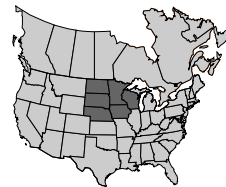


NEWS & VIEWS

A regional newsletter published by the
Potash & Phosphate Institute (PPI) and the
Potash & Phosphate Institute of Canada (PPIC)



Dr. T. Scott Murrell
Northcentral Director
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Research Programs in the Northcentral Region

RESEARCH is the foundation upon which best management practices are built. The Potash & Phosphate Institute (PPI) and the Foundation for Agronomic Research (FAR) provide partial or full support for research projects conducted by universities and government organizations that investigate all aspects of plant nutrition. PPI member companies and FAR contributors are concerned with discovering and implementing management practices which optimize the efficiency of inputs, maximize profitability, and protect the environment. This issue of *News & Views* is a summary of the research currently supported by PPI and FAR. For more information on these projects, please contact us or the project leader.

Iowa



Evaluation of Site-Specific Precision Farming Systems for Soybeans

Project Leader: Dr. Antonio Mallarino, Department of Agronomy, 3216 Agronomy Hall, Iowa State University, Ames, IA 50011, telephone: 515-294-6200, fax: 515-294-2458, e-mail: apmallar@iastate.edu.

This project is in its third year and is an extension of a project started in the Midwest in 1995-1996 to evaluate the agronomic, economic, and environmental implications of implementing site-specific precision farming technology in soybean management systems. This component evaluated conventional and variable-rate phosphorus (P) management strategies on four field-scale trials. Soils were typical of large areas of Iowa and southern Minnesota. Treatments were an unfertilized control, a fixed P rate based on field-average soil test P, and a variable P rate based on intensive grid soil sampling. Iowa State University fertilizer recom-

mendations for the two-yr corn/soybean rotation were used. Approximately 400 soil samples collected before and after applying fertilizer were analyzed for soil P by the Olsen, Bray-1, and Mehlich-3 tests. Samples were also tested for other nutrients.

Plant measurements included grain yield (harvested with yield monitors), early crop growth (above-ground parts at the V5 growth stage), early P uptake, and P concentration of corn ear leaves at silking and of soybean leaves at R2 stage. High-precision global positioning system (GPS) elevation models and soil electrical conductivity were mapped during previous phases of the project.

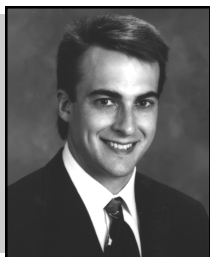
Fertilization increased early crop growth, plant P uptake, and grain yield when soils tested optimum or lower in P. Use of intensive soil sampling and variable-rate P fertilization markedly reduced soil-test P variability and avoided excess P application to high testing areas. However, the variable-rate method did not produce higher yields than the fixed rate method in any field. There were small or nonexistent additional yield increases from use of variable rate fertilization in low testing areas compared with the conventional fixed-rate fertilization. This result can be explained by small scale soil test P variability that current variable-rate technology cannot manage and a fertilizer management philosophy (common to the Corn Belt region) that recommends higher than needed fertilizer amounts for low-testing soils in order to build up soil P. However, the variable-rate method should become more cost-effective and environmentally sound over a longer period of time because it reduces soil test variability, applies maintenance fertilization over a field more effectively, and reduces fertilizer application to high-testing areas. *IA-08F*



Variability in Soil Test Potassium and Crop Yield

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The primary objectives of this research are 1) to study the variability in soil test potassium (K) and corn response



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to K fertilization and 2) to evaluate soil tests for K currently used in the Midwest as well as a new soil test for K with potential to improve the predictability of response. This research is based on evaluation of long-term trials at three research farms and several on-farm replicated strip trials. The conventional trials compared several rates of K fertilizer, and the strip trials compared fixed-rate and variable-rate fertilization. The various K treatments at research farms were replicated three to six times, depending on the farm. At the on-farm trials, treatments were applied to field-length, 60 ft. wide strips replicated three to four times across each field. Initial soil-test K levels before applying fertilizer treatments were measured on soil samples collected from 0.75-acre cells. After harvest, soil samples were collected from each strip and cell. Grain was harvested with plot combines at the research farms trials and with yield monitors at producer fields.

Results indicate that higher soil K levels than normally recommended are needed to optimize crop yields in many fields. In the early 1990s, a switch was made from wet to dry samples in the analytical procedures. This required conversion of calibration data from wet sample results to dry sample results. This project has revealed that conversion factors used up to this point have not been appropriate. The data suggest that the overestimation of soil K supply is worse in soils of the Clarion-Nicollet-Webster soil association, which dominates a major part of central and northern Iowa and southern Minnesota. Overestimations of soil K supplies have been found for other associations as well. *IA-09F*

Minnesota



Maximizing the Profitability of Site-Specific Nutrient Management in a Corn-Soybean Rotation

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The growing season of 2001 concluded the fifth year of site-specific nitrogen (N) and P research at the Windom location in southwest Minnesota. A modified factorial combination of 13 treatments including five N rates (0 to 180 lb/A) and three P₂O₅ rates (0 to 100 lb/A) was applied as constant rate strips with three repetitions of each treatment across a 30-acre field. The site is in a corn-soybean rotation, and fertilizer treatments were made prior to the corn production years of 1997, 1999, and 2001. Yield measurements were made every 50 feet within each treatment strip (1,200 foot strips). Regression techniques were used to describe site-specific crop response to fertilizer treatments. The soil test P at this location prior to treatment establish-

ment varied from very low to very high, while organic matter contents varied from less than 2 percent to near 10 percent. The 2001 corn grain yields when adequately fertilized averaged 155 bu/A.

Yield response due to P application averaged approximately 20 bu/A. This response was the culmination of three fertilizer applications over the five-year period. The economically optimum P rate for 2001 was approximately 50 lb P₂O₅/A. The average yield response from N was approximately 25 bu/A, and the economically optimum rate was approximately 100 lb N/A. Optimum rates for both N and P varied within the field. *MN-15F*



Evaluation of Site-Specific Precision Farming Systems for Soybeans

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This project is in its third year and is a continuation of a project started in the Midwest in 1995-1996 to evaluate the agronomic, economic, and environmental implications of implementing site-specific precision farming technology in soybean management systems. Research at this location is concerned with evaluating three different management strategies: 1) field-scale (uniform) management which does not utilize site-specific information, 2) non-integrated management concerned primarily with fertilizer management based on grid soil sampling, and 3) integrated site-specific management that utilizes a multi-disciplinary approach to managing all information, both spatial and temporal. This research is being conducted on a field located at the Southwest Experiment Station in Lamberton, Minnesota. Part of the project area was planted with corn, the remainder to soybeans. Treatments were applied in strips, and a combine with a yield monitor was used for harvest.

Corn and soybean yields in 2001 ranged from 140 to 160 bu/A and 35 to 44 bu/A, respectively. There was no statistical difference among the yields of treatments, consistent with the previous two years' results. Soil test levels for P and K have changed similarly with time for all three treatments, suggesting various management strategies have not affected soil test levels differently. *MN-17F*



Evaluating Banded Applications of Sulfur for Corn Grown in Conservation Tillage Production Systems

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This study was initiated in 1999 to evaluate the effects of sulfur (S) source, rate, and placement on corn growth and yield. Sulfur sources were ammonium sulfate (AS, 21-0-0-24) and ammonium thiosulfate (12-0-0-26). Rates were 0, 6, 12, and 18 lb S/A. Placement was either with the seed or banded 2 in. to the side and 2 in. below the seed (2x2). In 2001, the study was located on two sites. The site at the Staples Irrigation Center was under conventional tillage, and the soil was an irrigated sandy loam. The Winona county site utilized a ridge-till system on a silt loam soil.

Soil samples were taken six weeks after planting on plots receiving the highest S rate (18 lb S/A). Elevated levels of soil sulfate-S ($\text{SO}_4^{2-}\text{-S}$) were found below the seed when either ammonium sulfate or ammonium thiosulfate was applied with the seed. Such effects were seen at both locations. When applied 2x2, elevated soil SO_4^{2-} concentrations were observed below and to the side of the seed only when ammonium sulfate was the source. Less lateral movement of SO_4^{2-} was observed at the Winona county site with the silt loam soil.

Whole plant samples were collected at approximately growth stage V4. On the irrigated sandy loam, application of S increased early growth regardless of source, rate, or placement. When averaged over sources and rates, early growth was greater for the 2x2 placement. On the silt loam soil, ammonium sulfate produced greater plant weights than ammonium thiosulfate; however, early growth on plots receiving S was not significantly different from check treatments.

Stand counts were also collected at growth stage V4. Averaged over rate and placement, corn on the irrigated sandy loam exhibited greater emergence when ammonium sulfate was the source. Averaged over source and rate, the 2x2 placement resulted in a greater number of plants/A. On the silt loam soil, emergence of corn was affected only by fertilizer placement. The 2x2 placement resulted in more plants/A than placement with the seed.

Uptake of S by the above-ground plant portions was calculated from S concentrations and plant weights measured at V4. On the irrigated sandy loam, S uptake increased with increasing rates of applied S. Ammonium sulfate resulted in greater uptake than did ammonium thiosulfate. The 2x2 placement also resulted in greater uptake than did placement with the seed. On the silt loam soil, uptake was influenced only by S source. Again, plant

uptake of S was greater for the ammonium sulfate source.

Grain yield increased significantly when S was applied at both locations. At both sites, there were no significant differences in yield among the source, rate, or timing factors investigated. A rate of 6 lb S/A was adequate for optimum yield. On the irrigated sandy loam soil, placing ammonium thiosulfate with the seed at a rate of 18 lb S/A significantly decreased yield. MN-19F



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

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Field studies started in 1997 were conducted again in 2001 on very low to low P-testing (3 to 5 ppm Bray P-1) and medium to high testing (13 to 19 ppm Bray P-1) sites of a Nicollet-Webster clay loam complex at Waseca, MN. Four tillage systems (chisel + field cultivate, one-pass field cultivation or disking, strip-till, and no-till) were compared in a corn-soybean rotation. Fertilizer P at rates of either 40 or 50 lb $\text{P}_2\text{O}_5/\text{A}$ was applied to corn as either a starter with the seed or as a deep-band (4 to 5 in.) below the row and was compared to 80 or 100 lb $\text{P}_2\text{O}_5/\text{A}$ applied broadcast and a no P control. The residual effect of the P treatments was measured in the soybean phase of the rotation.

On the low P-testing site, tillage did not affect corn yields in 2001, the average corn yields, or the 1998-2001 soybean yields. Starter fertilizer increased corn yields by 35 bu/A in 2001 and by 45 bu/A/yr across the five-year period, while soybean yields were increased by 20 bu/A in 2001 and 14 bu/A/yr across the four-year period due to the residual effects of the starter. A starter fertilizer x tillage interaction was never found for either crop. Corn and soybean yields were generally increased over the 50 lb starter P and deep-band P treatments by the 100 lb broadcast P treatment, suggesting that band applications at a half-rate are usually not sufficient in low to very low P-testing soils.

On the high P-testing site, tillage affected corn yields in 2001 and the four-year and five-year corn and soybean averages. Highest yields were generally found with the chisel plow system followed by the one-pass and strip-till systems. Lowest yields were usually found with no tillage. Neither corn nor soybean yields were affected by any of the P treatments. The data from these studies suggest that P management strategies are more important than tillage systems for optimizing yields on low P-testing soils. However, on high P-testing soils, tillage has a greater effect on yield than does P management.

Tillage did not affect the P concentration in corn at either site, but did affect P concentrations in soybeans on the low-

testing site. Starter fertilizer greatly increased P concentration in corn and soybeans on both the low and high-testing sites. Applying the 100 lb P_2O_5/A rates at the low testing site did not increase P concentration in corn or soybean to the levels achieved without P application on the high-testing soils. Soil test P (STP) was greatly influenced by P placement method, but not by tillage, on both the low and high testing sites. The STP values were greatest where P was placed with the seed as a starter and lowest where P was placed below the seed in a deep-band strip. *MN-20F*

North Dakota



Soil Characteristics and Nutrition of Poor-Yielding Sugarbeet Areas

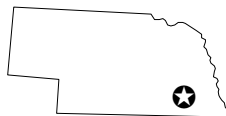
Project Leader: Dr. David Franzen, Department of Soil Science, North Dakota State University, 229 Walster Hall, Fargo, ND 58105, telephone: 701-231-8884, fax: 701-231-7861, r-mail: dfranzen@ndsuext.nodak.edu.

Sugarbeet growers in the Red River Valley have experienced poor yields in relatively linear areas of fields. Although these areas produce high yielding rotational crops, such as small grains or corn, sugarbeet growth and yields are reduced. Plant growth in these areas begins later than adjacent areas in the field located on similar soil mapping units. As the growing season continues, canopy coverage in affected zones slowly begins to fill in and resemble normal zones nearby, but yields are markedly reduced at harvest. The problem persists in the same areas on consecutive beet crops, but corn growth is not affected following beets. It is likely that a soil and/or landscape factor controls these zones.

In the year 2000, studies were conducted on transects within two beet fields exhibiting symptoms of stunting soon after emergence. Regression analysis of plant weight at the 6-leaf growth stage with soil and plant characteristics revealed a relationship with soil and plant magnesium (Mg) content.

Treatments in 2001 focused on Mg nutrition as a remedy. Two sites were selected: one near Glyndon, MN, the other near Galchutt, ND. Both sites had to be abandoned for the year due to stand problems at Glyndon and severe root rot at Galchutt. At Glyndon, in order to salvage some information from the site, an additional study comparing with and without 10 lb Mg/A as magnesium sulfate foliar spray was applied July 6 when the beets were in the 8-leaf stage. There were four replications in a randomized complete block design. Plots were 10 ft. wide by 20 ft. long. Although there was some stand variation, the stand was generally better than the original experimental area. The foliar treatment of 10 lb Mg/A had no effect on yield or sugar content. *ND-11F*

Nebraska



Ecological Intensification of Irrigated Corn and Soybean Systems

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In 1999, an interdisciplinary research team at the University of Nebraska established a field experiment to 1) quantify and understand the yield potential of corn and soybeans under irrigated conditions, 2) identify efficient crop management practices to achieve yields that approach potential levels, and 3) determine the energy use efficiency, global warming, and soil carbon (C)-sequestration potential of intensively managed corn systems. The experiment compares systems that represent different levels of management intensity expressed as combinations of crop rotation (continuous corn, corn-soybeans), plant density (low, medium, high), and nutrient management (recommended best management vs. intensive management). Detailed measurements include soil nutrient dynamics and C balance, crop growth and development, nutrient uptake and components of yield of corn and soybeans, radiation use efficiency, soil surface fluxes of greenhouse gases, root biomass, C inputs through crop residues, translocation of nonstructural carbohydrates, and amount, composition and activity of the microbial biomass.

Results to date indicate the following:

1) Fertilizer recommendations that are based on a yield goal that is well below the yield potential threshold do not allow expression of full attainable yield that is possible at higher plant densities and more intensive nutrient management.

2) Compared to current recommendations, high corn yields require higher plant density (40,000 to 44,000 plants/A) and greater N and K uptake per unit yield.

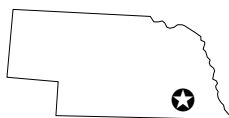
3) Corn growth in 2000 and 2001 was affected by hot weather during grain filling, but more research is needed to understand the interactions among plant density, N status, climatic stress at sensitive crop development stages, and yield potential, particularly during the grain filling period.

4) Without specific calibration, existing corn growth simulation models underestimate the actual dry matter production and yield measured at near-optimum growth conditions in the field. A new corn model, Hybrid-Maize, was developed to overcome some of these weaknesses, but requires further improvement to allow accurate simulation of yield potential.

5) High N use efficiencies were achieved at both levels of crop management in 1999, but not in 2000. A more dynamic

approach to N management may be required to improve the congruence of N supply and crop N demand and thereby avoid accumulation of residual soil nitrate and high rates of nitrous oxide emission under intensive management, particularly in years with high air and soil temperatures.

6) High-yielding corn systems significantly increased the amount of crop residue added to the soil. The resulting increase in the amount of C added is likely to improve soil quality in future years. The potential to increase C sequestration is greatest in continuous corn systems with intensive management that supports high yield levels. With intensive management, crop residue C inputs increased by about 30 percent, without a detectable increase in soil carbon dioxide flux. *NE-11F*



Effect of Potassium on Corn Stalk Strength and Yield

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Potassium effects on corn were last studied in Nebraska in the 1970s and early 1980s. Most of these studies were conducted on coarse-textured rangeland soils in the Sandhills that had been converted to growing irrigated corn. Yield response of corn to applied K was not significant, and some sites showed a decrease in plant weight, for which there was no explanation. However, K levels in these soils have decreased after 25 years of irrigated corn cropping. New corn hybrids have become popular, but their different yield response to K is not known. In recent years, standability problems have been observed, particularly in high-yielding fields, but little is known about the genetic variation in the effect of K on stalk rot and stalk strength. The objectives of this research are 1) to quantify the effect of K on grain yield and stalk strength for different hybrids, and 2) to identify possible mechanisms controlling the genetic variation in K effects on stalk strength.

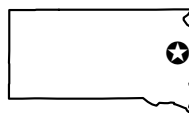
No significant grain yield differences were found among the three K rates tested. Soil test K in the 0-6 in. layer did not adequately account for the potential soil K supply because the exploitable rooting depth was likely large, and subsoil K contributes much to plant K uptake. Average response to K application was confounded by hybrid differences as well as large underlying soil variability. Some indicators suggest, however, that K application reduced the potential for lodging occurring after physiological maturity by slowing stalk dry-down and therefore creating more elastic stalks with much reduced stalk stress.

Considering both yield and stalk strength (lodging risk), Pioneer hybrids 34B24 and 33G30 seemed to perform best. Despite its excellent stalk strength characteristics, 34G13 yielded on average 22 to 25 bu/A less than 33G30 and

34B24. Although 33P67 had the highest average yield, it also had the most lodging (30 percent), making it a risky choice for farmers in this environment. Hybrids such as 33A14 and 34R07 had intermediate yields, but also weaker stalks and relatively high lodging risk.

Strong relationships occurred between landscape position (soil type) and stalk and rind strength. On poorer (sandy) soil, stalks were thin and more brittle, and they dried down much faster from physiological maturity to harvest. Such variations appear manageable to some degree via hybrid choice. *NE-12F*

South Dakota



Evaluation of Site-Specific Precision Farming Systems for Soybeans

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This project is a continuation of a project started in the Midwest in 1995-1996 to evaluate the agronomic, economic, and environmental implications of implementing site-specific precision farming technology in soybean management systems.

One component of this project investigates soil test P variability. Many fields contain hot spots or areas of very high nutrient concentrations. Identification of these hot spots is essential for more accurate fertilizer applications; however, intensive grid sampling techniques used to identify these areas can be expensive and labor-intensive. In this portion of the study, three fields were examined. Each was grid sampled. Aerial photographs taken in the 1950s and 1960s were obtained from the USDA-NRCS showing the location of historical farm building sites and feedlots long since converted to farmland. Results showed that high soil P levels were both visually and statistically related to farm building sites. When creating strategies for collecting soil samples, historical building sites may be an important consideration.

Another component investigated the possibility of using isotopic carbon (^{13}C) discrimination in plant tissue as an index of water stress in soybeans. Research was conducted in four eastern South Dakota fields. In two fields, soil water (0-2 ft.) was measured periodically during the growing season. Results to date indicate that approximately 57 percent of the yield variability observed at three sites was explained by changes in ^{13}C discrimination based on available water. These observations suggest that ^{13}C discrimination can be used to assess water stress in soybeans. *SD-08F*

Wisconsin



Evaluation of Site-Specific Precision Farming Systems for Soybeans

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This project is a continuation of a project started in the Midwest in 1995-1996 to evaluate the agronomic, economic, and environmental implications of implementing site-specific precision farming technology in soybean management systems.

Studies were conducted in 1999 and 2000 in four fields in southern Wisconsin to evaluate the efficacy of variable-rate liming in comparison to the standard uniform-rate approach. Two sets of fields managed by different private farmers were selected so that in each year two fields were in corn and two were in soybeans. Each field had three standard small plot experiments consisting of liming rates of none, 33, 66, 100, and 133 percent of the recommended rate that were intended to estimate the liming response in each field. A second phase of the study included the application of lime to replicated field length strips using either a uniform rate based on the field average lime recommendation or a variable rate based on grid soil sampling. Unlimed control strips were also included. Results from the small plot studies showed that liming increased soil pH proportionately according to rate and, in a few cases, increased yield. The relationship between soil pH and yield, however, was not significant. The response to lime application in the field length strips was marked in one field in which soybeans were grown in the first year. Consistent responses to liming in the field length strips was not found. Liming remains an important agronomic practice. This study did not demonstrate a benefit to variable-rate liming compared to a single rate treatment. *WI-21F*



Nitrogen Application Effects on Residue Decomposition and No-till Corn Yields

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Growers have questions about the need for and potential benefits from fall N additions to increase residue decomposition rates. Potential advantages of more rapid decomposition include increased N release and possibly higher early season soil temperatures in no-till corn systems. In a three-year field experiment, ammonium sulfate $[(\text{NH}_4)_2\text{SO}_4, \text{AS}]$ and urea-ammonium nitrate solution (28 percent UAN) were applied to corn residues in November at 30 lb N/A. Other N treatments included 100 lb N/A as AS applied in the fall and spring and various combinations of spring and fall N to provide a total of 190 lb N/A. Initial corn residue amounts ranged from 5,600 to 7,000 lb dry matter per acre. In 1999 and 2000, time and source of N application and residue chopping did not affect N mineralization, residue decomposition, or soil temperature. In 2001, residue decomposition measured in June was increased by fall N treatments, but did not affect N mineralization or soil temperature. Preplant soil nitrate and residue N content were lower in 2001 than in other years. In addition, the extent of residue decomposition from November to the following September was lowest in 2001. Collectively, these factors suggest that N applications in fall 2000 may have furnished N to stimulate residue decomposition in an otherwise N-deficient environment.

Nitrogen rate affected yield in all years. Yield was also affected by N timing and N source treatments, suggesting N loss from fall treatments and ammonia volatilization from surface-applied UAN. About 60 to 70 percent of the residue decomposed during the November to September period, largely due to C losses. Decomposition was accompanied by changes in residue N content and a decrease in residue C:N ratio. From a production perspective, fall N applications to promote corn residue decomposition did not improve no-till corn yields and do not appear to be justified. Fall N did not consistently increase residue decomposition, and did not influence soil temperature or N mineralization. Fall N was also subject to over-winter loss in some years. Ammonium sulfate was a more effective N source than UAN when surface applied in no-till systems. *WI-22F* ■



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