IPNI INSIGHTS
INTERNATIONAL PLANT NUTRITION INSTITUTE

Research Supporting Nutrient Stewardship

September 2012

THE principles of 4R Nutrient Stewardship require scientific support for the choice of practices that deliver the right source of nutrients at the right rate, time and place. The science needs to test these practices for their outcomes in terms of economic, social, and environmental sustainability.

This issue of *INSIGHTS* features Interpretive Summaries of the research projects supported by IPNI in the Northeast Region. More detail can be found at the research database at >**www.ipni.net/research**<.

Delaware

Evaluating Nitrogen Sources for Corn on the Delmarva Peninsula

Project Leader: Gregory Binford, University of Delaware Plant and Soil Sciences, Newark, DE. E-mail: binfordg@udel.edu

Numerous corn fields showed visual symptoms of S deficiency in the past 5 years, and in 2009 corn yield climbed more than 50 bu/A in response to applied S. In 2010, five studies compared N sources including ammonium sulfate and ammonium sulfate nitrate (ASN) at sites in Delaware and on the Eastern Shore of Maryland. These studies also included urea, polymer-coated urea, urea ammonium nitrate (UAN), and forms of urea with inhibitors of urease and nitrification.

Growing conditions in 2010 were extremely hot and dry, especially from June through early July. A local farmer noted, "In the thirty-some years that I've been farming, I've never experienced a year with such a long period of day-after-day intense heat and no rain." Drought conditions at the three non-irrigated sites led to smaller-than-expected responses to N in general and no significant differences among N sources. However, inclusion of S in the N source increased grain S at all three locations, and alleviated visual symptoms of S deficiency at one of the three. The lack of superior response to enhanced-efficiency forms of N is consistent with expectations, since there was little opportunity for N loss in the dry growing conditions.

At two irrigated sites, one showed no differences among N sources, and at the other either dribble-band UAN with urease inhibitor or broadcast ASN at sidedress produced yields 18 to 31% higher than either a UAN knife treatment or urea broadcast at sidedress. SuperU (urea with inhibitors of urease and nitrification) also performed well. Further evaluation of the results will continue after plant tissue analysis is completed. In the 2011 season, ammonium sulfate nitrate performed very well in comparison to other N sources, and there was evidence suggesting that part of the cause was a response to the S in the material. *DE-05F*

Dr. Tom W. Bruulsema
Northeast Director
International Plant Nutrition Institute (IPNI)
18 Maplewood Drive
Guelph, Ontario, Canada N1G 1L8
Phone: (519) 835-2498

E-mail: tom.bruulsema@ipni.net
Website: nane.ipni.net

Michigan

Evaluating Sulfur in Michigan Corn Nitrogen Programs

Project Leader: Kurt Steinke, Michigan State University, East Lansing, MI. E-mail: ksteinke@msu.edu

Corn growers in Michigan, like those elsewhere, seek to improve yields and N use efficiency at the same time. With declining deposition of S from the atmosphere, it is appropriate to evaluate the role of N sources that also supply S. This study evaluated 3 N sources, at 2 rates and 2 application timings. Owing to a rainy spring, planting was delayed to 24 May, four weeks after the pre-plant application had been made. Four inches of rain fell between pre-plant application and planting. Higher than normal rainfall occurred during the growing season as well.

Visual observations, plant analysis and yields all confirmed that pre-plant applications supplied less N to the crop than sidedress applications. Yields with sidedress applications averaged 188 bu/A, 8% higher than those with pre-plant application. Source differences were small, but ammonium sulfate and ammonium sulfate nitrate tended to produce higher yields than urea at the rate of 150 lb N/A, while at the 100 lb N/A rate ammonium sulfate produced lower yields than ammonium sulfate nitrate or urea. The results highlight how crop responses to N source and timing can depend on weather. They underscore the need to time applications and choose sources to suit site-specific and year-specific growing conditions. *MI-12F*

Notes and Abbreviations: N = nitrogen; P = phosphorus; K = potassium; S = sulfur; ppm = parts per million.

New York

Comparison of Tissue Potassium and Whole Plant Potassium for Alfalfa

Project Leader: Quirine Ketterings, Cornell University Nutrient Management Spear Program, Ithaca, NY. E-mail: qmk2@cornell.edu

Price increases for K fertilizers in recent years triggered many New York alfalfa producers to ask if K applications can be reduced without impacting yield, quality, or stand survivability. This study compared tissue sampling, whole-plant K levels, and soil test K levels as potential diagnostic criteria that could be used to fine-tune K recommendations.

In 2010, tissue samples taken of the top 6 inches of plants appeared similar to whole plant samples for K concentrations, with a 1:1 relationship across a wide range of K rates. In this experiment, tissue K levels reached 2% at a soil test K level of about 140 ppm. These results suggest that farmers can use the whole-plant analysis of their forage as an indicator of K sufficiency that can supplement soil test information.

This project included a 5-year experiment at the research station in Aurora, New York. In it, a residual effect of previous manure application was detected, even though the last application had been 5 years earlier. This showed that N-based manure management for silage corn can leave large amounts of residual K in soils. In this experiment, tissue K concentrations were not related to yields, and there were indications that other yield-limiting factors limited the response to the K applied each year in the spring starting in the second year of the stand. Yields ranged widely with previous history of the soils, with much higher yields on plots that had a history of manure or compost applications. Further data have been collected from plants and soils in the on-farm trials and will be reported on in the coming year. *NY-09*

Beta-testing the Adapt-N Tool in On-farm Strip Trials

Project Leader: Harold van Es, Cornell University Soil Crop & Atmospheric Sci, Ithaca, NY. E-mail: hmv1@cornell.edu.

Project Cooperators: Bianca Moebius-Clune and Jeff Melkonian

This project aims to increase adoption of adaptive N management for corn production using better rates and timing of application. The new Adapt-N tool provides N fertilizer recommendations adapted to the spring rainfall and temperature conditions of the current season, using high-resolution weather data, a sophisticated computer model, and field-specific information on soil properties and soil and crop management.

Based on experiences from past years, it is clear that a larger number of replicated strip trials are needed from multiple growing seasons. The objectives are to 1) further validate the Adapt-N tool for on-farm use, and 2) promote grower adoption of Adapt-N as part of their tool kit for adaptive N management. The main hypothesis is that the Adapt-N tool provides more accurate estimates of the current season's optimum N rate than conventional methods and tools.

Strip trials are planned to provide consultants (Dave DeGolyer, Western NY Crop Management Association) and Cornell Cooperative extension collaborators with the opportunity to learn how to use the tool in depth and understand its outputs enough to communicate with their growers about it. Farmers and crop advisers will also learn about N dynamics, and will receive help with safely testing this unique new tool. The overall outcome goal is more effective and efficient N management, thereby benefitting farmers, society, and the environment. *NY-10*

Ohio

Impact of Phosphorus and Potassium Fertilization and Crop Rotation on Soil Productivity and Profitability

Project Leader: Robert Mullen (left Ohio State University in 2011 to join Potashcorp).

Project Cooperator: Edwin Lentz, The Ohio State University Extension, Tiffin, OH E-mail: lentz.38@osu.edu

Growers in the eastern U.S. Corn Belt often fertilize the whole rotation rather than the individual crops. Typically, in the fall prior to corn planting, farmers supply enough P and K to satisfy the nutrient needs of both corn and the following soybean crop. This practice has proven to be a viable option for corn-soybean (CS) rotations on soils with adequate nutrient levels, but questions arise for producers in a 3-year rotation of corn-corn-soybean (CCS). In 2006, studies assessing P and K fertilization strategies were started in three locations. Two rotations were compared: corn-corn-soybean, and corn-soybean. These rotations were fertilized by broadcast application following soybeans and prior to fall tillage, at P and K rates corresponding to zero, once, and twice the crop removal for the rotation.

With the 2011 season, this trial has run 6 years: two cycles of the CCS rotation and three cycles of the CS rotation. For purposes of testing the soil test calibration, this provides a total of 36 site-rotation-years of high-quality data. Average yields for some site-years have been as high as 242 bu/A for corn and 68 bu/A for soybeans. Responses to the fall broadcast applied P and K have been as expected with respect to the critical soil test levels of the tri-state soil fertility recommendations used in Ohio. Soil test P levels ranged from 16 to 39 ppm by the Bray-P1 test (above the critical level of 15), so large responses to P were neither expected nor observed. An economic response frequency of 12 out of 28 site-years provides strong justification for applying P as recommended in the maintenance range. Soil test K levels ranged from 84 to 272 ppm, extending from well below the critical level to well above the maintenance limit. Yield responses to applied K as large as 16% were seen in soils testing below the critical level. These results suggest that the current critical values and maintenance limits for soil test P and K are still appropriate for today's higher-yielding corn and soybean crops, provided that appropriate adjustments to maintenance rates are made to match the higher removal rates of these nutrients. *OH-16F*

Ontario

Long-term Optimum Nitrogen Rates for Corn Yield and Soil Organic Matter in Ontario

Project Leader: Bill Deen, University of Guelph Dept of Plant Agriculture, Guelph, ON. E-mail: bdeen@uoguelph.ca

Project Cooperators: John Lauzon and Greg Stewart

Decisions on optimum N rates are often made on the basis of single-year responses. Data are limited on the long-term impact on productivity and soil organic matter of rates higher or lower than these short-term optima. This controlled experiment was designed as a base for testing the application of dynamic soil-crop-atmosphere models as predictors of N rates for corn that optimize sustainability. The specific objectives include: 1) assessment of short and long-term effects of N rate and application timing on productivity, environmental impact, profitability, and cropping system sustainability; and 2) validation of crop models, such as *Hybrid-Maize*.

The 2009 growing season was the first in which treatments were applied. Economically optimum rates of N were 15% higher than recommended for the pre-plant application, and 32% higher than recommended for the side-dress application, possibly because of a relatively cool, wet, and long growing season. Corn grain N concentration was 0.60 to 0.66 lb/bu at rates of N sufficient for maximum economic yield. Residual soil nitrate increased sharply when N rates exceeded the economic optimum, and were higher for side-dress than for pre-plant N applications. Favorable growing conditions in 2010 resulted in high yields, 195 bu/A at an optimum N rate of 190 lb/A, more than 50% higher than recommended. At this optimum rate, partial N balance (PNB) was 63% and recovery efficiency (RE) of N was 54%. Neither application timing nor duration of N treatment produced significant differences in optimum rate. Soil residual nitrate-N at harvest was about 10 lb/A higher at the optimum rate compared to the recommended rate, but was not affected by application timing or duration of treatment.

In 2011, yields were 175 and 171 bu/A for at-plant and sidedress N applications, respectively. Corresponding optimum N rates were 185 and 162 lb/A, again well above currently recommended rates. Responses to N did not differ between long-term and short-term rates. Recovery efficiencies of applied N ranged from 56% to 61%. Soil nitrate levels at corn maturity did not differ among any treatments.

This project also receives support from the Ontario Agri Business Association, for sampling soil residual nitrate and soil organic carbon, and from the Canadian Fertilizer Institute, for measuring nitrous oxide emissions. This additional support enables a more complete assessment of sustainability. *ON-29*

Corn Hybrid Interactions with Nitrogen and Foliar Fungicides

Project Leader: David Hooker, University of Guelph, Ridgetown, ON. E-mail: dhooker@execulink.com

Project Cooperators: J.D. Lauzon, W. Deen, T. Tenuta, G.A. Stewart, and K. Janovicek

Growers have shown interest in corn hybrid differences in response to applications of fungicide and N. Fungicides can potentially improve N use efficiency by delaying leaf senescence and enhancing the "stay-green" physiological mechanism. This project aims to determine the potential for yield improvement through exploitation of hybrid-fungicide-N interactions. Field trials implemented at three sites in southwestern Ontario compared six hybrid pairs (triple-stacked with corn rootworm resistance versus Roundup-Ready-only isolines) at five N rates with two fungicides (Headline and Proline) and a non-fungicide control.

Results in 2010 from two of the three sites showed strong evidence of hybrid-by-N interactions, and some evidence of hybrid-by-fungicide interactions. The highest yield of 224 bu/A was produced by the Pioneer hybrid 35F44 (a triple-stack) with Headline fungicide and N applied at 120 lb/A. The triple-stacked trait in general, however, did not have much influence on N use efficiency. The fungicides interacted only slightly with N rate, tending to increase both optimal rates and yields by about 2%. Dry growing conditions near the end of the season may have limited the expression of the stay-green trait.

Good results were obtained in 2011 from all three sites. Despite a rainy spring that delayed planting until June, peak yields at all 3 sites exceeded 200 bu/A, approaching 250 bu/A at one of the sites. The study provided clear evidence that yield response to N varied among corn hybrids, but was not correlated to the corn rootworm resistance or 'triple-stack' trait. Responses to fungicide application averaged 3 to 4 bu/A and did not depend on N rate. Analysis of plant and grain uptake and concentrations remains to be completed. Further studies exploring ways to improve yield along with NUE will build on the foundation of findings from this study. *ON-30*

Virginia

Evaluation of Ammonium Sulfate Nitrate in Virginia Snap Bean Production

Project Leader: Mark Reiter, Virginia Tech Eastern Shore AREC, Painter, VA. E-mail: mark.s.reiter@gmail.com

Fresh-market snap beans occupy 5,500 acres in Virginia. Producers are interested in exploring sources and rates to improve N use efficiency. This trial compared five N sources (urea with dicyandiamide, ammonium nitrate, calcium nitrate, ammonium sulfate-nitrate, and urea-ammonium nitrate) at three rates.

In 2009, for spring-grown beans, urea with dicyandiamide increased yield by 25% over the control, while the other sources did not. For fall-grown beans, all N sources increased yield by 56% over the control, with an optimum N rate of 80 lb/A, and reduced symptoms of common rust *(Uromyces appendiculatus)*. In 2010, an abnormally dry and hot summer hampered snap bean growth and as a result yields did not increase beyond 40 lb N/A. All N sources increased yields to a similar degree, except ammonium nitrate, which did not increase yields over the check. There were no responses to S applied either as gypsum or as ammonium sulfate-nitrate. In 2011, dry weather in May followed by an intense rainstorm in June resulted in poor yields and no response to applied N in spring beans. The fall beans responded positively to N but not to S. Ammonium sulfate-nitrate, urea, and urea with dicyandiamide produced higher yields than urea-ammonium nitrate or ammonium nitrate. Grade quality was not influenced by N source. These findings support N management decisions that optimize food yields while minimizing risk of water contamination by N on the sandy loam soils of the Chesapeake Bay watershed. *VA-22F*

Evaluation of Ammonium Sulfate Nitrate in Virginia Sweet Corn Production

Project Leader: Mark Reiter, Virginia Tech Eastern Shore AREC, Painter, VA. E-mail: mark.s.reiter@gmail.com

Virginia farmers grow over 3,000 acres of fresh market sweet corn. They are interested in exploring sources and rates to improve N use efficiency. This trial compared three N sources (urea-ammonium nitrate, ammonium nitrate, and ammonium sulfate-nitrate) at three rates. The first two N sources were compared with and without S, applied

as gypsum, at a rate designed to supply the equivalent amount of S provided by ammonium sulfate-nitrate (65 lb/A).

Averaged over two seasons (2009 and 2010), the three N sources increased marketable yields by 30 to 65% using optimum N rates ranging from 110 to 170 lb/A. Agronomic efficiency at optimum rates ranged from 26 to 45 lb of marketable yield increase per lb of N applied. Sulfur added as gypsum did not increase yields, and sources did not show consistent differences across the two seasons. In 2011, excessive heat during silking caused limited kernel set and thus marketable yields were zero. Application of N increased total yield, but the small differences among sources are unlikely to mean anything for years in which a marketable yield is achieved. For this reason, another year of testing these sources is advised. These findings support N management decisions that optimize food yields while minimizing risk of water contamination by N on the sandy loam soils of the Chesapeake Bay watershed. *VA-23F*

Sulfur Fertility for Barley Production in the Mid-Atlantic

Project Leader: Mark Reiter, Virginia Tech Eastern Shore AREC, Painter, VA. E-mail: mark.s.reiter@gmail.com

Project Cooperators: Wade Thomason, David Moore, and Keith Balderson

Virginia consistently produces approximately 69,000 acres of barley per year. As with any grain, S fertility recommendations need to be established to ensure adequate supply for producing high yields. Sulfur fertilizer applications have become an important consideration for farmers in the mid-Atlantic utilizing sandy loam soils, since S deposition from the atmosphere has declined as a result of air pollution controls. We conducted a S source × S rate study to determine if S fertilizer applications were necessary.

At the two sites in 2011, the first year of the study, application of S boosted yields by 17% to an average of 96 bu/A. Using ammonium sulfate as a source produced 8% higher yields, on average, than either ammonium-sulfate nitrate or a combination of urea-ammonium nitrate and ammonium thiosulfate. Of the three S rates compared, from 10 to 30 lb/A, the lowest rate was sufficient for highest quality grain and highest yields. *VA-24F* ■

COMING EVENTS

Symposium Announcement:

Fertilizing for Crop Qualities that Improve Human Health

Tuesday, October 23, 2012

American Society of Agronomy Annual Meetings in Cinncinnati, Ohio