a herbicide program based upon the number of times they have to clean the spray tank. This just isn't a basis for an agronomic solution to a weed control program," adds Greenfield.

### QUESTIONS TO ASK

**Mike Sims**, CCA, agronomy manager for AgPlus, South Whitley, IN, affirmed that in parts of his sales area the larger farmers are doing more of their own spraying, as well. "However, overall our custom application business has been up the last few years," he says. "I always ask the growers a couple of questions when they contemplate doing their own spraying: (1) Are you sure you want the liability of spraying close to the neighbor's garden? (2) What are you going to do when the state asks you for your

spraying records? (3) Do you really know the exact cost of the equipment including tractor time, fuel and your time? (4) Do you want to park your planter and go spray while you are planting?"

"We're the cheapest hired hand the farmer can have," explains Sims. He also noted his cooperative's tendency to bundle more programs and services to help keep the custom application business active. "We have a soil sampling program tied to fertilizer and herbicide applications, so that way we can discount the application costs to the customer utilizing our total program," he says.

### AUTO STEERING

Custom application means different things to different parts of the country. We talked with **Pete Romano**, CCA, president of Quincy Farm Chemicals in Quincy, WA. "Historically, I don't look toward application as a profit center," explains Romano. "Guidance systems have revolutionized our pre-emergence fertilizer and herbicide applications," he says. Romano is completing his second year with four application rigs utilizing an auto-guidance system from Beeline Manufacturing.

"The quality and accuracy is much higher with the auto-guidance," he explains. "Our drivers are more relaxed, there are fewer mental mistakes and they can focus on catching mechanical problems." Quincy Farm Chemicals applications are within a two-inch accuracy window on a variety of some 50 crops.

In many parts of the county the current state of adopting the new guidance systems is for retailers to shrug off the new technology with a question like, "sure it works on the high value crops but what about Midwestern row crops?"

Romano may have an answer to that question. "You could argue that increased accuracy in lower-value crops could

### CCA EVENTS

#### October 4-6: ICCA Fall Board Meeting

Chicago, IL  
Contact: 608/268-4977

#### October 24-26: CAPCA 30th Annual Conference

Anaheim, CA  
Contact: 916/928-1625

#### December 14-15: Indiana CCA Conference

Indianapolis, IN  
Contact: 800/387-1283

#### January 12-13: 2005 CCA Conference and Annual Meeting

Niagara Falls, Ontario  
Contact: 519/669-3350

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## CropLife Ambassador Network a Forum for CCA



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**D**oes the public know? More than 14,000 Certified Crop Advisers (CCAs) educate growers on efficient and responsible agronomic practices. You keep informed and up to date with the latest technologies to help solve the continuing challenge of producing high yields of quality food, fuel and fiber while using resources efficiently and minimizing harmful impacts on our environment.

They need to know. The CropLife Ambassador Network (CAN) is a forum that can help you get the message of your value out to the public. CAN is an educational program of the Mid America CropLife Association (MACA). Our mission is to provide scientifically based, accurate information to the public regarding the safety and value of American agricultural food production.

CAN uses industry members to educate the public, primarily grade school children, about agriculture and the methods commonly used by America's agribusiness. While students receive basic information about agriculture they are also exposed to the roles of industries involved.

Children in grades three through six are our primary emphasis.

It is much easier to teach scientifically based facts about our industry to the young than to combat misperceptions in adults. Children, especially in urban areas, tend to think food originates from the grocery store. Agriculture's positive message needs to be told in our classrooms not only to the stu-



*Francis Vahlkamp of St. Clair Service Co. talks to a class at Gateway Elementary School, St. Louis, MO.*

dents, but also to the teachers, who are more likely to relate a positive message to future students.

### AMBASSADORS ARE THE LINK

The core part of the program is the "ambassadors," volunteers from leading agricultural businesses in the Midwest. Currently we have just under 300 ambassadors throughout the Midwest participating. As the program coordinator, I provide the link between the ambassador and schools across the Midwest. Ambassadors find making the connection between their work and the people who benefit from it is rewarding.

During one-45 minute visit with a classroom, you leave a positive lesson about agriculture, and more importantly, you have introduced them to you, a Certified Crop Adviser. It's an opportunity to bring agriculture and your profession to a personal level.

The ambassadors may use the PowerPoint presentation tools developed at CAN, which can be downloaded from our Web site [www.maca.org](http://www.maca.org). Our presentations include America's Abundance, which ties in with the Thanksgiving season, while Feeding Planet Earth and Environmental Stewardship both correlate well with Earth Day in April. In addition, Biotechnology, Agriculture and Food Safety, Water Issues and Careers in Crop Protection are all available and continue to be very timely.

### A CHALLENGE TO YOU

With a strong network of individuals committing to one or two school visits per year, we CAN make a difference. During our spring 2004 campaign we reached over 1,400 students across the Midwest with facts about the safety of our food supply and the role of the industry that supplies it. I challenge you to be part of the future by volunteering as an ambassador.

To find out more or join our network, visit [www.maca.org](http://www.maca.org) and click on the CropLife Ambassador Network logo or call 314/849-9446.



*Syngenta's Doug Mertens generates a lot of enthusiasm in the classroom about agriculture's positive message each time he participates in MACA's CropLife Ambassador Network.*



## Chairman's Corner

# Thank You for the Opportunity to Serve as Your ICCA Chair



By Dr. Bob Beck  
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I appreciate your taking time to read my thoughts about our relationship. One of the key rules of business and personal interactions is "relationship first, business second." I would like to offer you a few points to ponder regarding our relationship and its impact on our business as CCAs.

My intent is to increase your awareness and invite you to share and enhance your professionalism. From this relationship, we can live up to the expectations that our clients, customers and colleagues have of us as we practice our profession: AGRONOMY.

We have been enhancing the professionalism together over this past decade, and this year we began our second decade as a certifying activity of the American Society of Agronomy. We have standardized nearly all of our activities and procedures and yet maintain a strong local oversight by the state, regional and provincial boards.

### UNIFIED PRESENCE

Our goal as a leadership team has been to present a unified presence to those who would doubt our professionalism and care of the environment we work in. This organization is a very dedicated, helpful and caring team of people with whom you have a relationship that you may not have thought much about.

I would like to share a story that I ask you to consider in the context of "being a Certified Crop Adviser." You may have viewed

a video or read a book about the FISH philosophy. The 17-minute video from Charthouse Communications features a successful team of fishmongers from Pikes Place Fish in Seattle, WA.

Being a fishmonger is not easy. They have a simple four-part philosophy as they go about fulfilling their vision statement of being "World Famous." That may sound like a very ego-centered vision, but let me explain.

### FOUR STEPS

The four parts are (1) be there, (2) choose your attitude, (3) make their day and (4) play. You have chosen right now to "be here" reading these words. Conscious of that decision or not, I believe from here forward you will be more aware that you control that decision. Choose wisely, it impacts relationships. Remember you choose to become certified. Congratulations.

You also "choose your attitude." Take time to evaluate your attitude at any given moment and realize you have freedom to choose a different one if this one is not enhancing the relationship. Your intent may be pure, but is your attitude in alignment? People cannot see your intent but they can observe your attitude.

You can "make their day." When you do your job to the best of your ability, you make someone's day by taking the time to think about how you would like to be treated in the same situation.

### PLAY!

The last step is what they call play, but it is the natural outcome of the first three steps when you have facilitated the solution to a problem you and your client are struggling with. It is a joyous moment and that, by the way, makes it fun and not work. When you are performing at peak efficiency and effectiveness, you have a lot of fun and I would call it play.

I challenge you to observe yourself in the four parts the FISH philosophy as you reflect on marketing yourself as a CCA. You are respected. That respect is critical to maintain as we work on the next farm bill and attempt to be certain you will have a key role in the food security of the world.

Thank you for the opportunity to serve as your chair this past year and I hope I have made your day or, if not yet, will do so soon.

## Trends in Custom Application *(continued from page 15)*

decrease product overlap, a problem that can really be costly to the grower and the custom applicator," he says.

Overall our informal poll shows the custom application is steady, slightly higher fees when they are up front, and more

program selling to include an application package. In the past many trends have moved from west to east, so if this holds true for custom application, look for retailers and their applicators to add guidance packages to their application equipment.



# Changes in Soil Phosphorus From Manure Application

By T.S. Griffin, C.W. Honeycutt, and Z. He

### EARN ONE CEU!

All CCAs may earn up to 20 Continuing Education Units (CEUs) per two-year cycle as board-approved self-study articles which will include CCA Advantage articles. The CCA CEU logo (above) marks all pre-approved material, with the CEU value indicated by the number in the middle. To receive one CEU in nutrient management, read this article, fill out the attached exam and mail the tear-out form, along with \$10, to the American Society of Agronomy.

**S**ustainable agricultural systems need adequate amounts of plant nutrients, including P, without increasing either environmental nutrient load or loss. Availability of soil P from current and past applications is influenced by a number of soil characteristics. A strong inverse relationship between soluble P concentration and extractable Al and Fe in acid soils, indicating adsorption of P on Al- and Fe-oxides, was demonstrated by studies in 1983 and 1995. Soil P may also form phosphate precipitates with soil Ca, Al or Fe. The availability of soil P and added P is also influenced by soil texture, primarily because of differences in clay content and soil organic C, and initial soil P levels. All of these factors interact to establish equilibrium between soil P pools that vary in plant availability. Because these P pools have different availabilities and are in equilibrium with each other, we do not expect added P to be completely available for plant uptake. The efficiency of added mineral fertilizer P for increasing soil test P (STP) levels is typically <20%. The availability of manure-P and its impact on soil P pools is clearly different from mineral fertilizer P.

Manure P availability is variable and not well understood. The objectives of this research were to (1) compare the effects of mineral fertilizer P ( $\text{KH}_2\text{PO}_4$ ) and animal manure P application on soil P concentrations over time and (2) determine the effects of mineral fertilizer P and manure P application rate and initial soil P level on soil P concentration.

Soil used for these laboratory experiments was collected from the USDA-ARS research site in Newport, ME. The sandy loam soil had a particle-size distribution of 61% sand, 29% silt and 10% clay. Selected soil properties include: soil pH = 5.8 (1:1, soil/water); cation-exchange capacity = 3.4 cmol  $\text{kg}^{-1}$ ; P = 16.5 kg  $\text{ha}^{-1}$ ; K = 303 kg  $\text{ha}^{-1}$ ; Mg = 169 kg

$\text{ha}^{-1}$ ; and Ca = 1130 kg  $\text{ha}^{-1}$ . Mehlich-III extractable Fe and Al were 87 and 1435 mg  $\text{kg}^{-1}$ , respectively.

Beef, dairy, swine and poultry manure were collected from storage structures on local commercial farms. The beef and swine manures contained sawdust-bedding material, and the dairy manure included sand bedding. There was no bedding material in the poultry manure.

### Experiment I: Changes in Soil Phosphorus Over Time.

Ten grams of air-dry soil was weighed into 20-mL vials. Four replications of the following treatments were prepared: beef, dairy, poultry and swine manures, and  $\text{KH}_2\text{PO}_4$ , all applied at 100 mg total P  $\text{kg}^{-1}$  dry soil, and an unamended control. Samples were destructively sampled 0, 7, 14, 28, 56 and 84 days after amendment. Dry soil and manure were thoroughly mixed, while  $\text{KH}_2\text{PO}_4$  was dissolved in water and added to soil at the same rates as the manures. Soil water was adjusted to 30% (approximately field capacity), and capped vials were incubated in the dark at 24°C. Extracted P available from manure or  $\text{KH}_2\text{PO}_4$  at each sampling time was corrected for the unamended soil, and the efficiency of an added P source to alter a soil P pool was determined.

Analysis of variance was used to identify significant effects of time, P source and their interaction on extractable soil P. Changes in soil P over time were evaluated using regression analysis. Both linear and nonlinear models were evaluated. Regression equations from different treatments were identified as significantly different if the 95% confidence intervals around the parameters did not overlap, or if the best-fit form was different (i.e., linear vs. nonlinear). Otherwise, regressions were recalculated using all manure treatments. Where regression did not adequately describe changes in soil P pools over time, fertility sources were compared.

### Experiment II: Soil Phosphorus Level and Phosphorus Application Rate.

To evaluate the effects of both initial soil P level and P application rate from different sources, soil P level was adjusted with  $\text{KH}_2\text{PO}_4$  to achieve varying levels of STP. Phosphorus was added to 1-kg portions of dry soil, assuming that 8 mg P  $\text{kg}^{-1}$  soil was required to increase STP by 1 mg P  $\text{kg}^{-1}$  soil. The amount of water applied was calculated to bring soil to 80% field capacity and contained a preweighed amount of  $\text{KH}_2\text{PO}_4$  to increase soil P to the desired level. Soil was allowed to dry every 20 days and was then rewet to 80% field capacity. This cycle was repeated

five times, and the soil was then stored dry for 150 days before use. The resulting three soils had Mehlich III (M3-P) concentrations of 150, 471 and 732 mg P kg<sup>-1</sup> dry soil, and are referred to as Low, Medium and High.

This experiment was designed using a complete factorial arrangement, examining P source, P application rate and soil P level. Air-dried soil was placed in vials. For each soil P level, dried manure (beef, dairy, poultry and swine) was added to quadruplicate vials at rates of 0, 100, 200, 400 and 800 mg total P kg<sup>-1</sup> dry soil, and soil and manure were mixed thoroughly. Mineral fertilizer P (as KH<sub>2</sub>PO<sub>4</sub>) was dissolved in water and added to soil at rates equivalent to those applied as manure. Water to increase soil moisture to field capacity was added to each tube. Vials were capped and incubated at 24 °C, without drying. After 90 days, soil was air dried, and the following extractions were performed: 0.01 M CaCl<sub>2</sub>, anion exchange membrane P (AEMP), Mehlich III (M3-P) and modified Morgan (MMP). Total P concentration in all extractions was measured; Al and Fe concentration in M3 were also determined. Response of soil P pools to P application rate was evaluated by linear regression. Comparison of regressions between treatments was accomplished by conducting ANOVA on the regression parameters *a* (*y*-intercept) and *b* (slope or efficiency). Aluminum and Fe extractable by M3 were also used to calculate the degree of P saturation (DSSP<sub>M3</sub>).

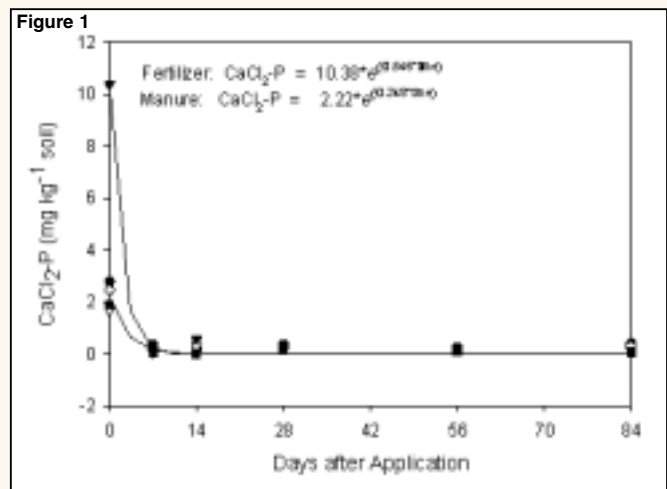
The relationship between DSSP<sub>M3</sub> and CaCl<sub>2</sub>-P was evaluated. The analysis identifies a value for the independent variable beyond which CaCl<sub>2</sub>-P increases more rapidly. This value is referred to as the “change point.”

## RESULTS AND DISCUSSION

### Experiment I: Changes in Soil Phosphorus Over Time.

Analysis of variance indicated that all extractable soil P pools changed over time, and most exhibited significant differences due to P source, time by P source interaction or both. All P fractions declined rapidly after manure or KH<sub>2</sub>PO<sub>4</sub> was added to the soil. Water-soluble P and CaCl<sub>2</sub>-P (shown in Figure 1), two P fractions essentially immediately available to plants, exhibited similar changes over time. Reduction in P concentration of both of these fractions could be described by a three-parameter exponential decay function (which declines sharply and then stabilizes around some minimum value), with P concentration stabilizing within 14 to 21 days of amendment. This very rapid decline in soluble P, coupled with the fact that both fractions stabilized at <3 mg P kg<sup>-1</sup> soil (in other words, <3% of applied P), are indicative of rapid sorption by soil Al and Fe. Changes in these two soluble P pools over time also indicate that effects of KH<sub>2</sub>PO<sub>4</sub> and manure were described by different regression equations – the primary difference between KH<sub>2</sub>PO<sub>4</sub> and manure P being that KH<sub>2</sub>PO<sub>4</sub> had a higher initial solubility in both extractants. This would be expected because this mineral P fertilizer source is completely soluble in water, while the average WSP concentration in the manures was between 18.6% (dairy) and 33.3% (swine) of

total P. Changes in MMP over time were very similar to WSP and CaCl<sub>2</sub>-P, with a rapid decline to levels as low as 2.0 mg kg<sup>-1</sup> soil. These results demonstrate that all P sources were <5% efficient in altering these soluble P pools. These are much lower than previous estimates of 5% to 30%. However, the soil used here has a high level of extractable Al, indicating the P sorption capacity is high.



The remaining two P fractions, AEMP and M3-P, also declined rapidly after addition to soil, with very little change after 14 days. Also, these two extraction methods were able to distinguish between P sources on most sampling dates, with fertilizer P resulting in higher P concentration than manure. Poultry manure increased M3-P more than dairy manure at most sampling dates, while other manure P sources were similar. The effectiveness of KH<sub>2</sub>PO<sub>4</sub> or manure P in increasing these P pools was greater than for those extractants described above. The efficiency of added KH<sub>2</sub>PO<sub>4</sub> was 31% to 39% (for AEMP and M3-P, respectively), while manure P efficiency ranged from near zero (dairy manure) to 33% (poultry manure, M3-P), averaging 12.8% for AEMP and 14.7% for M3-P.

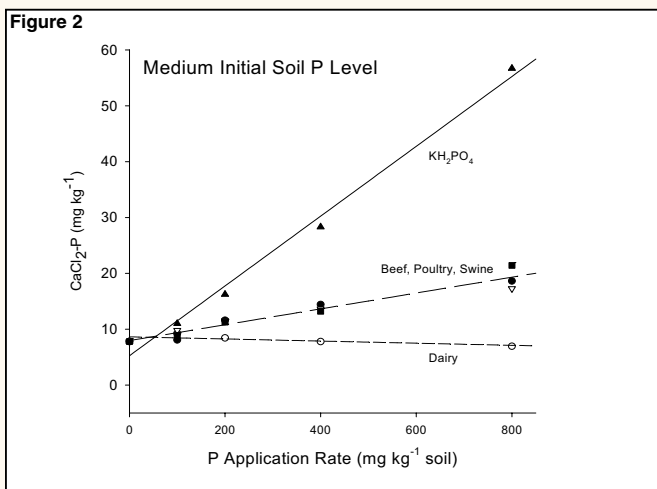
### Experiment II: Soil Phosphorus Level and Phosphorus Application Rate.

The three soils with Low, Medium and High levels of soil P clearly differed in P saturation. The DSSP<sub>so</sub> of these soils were 0.126, 0.216 and 0.310 mol mol<sup>-1</sup> (in other words, 12.6, 21.6, and 31%) for Low, Medium and High levels, respectively. They also showed distinct differences in their ability to adsorb P, which is a function of P saturation. The soils with Low and Medium P levels had the capacity to adsorb P as solution P concentration increased, with the Medium soil having somewhat less capacity to do so. The soil with the High P level, on the other hand, exhibited a net desorption at all solution P concentrations evaluated.

All P fractions were affected by P application rate, P source and soil P level, and interactions were common. In all cases, extractable soil P was a linear function of P application rate.

Results of  $\text{CaCl}_2$  extraction across these factors illustrates the interactive effects of the treatment factors, as shown in Figure 2. Fertilizer P increased this P fraction more than manure P. The  $b$  values for  $\text{KH}_2\text{PO}_4$  ranged from 0.015 to 0.105 (that is, efficiency of 1.5% to 10.5%) under Low and High soil P, respectively. Manure P sources generally had slopes between 0.00 and 0.02, although the dairy manure had a negative slope at Medium and High soil P level. The dairy manure originated at a farm that uses sand as bedding material. The sand may have contributed enough soluble Al, Fe or both to adsorb manure-derived P and indigenously soil P. Mehlich-III extractable Fe was not affected by application rate when fertilizer, beef, poultry or swine manures were applied. Increasing dairy manure application rate, however, did increase extractable Fe.

Differences in solubility of fertilizer versus manure P were demonstrated by researchers in 2000. They reported that 53% and 64% of P in poultry and dairy manure, respectively, was soluble by repeated water extraction. The manures used in our research contained on the average only about 25% WSP, as a proportion of total P. Our results indicate that these differences in solubility are evident even after a 90-day incubation in soil, with significantly more of the P from  $\text{KH}_2\text{PO}_4$  remaining in this soluble P fraction.



An additional trend is that as initial soil P level increases, the slope increases, presumably because the capacity of the soil to adsorb added P is reduced with higher initial soil P level. The amount of fertilizer P needed to increase  $\text{CaCl}_2\text{-P}$  by 1  $\text{mg kg}^{-1}$  dry soil was 66, 16 and 9.5  $\text{mg kg}^{-1}$  soil, for soil with Low, Medium and High soil P level, respectively.

In a comparison of treatment factors, modified Morgan P follows a trend similar to  $\text{CaCl}_2\text{-P}$ , in two regards: (1) for all P sources,  $b$  increases with soil P level, generally doubling or tripling from Low to High soil P level; and (2) there are clear differences between P sources. There are, however, important differences between these two extractants. Specifically, within each soil P level, poultry manure

is more efficient at increasing MMP than any other source. The other manures tended to be similar to each other and generally had greater  $b$  values than fertilizer P.

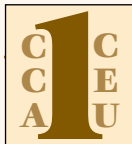
Mehlich-III P was also capable of distinguishing between P sources. At each soil P level, there were no significant differences in efficiency between fertilizer P and poultry and swine manure, ranging from 0.273 to 0.487. These results are considerably higher than the findings of three previous studies. The two ruminant manures used here, beef and dairy, were similar within each soil P level and were less efficient at increasing M3-P than the other P sources. The contrasting results of the MMP and M3-P extractions indicate that, although both of these soil tests are useful for predicting crop response to P, they are extracting different P pools in the soil. Clearly, the F-based Mehlich-III extractant is capable of cleaving Al-bound P, while the modified Morgan extractant is not. Our results suggest, however, that different sources of P contribute to different pools of soil P.

### Estimating Soil Phosphorus Saturation using Mehlich-3 Extraction.

Soil P saturation has been suggested as a way to identify critical soil P levels above which soluble P levels increase substantially. A number of different extractants have been used to estimate P saturation, usually using not only extractable P concentration but also extractable Al, Fe or both, because of the important role they play in immobilizing P under acid conditions. The calculations based on M3 have the advantage of using a common soil test extraction. We combined the data from Exp. I and II to assess the relationships between  $\text{CaCl}_2\text{-P}$  and P saturation using molar concentrations from M3, in the form  $(\text{P})_{\text{M3}}/(\text{Al} + \text{Fe})_{\text{M3}}$ .

A study in 2001 successfully used the M3-P concentration to identify what the researchers termed change points in the relationship between soil P level and  $\text{CaCl}_2\text{-extractable P}$ . The rate of increase in  $\text{CaCl}_2\text{-P}$  per unit of M3-P is greater above the change point than below the change point. The change point concept can also be used to identify critical P saturation levels, based on the M3. The change point  $(\text{P})_{\text{M3}}/(\text{Al} + \text{Fe})_{\text{M3}}$  is 0.207  $\text{mol mol}^{-1}$ . Below this level,  $\text{CaCl}_2\text{-P}$  concentration is very low and there is no relationship between P saturation and  $\text{CaCl}_2\text{-P}$ ; that is the slope is zero. This suggests that our earlier interpretation (Exp. I), that applied P is rapidly sorbed by Al in this soil, is correct. Above the change points, the slopes increase to 1.42, indicating that above this level, applied P remains in the more soluble  $\text{CaCl}_2\text{-P}$  pool, rather than being sorbed by either Al or Fe in the soil.

**Editor's note:** Content was adapted from the paper "Changes in Soil Phosphorus from Manure Application," which was published in *Soil Sci. Soc. Am. J.*, Vol. 67, March-April 2003, and is courtesy of T.S. Griffin, C.W. Honeycutt and Z. He.



# Continuing Education Self-Study Course

## Nutrient Management

### Get a CEU!

This exam is worth 1 CEU in **Nutrient Management**. An exam score of 70% or higher will earn CEU credit. The International CCA program has approved self-study CEUs for 20 of the 40 CEUs required in the two-year cycle.

### DIRECTIONS

1. Read the self-study article on pages 18-20 carefully.
2. Answer the questions by clearly marking an "X" in the box next to the best answer for each question.
3. Complete the self-study exam registration form on the back of this page.
4. Clip out this self-study examination page, fold and place in envelope.
5. Enclose a check for \$10.00 made payable to the American Society of Agronomy, for processing fees. Payment in U.S. funds only.
6. **Mail your self-study exam and fee to:**  
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7. An electronic version of this test is also available at [www.AgProfessional.com](http://www.AgProfessional.com). Go to the Certified Crop Advisers section (lefthand column) and access the "CCA Advantage" link.

## Changes in Soil Phosphorus From Manure Application September Self-Study Examination

### 1. A strong inverse relationship was demonstrated in acid soils between soluble P concentration and extractable:

- a. Zn and Ca.
- b. Zn and Mg.
- c. Al and Fe.
- d. Ca and K.

### 2. Soil P may form phosphate precipitates with soil:

- a. Ca, Zn, or O.
- b. Ca, Al, or Fe.
- c. O, Ca, or S.
- d. Ca, Al, or K.

### 3. The efficiency of added mineral fertilizer P for increasing soil test P levels is typically:

- a. <10%.
- b. <20%.
- c. <30%.
- d. <40%.

### 4. Soil used in the experiment was a:

- a. silt loam.
- b. silty clay loam.
- c. sandy loam.
- d. sandy clay loam.

### 5. Indicative of rapid sorption by soil Al and Fe were:

- a. the rapid decline in soluble P and the stabilization of water-soluble P and  $\text{CaCl}_2\text{-P}$  at  $<3 \text{ mg P Kg}^{-1}$  soil.
- b. the rapid decline in soluble P and the stabilization of water-soluble P and  $\text{CaCl}_2\text{-P}$  at  $<5 \text{ mg P Kg}^{-1}$  soil.
- c. the rapid decline in soluble P and the stabilization of water-soluble P and  $\text{CaCl}_2\text{-P}$  at  $<7 \text{ mg P Kg}^{-1}$  soil.
- d. the rapid decline in soluble P and the stabilization of water-soluble P and  $\text{CaCl}_2\text{-P}$  at  $<9 \text{ mg P Kg}^{-1}$  soil.

### 6. $\text{KH}_2\text{PO}_4$ had a higher initial solubility in both water and $\text{CaCl}_2$ extractants. This would be expected because:

- a. mineral P fertilizer is not soluble in water.
- b. mineral P fertilizer is 45% soluble in water.
- c. mineral P fertilizer is completely soluble in water.
- d. manure P is not water soluble.

### 7. The three soils with Low, Medium, and High levels of soil P clearly differed in P saturation with the DSSP of the soils:

- a. 0.126, 0.216, and 0.310 respectively.
- b. 0.129, 0.225, and 0.330 respectively.
- c. 0.130, 0.230, and 0.335 respectively.
- d. 0.140, 0.240, and 0.340 respectively.



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## Continuing Education Self-Study Course

### Nutrient Management

**8. The soils with Low and Medium P levels had the capacity to adsorb P as solution P concentration increased:**

- a. at the same level.
- b. with the Low soil having somewhat less capacity to do so.
- c. with the Medium soil exhibiting an ultimate desorption.
- d. with the Medium soil having somewhat less capacity to do so.

**9. Extractable soil P:**

- a. was an inverse function of P application rate.
- b. was a linear function of P application rate.
- c. did not change with P application rate.
- d. varied only by soil texture.

**10. The change point for critical P saturation levels based on the M3 is:**

- a. 0.186 mol mol<sup>-1</sup>.
- b. 0.193 mol mol<sup>-1</sup>.
- c. 0.200 mol mol<sup>-1</sup>.
- d. 0.207 mol mol<sup>-1</sup>.



### SELF-STUDY EXAM REGISTRATION FORM

Name: \_\_\_\_\_

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X

Signature of Registrant as it appears on Code of Ethics

I certify that I alone completed this self-study course and recognize that an ethics violation may revoke my CCA status.

**This exam issued September 2004 expires September 2007.**

### SELF-STUDY EXAM EVALUATION FORM

**Rating Scale: 1=Poor 5=Excellent**

Information presented will be useful in my daily crop advising activities: 1 2 3 4 5

Information was organized and logical: 1 2 3 4 5

Graphics/tables were appropriate and enhanced my learning: 1 2 3 4 5

I was stimulated to think how to use and apply the information presented: 1 2 3 4 5

This article addressed the stated competency area and performance objective(s): 1 2 3 4 5

Briefly explain any "1" ratings: \_\_\_\_\_

Topics you would like to see addressed in future self-study materials: \_\_\_\_\_



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