

NEWS & VIEWS

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Northcentral Phosphorus and Potassium Research Funded by the Foundation for Agronomic Research (FAR)

THE Foundation for Agronomic Research (FAR) is a non-profit research and education organization. Its mission is to improve the economic vigor and sustainability of agriculture while protecting and enhancing the environment. FAR is supported through cooperation with the Potash & Phosphate Institute (PPI) and numerous contributors involved in North American agribusiness. Each year, FAR helps fund research projects with universities, colleges, and government agencies, and develops agronomic educational materials. The following projects have received support from FAR in the Northcentral Region.



The summaries that follow provide a brief overview of each project. You can also view the full annual reports of each project (current and past), when available, at the website:

>www.ppi-far.org/research<.

indications of whether or not crops will respond to additional K. This finding was used to alter soil test K recommendations in 2002. Ongoing small plot and on-farm research trials are showing that the new recommendations provide better predictability about whether or not crops will respond to additional K; however, much more research is needed into the possible causes of crop response variability. *IA-09F*



Removal of Phosphorus in Corn and Soybean Grain as Related to Long-Term Crop Yield and Soil Test Phosphorus

How variable is phosphorus (P) concentration in corn and soybean grain? What causes this variability? What impact does this variability have on P recommendations and P nutrient budgets? To address these questions, corn and soybean grain are being analyzed from several existing experiments investigating P nutrition of crops. In the future, these data will be analyzed to see what factors impact P removal coefficients used by advisers to create P recommendations for farmers. *IA-10F*

Iowa



Variability in Soil Test Potassium and Crop Yield

How great is the variability in potassium (K) soil test levels across fields and years? How does this variability impact crop responses to applied K? How well do currently-used soil test K methods predict the likelihood that crops will respond to K additions? Research in Iowa is showing that the current practice of using dried samples in soil test K procedures may sometimes provide inaccurate



Iowa Component of Coordination of Management Practices Enhancing Total Efficiency (COMPETE) Project

In the U.S., P and K recommendations are based on soil tests. For soil tests to have meaning, they must be calibrated to yield response. Much of the calibration data for soybeans was collected decades ago, when varieties, tillage, and other management practices were much different than they are today. Using outdated interpretations of soil test levels can lead to misapplications of nutrients for current and future soybean production. Consequently, the need for updated information is ever-present. Ongoing calibration research in Iowa is discovering that soil series may be an important factor for determining how likely it is that soybeans will respond to applied K at various soil test levels. Potassium recommendations by Iowa State University were changed in 2002 and were actively investigated in 2003 to find further



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refinements. Iowa State University research is also investigating the efficacy of using different soil test procedures that index K availability in soils.

In states where the transition is made from temperate to dryland cropping systems, such as Minnesota and Iowa, many soybean producers and their advisers must use two different P soil tests...one for more acid soil conditions and one where soils are more basic. The need to perform two different tests is awkward for laboratories and provides serious limitations for mapping soil test results from site-specific samples, where acid and basic conditions exist within the same field. Consequently, there is great interest in adopting a different soil test procedure that is accurate at all levels of soil acidity. This procedure (Mehlich 3) is being actively researched by Iowa State University. While more data need to be collected, research to date indicates that this different procedure may provide the desired improvements. *IA-11F*

Illinois



Soil and Crop Management Systems Information Management and Outreach

The continuation of this multi-year outreach project provided workshop modules that were used for numerous training sessions for advisers who work with farmers in analyzing data and making recommendations using site-specific management systems and geographic information system (GIS) technologies. To date, over 3,000 people have attended programs where these tools have been demonstrated. Nearly 1,000 have participated in hands-on computer workshops conducted by PPI and FAR. This project has helped support two InfoAg Conferences in Indianapolis (2001 and 2003), has helped support more than 15 additional topics to the ongoing *Site-Specific Management Guidelines* publication series, supported the development of a Meeting Planner software program, and several other tools to enhance outreach efforts to get information and tools for site-specific crop and soil management into the hands of end users. The project materials and detailed reports are all available on the website: www.FARmresearch.com.

Support for this project came through a special FAR grant from USDA-CSREES under the IFAFS program. *IL-24F*



Implementation and Validation of Sensor-Based Site-Specific Crop Management

This is a cooperative project with the University of Missouri and the University of Illinois, funded by USDA-CSREES, IFAFS, NASA, and by corn, soybean, wheat, and cotton commodity groups under the Ag2020 program. FAR is coordinating development of outreach activities for this project and cooperating on some of the field work on two Illinois farms. To date, most of the effort has been in establishing on-farm studies in Missouri and Illinois, collection of ground observations, and collection of remote sensing data on the respective farms. The interpretation and outreach efforts will become a more active part of the work in 2004. *IL-25F*



Survey of the Nutrient Status of Alfalfa

Traditionally, Illinois growers have not adequately fertilized alfalfa, particularly with K and lime. Another element of concern for alfalfa producers is sulfur (S), primarily in northern Illinois, where atmospheric S contributions have been decreasing and the long-term production of alfalfa has depleted S supplies from some soils. A total of seven of 33 sites in 2003 and five of 34 in 2003 had concentrations of K below that accepted for optimum production. Nearly all of these sites had correspondingly low K soil test levels. Many producers do not recognize the large amount of K that is removed in a high yielding alfalfa crop and consequently do not apply enough supplemental K to meet crop removal.

Three locations in 2002 and one in 2003 had S concentrations below the critical level. The S soil test level was low at two of the four sites. Alfalfa has a high demand for boron (B), and 11 of the 67 sites in this survey were deficient in B. Many of these deficient sites were low in organic matter, a condition that would lead to B deficiency.

The S soil test indicated that 49 of the 67 sites contained less than adequate amounts of S for optimum plant growth. However, the plant analysis showed only three locations were deficient. This further exemplifies the fact that the S soil test is not very reliable. Plans are underway to combine these data with those from Wisconsin to attempt to improve the S soil test. *IL-26F*



**Coordination of Management Practices
Enhancing Total Efficiency (COMPETE)
Project**

FAR and PPI staff serve as the overall coordinators of a series of field studies in 11 states, under the COMPETE project funded by the United Soybean Board. The overall objective is to provide on-farm research results and information management tools that will help competitiveness of U.S. soybean producers through implementation of improved management practices to improve yield and production efficiency.

These projects are outlined in more detail in the respective state reports. This master project handles the administrative activities of report and proposal writing and coordination of work among states. The project results and activities are publicized on the website, >www.FARmresearch.com<. Each state subproject focuses on a competitiveness factor appropriate for that state. The Illinois component includes ongoing high-fertility management studies on two Illinois farms where we are demonstrating a variety of precision ag and on-farm research tools. Fertility levels at the university-recommended levels and at a level significantly higher have been established and are being compared. Results have been shared through the website, InfoAg Conferences, and a variety of training programs. *IL-27F*

Indiana



**Potassium and Phosphorus Effects on
Yield Components, Tissue Nutrient
Concentrations, and Fertilizer Efficiency in
Alfalfa**

Fertilization with P and K is essential to maintain alfalfa productivity. Our objective was to examine how P and K fertilizer influenced alfalfa yield and yield components, plant persistence, and root physiology. Replicated plots of P (0, 50, 100, 150 lb P₂O₅/A) and K (0, 100, 200, 300, 400 lb K₂O/A) treatments were arranged in a factorial design. Forage harvests occurred four times annually between 1998 and 2003.

Yield, mass per shoot, and shoots per acre were determined. Roots were dug in May and December of each year to estimate plant populations and determine whether plants were dying during “summer” (May to December) or during “winter” (December to May). Roots were analyzed for starch, sugar, amino acid, and protein concentrations. Total annual yield increased with application of P and K, but K application did not increase first harvest yield. Yield increases were due to greater mass per shoot, whereas stems/area were not related to forage yield. Plants died

during summer and not during winter. Although P fertilizer increased forage yield significantly, it decreased plant populations by producing fewer, but larger individual alfalfa plants. Fertilization with P alone resulted in faster stand thinning than observed in plots provided both P and K, and those left unfertilized. This rapid stand loss was associated with low concentrations of root reserves including starch, amino acids, and protein in taproots. Balanced P and K nutrition is essential to maintain stands and have high forage yield. *IN-14F*



**Nutrient Management for
High Yield Corn and Soybeans**

The gap between current yields and those possible is an area of intense interest to corn and soybean producers. To increase yields and narrow this yield gap, producers must consider many factors. One that is thought to be important is the distribution of nutrients in the soil profile. In reduced tillage systems, nutrient stratification is common, with higher levels of nutrients near the surface and lower levels deeper. The extent to which nutrient stratification impacts yields in high yield environments has not been extensively researched. This project examines various P and K nutrient placement methods under intensive management systems. The importance of enriching the deeper soil profile with P and K appears to depend upon hybrid characteristics and plant density. In 2003, one of the two hybrids tested responded favorably to P placed deeper in the soil, while the other did not. This response occurred only when corn was planted at a density that was about 30% higher than is commonly used. Consequently, there appears to be no single nutrient placement approach that characterizes high yield systems. Rather, the positional availability of nutrients must be matched to the characteristics of the hybrids grown. *IN-18F*



**Coordination of Management Practices
Enhancing Total Efficiency (COMPETE):
Indiana Project on Improving Nutrient
Recommendations**

Funds made available through this project coupled with additional matching funds are permitting the analyses of 900 archived grain and 4,650 archived tissue samples collected from 1997 through 2002. This analysis is only partially complete. Statistical analysis and interpretation of these data will be the primary activity in 2004. Interpretations for soil test K may be improved by weighting soil test results according to general mineralogy and texture. Soil test interpretation may require further modification to account for surface soil stratification. Some soils may require crop-specific recommendations, especially soils with plant available K (non-exchangeable and/or deep-profile) that is not measured in the routine analysis of soil collected to an 8 in. depth or less. Evaluation of site-specific

pH data suggest that the center point sample on a 2.5-acre grid basis is too sparse to develop accurate continuous pH and lime requirement maps. Sampling by soil map unit appears to be a viable, cost-effective strategy for sampling, especially where other information can be used to confirm or adjust boundaries between distinct soil series. Some temporal stability exists for within-field soybean yield patterns. Yield monitor data can be used to identify these consistent yield patterns. A dominant feature in this study is spatial variability in drainage. Under non-irrigated conditions, differences between zones may be linked to crop-specific responses to early season soil saturation as well as to spatial variability in plant-available water later in the growing season.

Data from intensive soil and plant sampling regimes are being used to construct a K balance for six crop cycles (3 full rotations). Soil nutrient absorptive strength, soil buffering power, and soil quantity/intensity relationships are being evaluated with depth in the soil profile for their effect on plant-availability of K. Data are being analyzed for soil test critical levels needed in surface soils to attain optimal yields and grain quality (protein and oil yield). We will use these analyses to re-evaluate / revise university recommendations on interpretation of soil and tissue test results to improve K fertilizer management. Revision is anticipated to include soil- and crop-specific interpretation of soil test results and guidance on how to manage K fertility to maximize yields in both low and high yielding environments. *IN-22F*



**Coordination of Management Practices
Enhancing Total Efficiency (COMPETE):
Indiana Project on Improving Assessments
of Soybean Nutrient Needs**

This project is exploring the residual effects of fertilizer placement for corn on the following year's soybean crop. It is relatively early in the rotation, so more years are needed to draw conclusions. However, the following observations have been made for the 2003 season: (a) the prior tillage system in corn had no significant impact on any of the plant responses measured (the only exception being higher leaf potassium (K) concentrations following no-till corn in 2002; (b) seed K concentrations, although highly variable among years, were consistently (0.02 to 0.22%) higher after the fall K and fall plus starter K treatments following all tillage systems; (c) seed oil concentrations were only slightly (0.1 to 0.3%) higher after treatments with K relative to the control; and (d) soybean yields were not significantly increased in response to the residual K fertilizer treatments in any of the years.

Soybean trifoliolate leaf K concentrations were consistently above the 1.7% K accepted as the critical level in the Corn Belt. As expected, protein concentrations declined slightly when oil concentrations went up. Residual K fertility treatments had relatively minor impacts on no-till soybean yield and traditional quality parameters like oil and

protein. However, the site-specific nature of the soybean response to the 216 individual sampling positions each year must still be analyzed. A Veris tool measured electrical conductivity at two depths in all three years, and we hope to determine the possible relationships to the soil and crop quality parameters. We will complete this site-specific analysis in 2004. This project was featured at a Purdue Soybean Research Day, and the plots were visited by several other groups. Preliminary results were presented at Certified Crop Adviser (CCA) conferences in Illinois, North Dakota, and Kentucky, and at the regional (NC) American Society of Agronomy Meetings. *IN-23F*

Minnesota



**Precision Placement for Improved
Phosphorus Management of
Corn/Soybean Rotations in
Very Reduced Tillage Systems**

How should P be placed to maximize its effectiveness, yet minimize unwanted environmental losses? Does P placement need to be tailored to different tillage systems? When soils are deficient in P, this study has shown that broadcast applications of P provide the greatest yield advantage. However, this placement method also carries the greatest environmental risk under erosive conditions. Deep placement of P kept P concentrations much lower near the soil surface, reducing environmental risks.

An assumption often made is that P placed in a concentrated band provides increased nutrient use efficiency. For this reason, recommended rates for banded applications have traditionally been reduced from those recommended for broadcast applications. In this study, reducing the banded rate to half of the broadcast rate resulted in lower yields when soil test P levels were low. This indicates that banded applications are not twice as efficient as broadcast applications. Just how much more efficient banded application are under the conditions of this study requires further investigation, including evaluation of residual effects of the P management approaches. *MN-20F*



**Coordination of Management Practices
Enhancing Total Efficiency
(COMPETE): Improving Assessments
of Soybean Nutrient Needs**

In many areas of the western Corn Belt, iron (Fe) deficiency severely limits soybean yields. This deficiency arises because of the basic soil conditions encountered in these more arid areas. Soybean producers in these states have a keen interest in knowing how this problem affects other aspects of soybean nutrition. To address this problem, researchers at Minnesota examined how total nutrient uptake changed under varying degrees of Fe deficiency chlorosis. They found that seed concentration of P and K

did not change predictably with Fe chlorosis severity or with Fe treatments. Most of the changes in nutrient concentration were attributed to the deleterious effects of Fe deficiency on yield. *MN-22F*



Coordination of Management Practices Enhancing Total Efficiency (COMPETE): Gaining Better Assessments of Soil Fertility

Most soybean producers fertilize prior to the corn year and let soybeans feed off residual fertility. A question often posed by producers is whether or not residual P has a significant impact on soybean yield. Minnesota investigations revealed that P fertilization history alone was not a good indicator of crop response. Soil test P levels were a much better indicator. Variability in not only P, but other soil and environmental factors across the field influenced soybean yield and quality. This reinforces the need to better characterize within-field variability of yield-limiting factors for soybean production. *MN-23F*

South Dakota



Coordination of Management Practices Enhancing Total Efficiency (COMPETE): Improving Assessments of Soybean Nutrient Needs

An important factor influencing soybean nutrition is availability of water. Research in South Dakota examined how water stress impacted uptake of nutrients by soybeans. The methodology used was state-of-the-art, with isotopic carbon discrimination being used to quantify degree of water stress in soybeans. Data are currently being analyzed to determine how water stress and nutrient uptake interact in soybean.

Central to sound management decision-making by soybean growers is the ability to accurately create field enterprise budgets. To ensure producers are making these calculations correctly, researchers at South Dakota State University have developed step-by-step guidance on creating enterprise budgets using simple and widely-available spreadsheet software. These techniques have been transferred to producers and crop consultants through numerous hands-on workshops conducted in 2003. The techniques are equally applicable to farmers with or without precision agriculture programs and are available at <http://plantsci.sdstate.edu/precisionfarm/Publications.htm>. *SD-13F*

Wisconsin



Fertilizer Placement Effects on Potassium and Phosphorus Uptake of Soybean Grown under Three Different Tillage Systems

How do tillage and fertilizer placement interact to affect soybean development and yield? To investigate this question, research was conducted in Wisconsin that examined three conservation tillage systems (chisel, no-till, strip-till) and three fertilizer placement methods (broadcast, shallow band, deep band). Population and early season dry matter accumulation were highest in the chisel system. This response diminished as the season progressed, and was possibly influenced by unusually dry conditions at the pod fill stage. Fertilization reduced soybean stands for all placement methods, but the broadcast fertilizer treatment produced significantly greater total dry matter production at the end of the season. Fertilization in the row showed a trend of increasing dry matter early in the growing season, but not at the end. Grain yield was not significantly affected by either tillage or fertilizer, although there was a trend for higher yield where the fertilizer materials had been broadcast. Plant analysis is currently being conducted to determine treatment effects on nutrient accumulation. *WI-24F*



Improving Nitrogen Management for Corn on Irrigated Sandy Soils

Are there ways of improving N management for intensive, irrigated corn production on sandy soils? A major concern in such situations is the large potential for economic and environmental N losses through leaching. To investigate this question, research efforts were started in 2003 on the Central Sands region of Wisconsin. The soils in this area are coarse textured and have a relatively shallow water table. Several aspects of N management were examined: various rates, different sources, and various application times. In 2003, different N application times significantly affected corn grain and silage yields. Generally, corn and silage yields were lowest when all of the N was applied at eight weeks after planting. Economic optimum N rates (EONRs) ranged from 189 to 199 lb N/A for corn silage production and 181 to 200 lb N/A for corn grain production. Silage and grain yields at EONRs ranged from 8.33 to 9.72 t/A and 196 to 218 bu/A, respectively. *WI-25F* ■



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