IPNI INSIGHTS
INTERNATIONAL PLANT NUTRITION INSTITUTE

September 2012

Northcentral Research Update Report

AGRICULTURE is being asked to solve monumental problems — global warming, hypoxia, eutrophication, food security, and sustainable energy to name a few. The research of soil fertility and plant nutrition is as important as ever as we strive to better understand the elements of sustainable nutrient management. The studies contained in this publication are efforts to that end, and represent continued efforts to help agriculture meet the growing number of demands placed upon it.

This issue of *INSIGHTS* features the brief Interpretive Summaries related to research projects partially supported by IPNI and the Foundation for Agronomic Research (FAR) in the Northcentral Region. This information and more detail on each project can be found at the research database at our website: >**www.ipni.net/research**<.

Iowa

Variability in Soil Test Potassium and Crop Yield in Iowa

Project Leader: Antonio Mallarino, Iowa State University Department of Agronomy, Ames, IA. E-mail: apmallar@iastate.edu

We advanced at summarizing, for publication, a project to study the impact of genetic rootworm resistance on corn response to K. Work also continued on five long-term trials with corn-soybean rotations managed with and without tillage to understand soil-test K (STK) temporal variability and relationships among K rates, placement, STK, and grain yield. A summary was completed of 16 years for the no-till treatment, which included measuring removed K.

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Potassium had inconsistent or small effects on grain K concentration (means of 0.32% for corn and 1.63% for soybean), but increased yield and K removal with STK less than 150 to 180 ppm. Yield was poorly correlated with grain K concentration, but was linearly correlated with removal. STK decreased 2.5 to 3.8 ppm per yr. STK and K removal were well correlated only over the long term. There was a large stratification of STK and non-exchangeable K, and non-exchangeable K partially explained STK variation across K rates and years.

Work was also completed for a third year of two trials that evaluated interactions among hybrid (rootworm susceptible or resistant) and N-K fertilization in corn. Analysis completed for one site showed a positive N-K-hybrid interaction (higher yield and response to N with adequate K for the resistant hybrid). Results of tissue tests for grain and leaves are being studied.

Finally, progress was made on the study of K recycling with corn residue at seven trials. We observed significant K loss from standing plants or residue from physiological maturity until the following spring. About 70% of the plant K was lost by late March, and precipitation increased K loss. *IA-09F*

Global Maize Project in the United States: Ames, Iowa

Project Leader: Roger Elmore, Iowa State University Agronomy Department Ames, IA. E-mail: relmore@iastate.edu

Project Cooperator: John Sawyer

The objective of this study is to determine whether or not an ecological intensification approach can increase yields more quickly over time than current farmer practice. The study design is a split plot. The main plot is management system: 1) farmer practice (FP), and 2) ecological intensification (EI). The split plot is: 1) N application according to the management system, and 2) no N. The treatments are in a randomized complete block, with four replications.

In 2011, there were no soybean grain yield differences between the systems (58.8 and 60.8 bu/A for FP and EI, respectively). For corn grain yield, the N application was

Notes and Abbreviations: N = nitrogen; P = phosphorus; K = potassium.

significant between without and with N (138 and 221 bu/A, respectively). There was no effect of management system nor was there an interaction between management system and N application. Therefore, the site was highly N responsive in both systems, but systems or differences in N source and application rate had no effect on corn yield (FP with N was 220 bu/A and EI with N was 222 bu/A). *IPNI-26*

Indiana

Comparative Nutrient Use Efficiency by Candidate Biofuel Crops

Project Leader: Jeffrey Volenec, Purdue University Department of Agronomy, Lafayette, IN. E-mail: jvolenec@purdue.edu

Project Cooperators: Sylvie Brouder, Keith Johnson, and Brad Joern

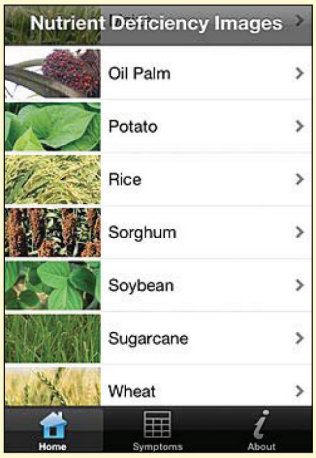
Maximizing biomass yield while minimizing nutrient input represents a new challenge for bioenergy cropping systems. Our objective in this study initiated in 2007 was to determine if nutrient use by perennial and annual bioenergy crops was fundamentally different from well-characterized cropping systems. Using meta-analysis and field experimentation, we studied the relationships between N, P, and K uptake, biomass yield, and composition of sorghum, miscanthus, and switchgrass. Maize was included as a control.

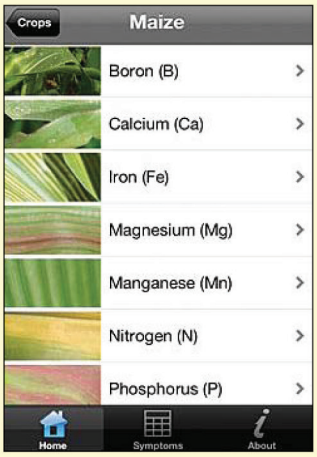
Meta-analyses revealed that nutrient uptake scaled with biomass production across species. Nutrient losses to the environment occurred when senescent biomass was harvested in winter. Miscanthus and switchgrass biomass yields often were not increased with N, P, and K fertilization. High yields of switchgrass were possible with low tissue K concentrations that favor pyrolytic conversion processes. Under low N, yield of sorghum lines exceeded that of maize. Photoperiod-sensitive and sweet sorghum lines produced nearly twice the dry matter of maize at 67 kg N/ha. System differences in nutrient responses should be exploited when deploying candidate biomass species onto marginal soils. *IN-25F* ■

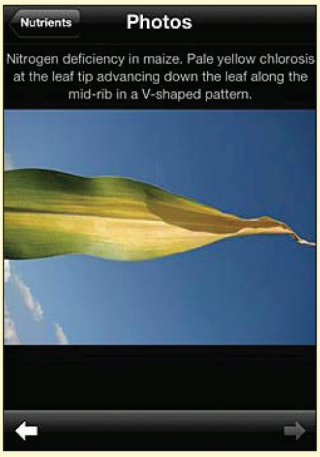
Ref # 12077

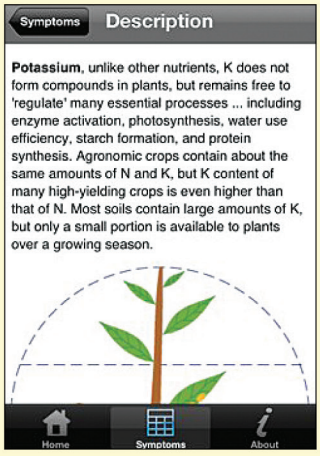
Nutrient Deficiency Photo Application for iPhone/iPad Released

IPNI has released a new Crop Nutrient Deficiency Photo Library app for your iPhone or iPad (see http://info.ipni.net/ndapp). The app contains key photos of classic nutrient deficiency documented from research plots and farm fields for 14 common crops. It also provides supporting text and illustrations of nutrient deficiencies. This mobile app will be a great tool for crop advisers, consultants, farmers, and anyone wanting help in identifying nutrient deficiency symptoms in common crops. BC









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Northern Great Plains Research Report

The emphasis on research to improve crop yields and harvested crop quality is regaining importance because of continuing population growth and an increased demand for improved food quality and quantity. This renewed emphasis is needed after a couple of decades when production agriculture was thought to be a lower priority. This was a misconception because even though we generally had ample yields and food supplies through the two decades from 1990 to 2010, food production never loses it's importance. However, the importance of maintaining and improving yields through research advances received less attention. Greater crop yields result when there are improvements in nutrient management resulting in improved fertilizer use efficiency. Improved yields and greater fertilizer use efficiency is the emphasis of research for IPNI in the Northern Great Plains Region.

This issue of *INSIGHTS* contains brief Interpretive Summaries of research projects supported or arranged by IPNI in the Northern Great Plains Region in 2011. More detail on these and projects from other IPNI regions can be found at the research database at our website: >**www.ipni.net/research**<.

Alberta

Evaluation of Phosphate and Nitrogen Fertilizers Treated with Polymer Additives to Increase Fertilizer Efficiency

Project Leader: Dick Puurveen, University of Alberta Sustainable Resources Department, Edmonton, AB. E-mail: puurveen@ualberta.ca

Project Cooperators: Claire Langlois, Guy Lafond, and Brian Hellegards

This project consisted of two experiments, one at Willingdon, Alberta comparing P fertilizer sources; and another at Dapp, Alberta comparing N fertilizer sources. This study was initiated in April 2008 making this the fourth year of experiments conducted by the University of Alberta.

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In the P experiments, 13 treatments compared two P fertilizer products [granular monoammonium phosphate (11-52-0) and liquid polyphosphate (10-34-0)], three P rates (9, 18 and 27 lb P_2O_5/A), and P fertilizer product with and without the Avail® fertilizer additive. Unfortunately, there appeared to be no response to P at the site, and because of adverse cool and excessive moisture conditions affecting germination and seedling establishment. There was no observable difference between the two P fertilizer products, rate of P, and whether Avail® was added or not.

In the N experiment, an experimental design was used to compare three forms of N (urea, ESN® urea, and Nutrisphere®-treated urea), and four rates of N (22, 44, 88 and 132 lb N/A). All N fertilizer was side-banded at planting. A check or zero N treatment was included in each replicate to assess N response. The coefficient of variation (CV) was high for the site, i.e. 24.5%, due to uneven flooding adversely affecting plant stands over the plot area. There was a moderate response to N observed with the 88 and 132 lb N/a rates significantly out yielding the zero N treatment average. There was no observable difference between N forms except at the 88 lb N/A rate where ESN and Nutrisphere N resulted in higher yields compared to regular urea. *AB-26F*

Large Urea Granules for Broadcast Application in No-till Barley Cropping

Project Leader: Dick Puurveen, University of Alberta Sustainable Resources Department, Edmonton, AB. E-mail: puurveen@ualberta.ca

This is the third year of an experimental study that was initiated to evaluate the potential use of two technologies for broadcast urea granules prior to no-till planting of small grain cereals in the Northern Great Plains region of North America. This is seen as a possibility to allow N application with less energy required during planting compared to banding N. The two technologies being evaluated are: 1) the size of the urea granules, comparing regular size granules (approximately 3 mm, or 1/8 in.) to large forestry grade granules (approximately 10 mm or 1/2 in.) and 2) adding urease inhibitor, and or a urease plus nitrification inhibitor to the granules. One additional experimental factor is the timing of application, which being in the mid-fall, compared to early spring, and at planting. There are two control treatments included in the study. One is a zero N treatment in order to determine the N response at the site,

Notes and Abbreviations: N = nitrogen; P = phosphorus

and the other is a common farmer practice of side-banding N fertilizer during the planting operation, or so-called "double-shoot planting". All rates of N were 62 lb N/A, which is sub-optimal, but chosen to hopefully show potential differences between experimental factors. The research experiment was conducted at the University of Alberta (AB) Research Farm at Ellerslie, AB. Spring barley was no-till planted on April 27, 2011. The 2011 growing season was very wet and cool during May, but warmed up for June, July and August. Moisture was adequate, but not excessive precipitation. Barley was harvested on September 8, 2011.

All the broadcast urea treatments with large or regular sized granules, and with or without addition of an urease inhibitor, or an urease inhibitor plus a nitrification inhibitor, yielded similarly to the common farm practice of side-banding urea during planting. The side-banding treatment yielded an average of 73 bu/A. There was an overall response to added N with the control or zero-N treatment yielding only 65 bu/A, while some of the N treatments yielded up to 90 bu/A. It is planned to continue this experiment for one more growing season. *AB-27*

Large Urea Granules for Broadcast Application in No-till Spring Wheat

Project Leader: Ross McKenzie, Alberta Agriculture, Food and Rural Development Agricultural Research Division, Lethbridge, AB. E-mail: ross.mckenzie@gov.ab.ca

Project Cooperator: Ross McKenzie

This is the second site-year for this experiment. In 2010, the experiment was severely flooded, and this is the first year of analyzable data. The control zero N treatment yielded 43 bu/A, with the highest fertilizer treatment yielding 71 bu/A. The site was quite variable with a coefficient of variation (CV) of 15%. All of the fertilizer treatments were applied with a sub-optimal N rate (63 lb N/A) because emphasis of this experiment was to compare timing, i.e. fall versus spring; size of urea granule, i.e. regular sized urea (1/8 in.) vs. large of the urea granule (1/2 in.); and whether or not adding an urease inhibitor (Agrotain®) resulted in greater yields. All of the N fertilizer treatments resulted in similar yields statistically. There didn't appear to be any advantage or disadvantage of using a larger sized granule as the 1/2 in. granules performed just as well as the regular 1/8 in. granules. There was no statistical yield disadvantage to fall application compared to spring application, or adding Agrotain to the urea, but there did appear to be a trend towards higher yields in the spring applications, and with application of Agrotain. *AB-28*

Large Urea Granules for Broadcast Application for No-till Cropping in Spring Wheat

Project Leader: Audrey Bamber, Chinook Applied Research Assn, Oyen, AB. E-mail: cara-ab@telus.net

Project Cooperators: Dick Puurveen, Ross McKenzie, and Chengci Chen

The crop year 2011 was an excellent growth year with 8.8 in. of precipitation after planting and warm dry weather in July and August to ripen the spring wheat crop sufficiently so that harvest was done on 8-Sept-2011, close to an average harvest date for the area. The challenge about having a moist warm growing season is that even though the site was

initially rated as deficient in N, there was probably above average mineralization of N soil organic matter by the soil microbial population. The above average N mineralization caused the check or zero N treatment to yield well, 68 bu/A, compared to the N fertilizer treatments all applied at 63 lb N/A, that ranged from 66 to 74 bu/A. Yields in this area are more commonly around 40 to 45 bu/A. Measurements of grain height at harvest showed that the majority, 16 out of 18, of the 18 fertilizer treatments had significantly taller wheat (at 90% confidence) than the check treatment. That being 30 in. height for the check treatment compared to a range from 31 to 34 in. height for the fertilizer N treatments. Variability at the site was very low for both yield and crop height, i.e. 7% and 3% coefficients of variation (CV) respectively. All fertilizer treatments yielded well with no significant differences between granule size (1/8 in. compared to 1/2 in.), time of application (fall or spring), and with or without urease and nitrification inhibitors. It is hoped that with a more normal precipitation year in 2012 that there will be a greater response to fertilizer N compared to the check treatment, and that differences between N fertilizer treatments will be observed. *AB-29*

British Columbia

Evaluation of Phosphate and Nitrogen Fertilizers Treated with Polymer Additives to Increase Efficiency

Project Leader: Claire Langlois, BC Grain Producers Association, Dawson Creek, BC. E-mail: bcgpa-r@pris.ca

Project Cooperators: Dick Puurveen, Guy Lafond, and Brian Hellegarda

Fortunately, this set of research experiments was conducted under favorable weather conditions in 2011. During the previous 3 years (2008 to 2010) this area experienced severe drought, but growing season moisture was received close to the normal 11.6 in., in contrast to 2010 when only 7 in. was received. Barley yields were high with average yields over 100 bu/A.

In the P experiment there was no significant response to applied P with the control or zero-P treatment yielding similar to all rates of P, both 15 and 30 lbs P_2O_5/A. The zero-P treatment yielded 100 bu/A, and all the P treatments yielded between 94 to 114 bu/A, with a Least Significant Difference (LSD) of 20 bu at a 90% level of confidence. Perhaps since the area came out of a severe drought after 3 years, there was enough available P from increased microbial activity that there was no response to applied P. Since there was no response to P, there was no differences observed between form of P fertilizer (i.e. ammonium polyphosphate, or monoammonium phosphate), rate of P_2O_5 (0, 15 or 30 P_2O_5/A), and whether or not the Avail® polymer was added or not.

There was an even higher yield measured in the N experiments. The check or zero N treatments averaged 120 bu/A, while all the N fertilized treatments, both 54 or 108 lb N/A averaged around 150 bu/A. There was about a 30 bu/A response to added N whether 54 or 108 lb N/A. In comparing the three forms of N, the overall average yields did not show any significant differences. Regular untreated urea averaged 150 bu/A, the Super Urea® 150 bu/A, and

the Nutrisphere®-N treated urea yield was 151 bu/A, with an LSD of 7 bu/A at 90% confidence. The data from the 4 years of the study at this site will be grouped and final data analysis done to compare regular P and N fertilizers to those treated with polymer additives, and urease, and nitrification inhibitors. This analysis will be described in the final project report. *BC-17F*

Manitoba

Impact of Long-Term Application of Phosphate Fertilizer on Cadmium Accumulation in Crops

Project Leader: Cynthia Grant, Agriculture & Agri-Food Canada, Brandon, MB. E-mail: cgrant@agr.gc.ca

Project Cooperators: Wole Akinremi (University of Manitoba), Don Flaten (University of Manitoba), Xiying Hao (AAFC Lethbridge), Ross McKenzie (Alberta Agriculture), Dick Purveen (University of Alberta), and Sukhdev Malhi (AAFC Melfort).

Cadmium (Cd) can accumulate in soils from long-term application of P fertilizer, but the availability of the Cd added in P fertilizers will be affected by soil characteristics. Field studies were established in 2002 at seven sites across the Canadian prairies to evaluate the impact of repeated applications of 0, 20, 40, and 80 kg P/ha of mono-ammonium phosphate (MAP) fertilizer containing 0.38, 70, or 210 mg/kg of Cd. The sites were planted each year following a durum wheat-flax cropping sequence. Fertilizer was applied each year until 2009. Grain concentration of Cd was measured each year in each treatment and the soil concentration of Cd, P and other elements was measured in the 0 to 7.5 and 7.5 to 15 cm soil depths in the control and at the highest P application rates. In 2010 and 2011, crops were seeded with no addition of P fertilizer to evaluate the residual effect of the long-term application of P and Cd on grain Cd content. Chemical and statistical analysis of the 2010 and 2011 samples is continuing.

Based on the data analyzed to date, extractable P was strongly related to the amount of P added to the soil with the rate of increase being inversely related to soil CEC, pH, Fe, and Ca. DTPA extractable soil Cd in the surface 7.5 cm depth increased with application of MAP containing moderate or high concentrations of Cd, but concentration in the 7.5 to 15 cm depth only increased with the high-Cd MAP. Cadmium concentration in both durum wheat and flax seed increased with increasing input of Cd, but the magnitude of the effect varied with soil characteristics and was not consistently related to DTPA-extractable soil Cd. Plant availability of the Cd added in P fertilizer was higher on coarse-textured or acidic soil than on fine-textured or higher pH soils. As the effect of MAP applications on extractable P and Cd in the soil and on grain Cd concentration is affected by soil characteristics, it is important to consider soil characteristics when assessing environmental and health risks associated with P and Cd accumulation in soils. *MB-24*

Montana

A Micrometeorological Study to Quantify Ammonia Volatilization Losses from Surface-Applied Urea in the Semiarid Northern Great Plains

Project Leader: Richard Engel, Montana State University Land Resources and Environmental Sciences, Bozeman, MT. E-mail: rengel@montana.edu

Montana grain growers annually seed over 5 million acres of wheat, primarily winter wheat. Nitrogen is the primary nutrient that limits wheat production on this land. Hence N fertilization is essential for sustaining yields as well as ensuring production of high protein quality grain. To meet this challenge Montana wheat growers apply N fertilizer to their fields. Most frequently this is achieved through broadcast applications of urea-N (46-0-0) to the soil surface with applications occurring between October and early May. Surface urea applications are susceptible to ammonia (NH_3) volatilization losses if not incorporated with tillage or by rainfall. A number of environmental and soil related factors interact together to affect this process and define the magnitude of loss. Research has continued on this project for the fourth year.

There have been sufficient sites where NH_3 losses were measured (approx. 20), with different weather patterns experienced, that it is now possible to better understand what weather and soil conditions result in low, moderate, and higher relative losses of NH_3. The loss amounts and associated weather patterns can be separated into three categories: low (when applied urea loss is <10%), moderate (when applied urea loss varies between 10 and 20%) and high (when applied urea loss is >20%). Associated soil and weather patterns for these categories include urea applied to dry soil surface then large precipitation events (>0.7 in.) following fertilization for the low category, urea applied to dry soil surface followed by light scattered precipitation events (<0.3 in.) for the moderate category, and urea applied to wet or damp soil surfaces followed by slow drying without precipitation, daily soil temperatures cold (-2 to 3˚C) for the high category.

At all of the research sites besides a control or zero N treatment, there has been an application of NBPT urease inhibitor (Agrotain® at 0.01% by weight) to urea for comparison. Generally use of NBPT has been shown to reduce NH_3 losses by around 50%. Additional laboratory experiments are being conducted to better understand the effect of soil pH on the length of effectiveness of the NBPT. This is being done because of observations made of increased length of effect of NBPT on alkaline soils compared to acidic soils. Laboratory research on this will continue over the next year. *MT-17*

Nitrogen Fertilization Methods for No-till Cropping of Winter Wheat in Central Montana

Project Leader: Chengci Chen, Montana State University CARC, Moccasin, MT. E-mail: cchen@montana.edu

Project Cooperators: Audrey Bamber, Dick Puurveen, and Ross McKenzie

The most common method of applying N fertilizer to winter wheat crops in central Montana, is to broadcast urea or dribble apply liquid urea ammonium nitrate in the late fall, or early spring. With shallow soil profiles in central Montana, the soils do not hold much precipitation over winter. When precipitation exceeds the soil water holding capacity, the excess water carries N out of the soil profile, causing ground water contamination.

A study was started in the fall of 2010 to compare other possible methods of applying N fertilizer to winter wheat crops, that may reduce the risk of leaching or denitrification losses of applied N fertilizer. Other possible methods include side-banding urea during the planting operation of wheat in mid to late September, placement of ESN® or controlled-release polymer coated urea in the seed-row of wheat at planting, or application of urea treated with urease and nitrification inhibitors in the mid-fall or early spring. In this experiment the winter wheat was planted in mid-September 2010, the two at-planting treatments described above were applied at this time. The fall broadcast treatments were applied on October 5, 2011, and the spring broadcast treatments on March 24, 2012. Treatments included: urea broadcast in mid fall, urea broadcast in early spring, Super Urea® broadcast in mid fall, Super Urea broadcast in early spring, ESN applied in the seed-row at planting in the fall, regular urea applied in the seed-row at planting in the fall, and check (no N applied).

Winter wheat grain yield was significantly affected by N source, application timing, and application method. Generally, spring application had greater yields than fall application. This study will be continued for two more growing seasons. *MT-18*

North Dakota

Nitrogen Recalibration for Corn in North Dakota

David Franzen, North Dakota State University Department of Soil Science, Fargo, ND. E-mail: david.franzen@ndsu.edu

This is the second year of the project designed to allow the research-based re-evaluation of the corn N recommendations in North Dakota. A total of 22 sites were planned in 2011. With the sites from 2010, there have been a total of 36 sites that can be evaluated. In addition, sensor readings using both a Greenseeker® (N-Tech) sensor and a Holland Scientific Crop Circle sensor were used when the corn was about 6 leaf and again about 2 weeks later over the top, and at the later season also below canopy height. These sensor readings were taken to try to develop a predictive measurement to guide growers in the need for added N at side-dress time. The site yield and N-rate evaluations were evaluated as a whole and partitioned based on regional and soil considerations.

The response of corn to N rate from the total of the two years was quite variable ($R^2 = 0.19$). The no-till sites, a total of five in the 2 years, responded differently than conventional sites, and the 50 lb N/A long-term credit used in the spring wheat and durum recommendations also appears to be justified for corn. High clay sites required far more N for similar yields as the remaining eastern North Dakota sites. Based on a comparison of similar yields from the rest of eastern North Dakota, clay sites lost about 80 lb N/A in 2010 due probably to denitrification and more than 120 lb N/A in 2011. The well-tiled clay sites were less affected by N loss and responses to N near those of medium-textured soil sites in the east. Considering the amount of N lost in high clay soils in 2010 and 2011, and probably by growers in many springs, there is ample cause to begin recommending a planned side-dress N application in high clay soils. It is planned to conduct field sites for two more years, 2012 and 2013, and then summarize the experimental results and release updated N recommendations for the various regions in North Dakota. *ND-16*

Saskatchewan

Evaluation of Urea Nitrogen Fertilizer Treated with Nutrisphere® Polymer Additive to Increase Fertilizer Efficiency

Project Leader: Guy Lafond, Agriculture and Agri-Food Canada Indian Head Research Farm, Indian Head, SK. E-mail: lafond@agr.gc.ca

Project Cooperators: Claire Langlois, Dick Puurveen, and Brian Hellegardsa

This project, at the Indian Head Research Farm near Indian Head, Saskatchewan, consists of three experiments comparing regular granular urea, urea treated with Nutrisphere-N® (a polymer coating), and Super Urea® (including both urease and nitrification inhibitors) at 45, 90, and 135 kg N/ha. The experiments were conducted on spring wheat, barley, and canola. The study was initiated in April 2008, and repeated in 2009, 2010, and 2011. In 2011, growing conditions were cool and more moist than normal, early in the growing season, and drier and warmer than normal in the last half of the growing season.

A significant response to N was observed for all three crops. There was a slight overall yield benefit to the slow release N products observed with canola, but not for wheat or barley. It is thought that the soil conditions susceptible for denitrification losses were met at Indian Head from late May through June which could have increased the potential for a benefit to the side-banded Super-U and NSN, but at least for the barley, yields were limited more by the excess spring moisture than by N. Both the wheat and the canola ended up yielding well and the response to N for both crops was quite linear up to 134 kg N/ha. The conditions suitable for denitrification losses are not experienced very often in this area of Saskatchewan, but it does demonstrate the potential benefits of these enhanced urea products when the potential for N loss is high. *SK-40F* ■

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IPNI INSIGHTS
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Research Supporting Nutrient Stewardship

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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

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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*

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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

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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

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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

IPNI INSIGHTS
INTERNATIONAL PLANT NUTRITION INSTITUTE

September 2012

Southeast Region Research Report

RESPONSIBLE management of crop nutrients requires research. Research is one step in the development process of best management practices (BMPs) that specify the right source of nutrient to be applied at the right rate, time, and place. Scientists need to test these practices for their impact on productivity, profitability, cropping system sustainability, and environmental health..

This issue of *INSIGHTS* features the brief Interpretive Summaries related to research projects supported by IPNI in the Southeast Region. This information and even more detail on each project can be found at the research database at our website: >**www.ipni.net/research**<.

Alabama

Evaluation of Fertilizer Application Uniformity and Nutrient Distribution

Project Leader: John Fulton, Auburn University Biosystems Engineering, Auburn, AL. E-mail: fultonjp@auburn.edu

Project Cooperators: Charles Wood and Greg Pate

Blended fertilizers are commonly applied to crop and pasture land using spinner-disc spreaders. However, the nature of blended fertilizers can make it difficult to spread uniformly due to varying physical properties of the different granules, which can lead to segregation during application. Further, variable-rate application of blended fertilizer could pose challenges in terms of accuracy and uniformity to meet target prescription rates. Therefore, a study was conducted with the primary objective of evaluating the potential of fertilizer segregation during application with a spinner-disc spreader. A series of standard pan and field tests were performed to evaluate mass and nutrient distribution for a blended fertilizer product (17-17-17). Spreader calibration was conducted prior to data collection according to manufacturer specifications. After calibration, replicated standard pan testing was conducted to measure both distribution based on mass and nutrient (N, P_2O_5 and K_2O) concentration across the spread width. Field tests consisted of generating fertilizer prescription maps followed by a variable-rate application using 17-17-17. Collection pans were randomly placed across the field and fertilizer collected in each pan was weighed to determine the actual rate applied and analyzed for nutrient concentration. Field data, prescription, and as-applied maps were used to evaluate performance and product segregation.

Results indicated that P and K concentrations (CV 25% and 26%, respectively) varied significantly across the swath and in the field indicating the occurrence of fertilizer segregation. Nitrogen concentration remained uniform across the swath during both pan tests (CV=4%) and during field application (CV<8.5%). Particle size difference between the individual fertilizer constituents was the primary reason for segregation. The segregation of fertilizer particles resulted in under-application of P, but under- and over-application of K during field application. Of note, this study represents results for one spreader setup and a single blended product and may not reflect possible performance for a different setup, spreader, and other blended products. A more detailed study is planned for 2012 to gain insight into understanding blended formula segregation applied with modern spinner spreaders. *AL-19*

Arkansas

Biomass and Macronutrient Accumulation and Losses in Switchgrass During and After the Growing Season

Project Leader: Charles West, University of Arkansas Crop, Soil and Environmental Sciences, Fayetteville, AR. E-mail: cwest@uark.edu

Field studies were conducted for the third year on switchgrass yield response to N fertilizer in northwest Arkansas. Another study evaluating N, P, and K fertilizer response was established in eastern Arkansas in 2011 and switchgrass variety trials were conducted in 2010 and 2011. For the N, P, and K fertilizer trials, average forage yield was 7 ton/A. The fertilizer nutrients were tested in physically separate trials, which were adjacent to each other. In the N rate trial, N concentration increased,

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Notes and Abbreviations: N = nitrogen; P = phosphorus; K = potassium; Mg = magnesium; Ca = calcium; S = sulfur.

P concentrations were unaffected, and K concentrations declined with increments of N fertilizer. In the P trial, no elemental concentrations were affected by P fertilizer rates. In the K trial, there was a slight, nonsignificant trend for an increase in K concentration with K fertilizer increments, whereas N and P were unaffected. The N rate study in 2011 showed a significant increase in biomass yield with increments of fertilizer applied as urea in one application in early May. The trend in response was linear from 0 to 90 lb N/A, then leveled off at the highest increment. This was similar response to that found in 2010. Yields were lower in 2011 than in 2010 because of record high summer temperatures and a prolonged drought. Concentrations and removal rates of N, P, and K are still being analyzed.

The variety trials compare advanced breeding lines 'Cimarron', 'C75', and 'C77' with the standard, commercially available cultivar, 'Alamo'. All plots received 60 lb N/A in late April each year. At the beginning of 2011, the plot area was found to have low soil test values for P and K. Therefore, 60 and 115 lb/A of P_2O_5 and K_2O, respectively, were applied to the plot area. Cimarron, a new release, exhibited greater biomass yield than Alamo. New, high-yielding cultivars of switchgrass would be expected to remove more N, P, and K from the field than Alamo. The added P and K fertilizer probably explains most of the increase in biomass yield in 2011 compared to 2010; however, somewhat more favorable rainfall in 2011 may explain some of the increase. Although not designed as a fertilizer response study, the results suggest that switchgrass does respond to P or K, with K being the more likely limiting nutrient, as indicated by the increased K tissue concentrations in the K fertilizer trial described above. *AR-33*

Florida

Bahiagrass Production and Nitrogen Leaching from Various Nitrogen Fertilizer Sources

Project Leader: Maria Silveira, University of Florida Soil and Water Science, Ona, FL. E-mail: mlas@ufl.edu

Bahiagrass covers nearly 5 million acres in Florida and is the most widely used improved grass in the state. This grass requires relatively moderate amounts of N for optimum production and can efficiently respond to inorganic fertilizer application. Nitrogen fertilizer can increase both yield and nutritive value of bahiagrass pastures, particularly in low fertility Coastal Plain soils where N is often the most limiting nutrient for forage production. Although N is an important agronomic input for productive bahiagrass pastures, increasing input costs and environmental problems associated with improper fertilization management have prompted the need to re-examine optimum rates and efficient sources to supply pastures with N. This experiment was designed to examine the effectiveness of various N sources on bahiagrass dry matter yield, nutritive value, and N leaching potential. Nitrogen was applied at 0, 50, and 100 lb/A/yr as ammonium nitrate (AN), ammonium sulfate (AS), urea, and ammonium sulfate nitrate (ASN) on a Basinger fine sand (siliceous, hyperthermic Spodic Psammaquents). The study was conducted at the Range Cattle Research and Education Center in Ona, FL during May to November, 2011.

Because of lack of rainfall in 2011, bahiagrass yields were significantly reduced as compared to previous years. Nitrogen sources increased cumulative bahiagrass dry matter yield by approximately 65% compared to control plots (no N applied). Bahiagrass yields responded linearly as N rates increased from 0 to 100 lb/A. Bahiagrass crude protein concentration was not significantly affected by N source. There were no significant differences in bahiagrass crude protein concentrations between the control plots (CP = 8.8%) and the treatments receiving 50 lb N/A (CP = 9.8%). However, application of 100 lb N/A resulted in higher CP concentrations (CP = 10.7%). Soil extractable inorganic N concentrations and soil pH at the 0 to 6 and 6 to 12-in depth were not affected by N fertilizer application. *FL-29F*

Nitrogen Rate Study for Potato Production in Northeast Florida

Project Leader: Lincoln Zotarelli, University of Florida Ag-Horticultural Sciences, Gainesville, FL. E-mail: lzota@ufl.edu

Project Cooperator: Daniel Cantliffe

With approximately 25,000 acres of winter and spring potatoes, Florida is an integral part of the supply chain for freshly harvested potatoes in the United States. Fertilizer BMPs are being developed to increase N-use efficiency for potato production and to reduce N-leaching. This ongoing study aims to determine optimal N-rates for commercial potato production. This study was performed with grower collaboration in six seepage-irrigated locations throughout northeast Florida, with three locations growing potato variety 'Atlantic,' and three growing 'FL 1867.' Nitrogen fertilizer rates ranged from 100 to 300 lb N/A as ammonium nitrate. All plots received 50 lb N/A of N at fumigation; N was then sidedressed twice with the plots receiving 0, 50, 100, or 150 lb N/A at emergence then 50 or 100 lb N/A at the 6 to 8-in growth stage. Total and marketable yield, specific gravity, plant dry weights, and N levels in the plants (tubers, leaves, and stems) were evaluated. Soil N levels were recorded throughout the season. Nitrogen content in the soil and N uptake into the plant were monitored throughout the season and potato yields were compared among treatments.

No difference in potato yields was observed among N rate treatments for Atlantic at any location. The Atlantic variety accumulated about 90 to 140 lb of N/A in the tissues (leaves, stem, and tubers). Atlantic total yield ranged between 200 and 290 cwt/A and N fertilizer rates above 230 lb N/A did not increase total yields. FL1867 was more responsive to N fertilization and highest yields were obtained when 100 to 150 lb N/A was applied at emergence in two of the three locations. For FL1867, total yields ranged from 350 to 395 cwt/A. For both varieties, the N accumulated by potato plants ranged from 130 to 190 lb N/A. The residual soil nitrate after harvest tended to increase according to N fertilizer rate. N fertilizer rates above 200 lb N/A left 60 to 120 lb N/A in the soil following harvest. The preplant N application did not increase soil N availability at plant emergence. Reduced soil N content coincided with heavy rainfall events. More research is needed to confirm these initial results. *FL-30*

Louisiana

Validation of an On-Site, Active Sensor-Based Midseason Nitrogen Decision Tool for Rice Production in the Mid-South

Project Leader: Brenda Tubana, LSU AgCenter School of Plant, Environment and Soil Science, Baton Rouge, LA. E-mail: btubana@agcenter.lsu.edu

Project Cooperators: Dustin Harrell, Timothy Walker, Yumiko Kanke, and Josh Lofton

Nitrogen is the most limiting and expensive plant nutrient in rice production. A need-based application of N fertilizer plays an important role in developing a more profitable and environmentally-sound rice production system in the Mid-South. Three years of optical sensor and rice yield data were collected and used to establish the working algorithm that runs a sensor-based N decision tool (SBN tool) that was used for determination of topdress N application rates for rice in 2011. Validation studies for the SBN tool were conducted at three sites in Louisiana and Mississippi using three rice varieties (CL152, CL162, and CL261). Different rates of N fertilizer applied either one time at preflood or split between preflood and midseason were arranged in a randomized complete block design with four replications. Two additional treatments, 75 and 105 lb N/A preflood N followed by a topdress N rate based on the SBN tool recommendation, were also included.

All sites were responsive to N fertilization except Rayville in Louisiana. Highest grain yield response was obtained from rice grown in Crowley (107% increase in grain yield). There were no significant differences in yield, N uptake, N use efficiency, and net return between plots which received SBN N rate recommendations and predetermined split N rates (75-45 or 105-45 lb N/A). However, topdress rate recommendations using the SBN decision tool ranged between 32 to 45 lb N/A and 21 to 28 lb N/A for Louisiana and Mississippi sites, respectively. Results showed that the SBN decision tool performed better than predetermined N rates using NUE and net return to N as performance indicators. Future work will include attempts to refine the working algorithm by considering the use of a single yield potential predictive equation for both Louisiana and Mississippi, and economic parameters (cost of rough rice and N fertilizer). *LA-24*

Missouri

Survey of Weed Nutrient Removal Potential in Missouri Soybean

Project Leader: Kevin Bradley, University of Missouri Plant Sciences, Columbia, MO. E-mail: bradleyke@missouri.edu

With the increasing adoption of glyphosate-resistant crops, concern for the timeliness of herbicide applications has declined and in many cases herbicide applications are made to large weeds that have already resulted in yield loss. With this in mind, a survey was conducted in 2011 to monitor 32 soybean fields in Missouri. The objectives of this survey were: 1) to determine the most common weeds encountered in soybean fields in Missouri, 2) to determine the average size and density of weeds present at the time of the post-emergence herbicide application, and 3) to determine the impact of typical weed infestation levels on nutrient removal. Observations were made once every two weeks from soybean planting through canopy closure in each of the survey locations. Just prior to the time of the post-emergence (POST) herbicide applications, sub-samples of weeds present at each location were harvested and analyzed for nutrient content.

At the time of the first POST herbicide application, all broadleaf weeds other than waterhemp were present at an average density of 1 plant/ft^2. The average height of broadleaf weeds other than waterhemp and all grass weeds present at the time of the first POST herbicide application were 7.5 to 10.5-in, respectively. Waterhemp was encountered at an average density of 2 plants/ft^2 and average height of 8.5-in at the time of the first POST herbicide application. Estimated soybean yield losses based on the weed densities and height of weed present ranged from 0 to 8 bu/A, with an average yield loss of 2.5 bu/A occurring across the 32 surveyed locations. Based on the weed densities present in the survey locations, the average amount of N, P, and K weed removal in soybean fields in Missouri was 3.2, 0.4, and 3.7 lb/A, respectively. The weed infestations encountered also resulted in an average removal of 0.7 lb of Mg, 2 lb of Ca, and 0.3 lb S per acre. To date, these first-year results indicate that yield loss is likely occurring in the majority of soybean production fields in Missouri as a consequence of waiting too long to control broadleaf and grass weed species, and that at least some portion of this yield loss can be attributed to weed nutrient removal. *MO-34*

North Carolina

Soil Fertility Management for High Population, Narrow Row Corn Production

Project Leader: Carl Crozier, North Carolina State University Soil Science Department, Plymouth, NC. E-mail: carl_crozier@ncsu.edu

Project Cooperators: Ronald Gehl, Alan Meijer, and Ronnie Heiniger

The objectives of this research were to determine the optimum N timing and rate in high population, narrow row corn production systems. A series of 11 N fertilizer response experiments were conducted on Tidewater, Coastal Plain, Piedmont, and Mountain (grain and silage) region sites in North Carolina during 2010 and 2011. Corn yield response and yield components (# rows per ear, # kernels per row, and kernel size) were compared among wide row (30- to 40-in) and narrow row (15-to 20-in) corn that was fertilized with N either all at planting, or with both starter fertilizer (limited to 5 gpa 11-37-0) and sidedress N (between V5 and V8 stage). The starter band application of 6 lb N/A was applied to all plots in all experiments to insure rapid early season growth, except for one site to which 50 lb N/A had been applied uniformly in a granular pre-plant broadcast blended fertilizer. These data document general principles of N-use efficiency associated with different corn row widths and N application timing.

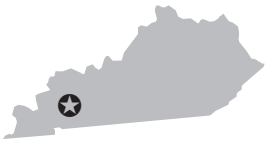
On average, approximately 0.7 lb N/bu was required to achieve optimum corn yield levels at these sites. In most cases yields did not differ due to N timing or corn row width. Nevertheless, when significant differences were noted, sidedress N applications resulted in higher yields compared with applying all N at planting, and narrow row planting

resulted in higher grain yield than wide row planting. Data also suggest that corn plants experience more N limitations during late season periods, since changes due to N rates were detected in later-determined ear yield components, rather than plant and ear density components. The average number of rows per ear increased by a relatively small amount, from 15.9 to 16.4; while relatively greater increases were observed in row length, from 27 to 32 seeds per row, and seed weight, from 222 to 252 mg per seed. This could direct future management research into methods to ensure later season N sufficiency. *NC-21*

Kentucky

Evaluation of Sidedress Nitrogen Sources in Dark Tobacco

Project Leader: Andy Bailey, University of Kentucky Research & Education Center, Princeton, KY. E-mail: andy.bailey@uky.edu



Research was conducted in 2011 to evaluate the effect of several sidedress N sources on crop vigor, yield, and quality grade index of dark fire-cured tobacco. The site had a soil test P index of 62 (high), soil test K index of 216 (medium), and pH 6.2. One ton/A agricultural lime was applied and disk incorporated in early spring and 150 lb N/A (urea/DAP), 80 lb P_2O_5/A (DAP), and 180 lb K_2O/A (potassium sulfate) was broadcast and incorporated to the entire area on June 6, one week prior to transplanting 'PD7309LC'dark tobacco on June 14. Treatments were arranged in a randomized complete block design with 4 replications and individual plots were 4 rows by 40 ft long. Non-fertility practices followed standard production guidelines. Weather conditions during the 2011 season were wet prior to transplanting in April and May, with hot temperatures but adequate moisture during the growing season, and ample moisture during the curing season. Ambient rainfall was supplemented with drip irrigation in this trial. Sidedress N applications were made on July 22 at 150 lb N/A and immediately incorporated. Seven sidedress N source treatments were in the trial and included no sidedress (150 lb N/A pre-transplant only), Sulf-N 26 ammonium sulfate nitrate, 50:50 blend of Sulf-N ammonium sulfate and urea, ammonium nitrate, UAN-32 liquid, UCAN-17 liquid (CN-9 + UAN-28), and potassium nitrate. Crop vigor was evaluated in late August with the best crop vigor occurring from tobacco treated with potassium nitrate and lowest crop vigor in tobacco that received no sidedress N. Tobacco was manually stalk harvested in early October, housed in a traditional dark-fired barn, and fired four times with hardwood slabs/sawdust as is standard. Tobacco was taken down and stripped into 3 stalk positions (lug, second, leaf) in early December.

There were slight differences in the lug position yield, with lugs produced from tobacco treated with ammonium nitrate weighing slightly more than lugs produced from tobacco receiving no sidedress N or UCAN-17. Total dark fire-cured tobacco yield ranged from 3,441 to 3,642 lb/A with no statistical differences among N treatments. There were differences in quality grade index between treatments, with the highest grade index occurring in tobacco receiving the 50:50 blend of Sulf-N ammonium sulfate and urea (56.8), and the lowest grade index occurring in tobacco receiving no sidedress N or UCAN-17 (30.6 to 31.2). *KY-10F*

Evaluation of Sidedress Nitrogen Sources in Burley Tobacco

Project Leader: Bob Pearce, University of Kentucky Plant and Soil Science Department, Lexington, KY. E-mail: rpearce@uky.edu

Various N fertilizer sources were evaluated for use in burley tobacco production during the summer of 2011. The materials tested included ammonium nitrate (34-0-0), calcium-ammonium nitrate (27-0-0), urea (46-0-0), and Sulf-N 26 ammonium sulfate nitrate (26-0-0-14S). An extremely wet spring at this location delayed planting until after the first of June. The field was prepared as is typical for burley tobacco production and a base rate of 50 lb N/A was applied in the form of urea. Burley tobacco (var. KT-209) was transplanted into the field on June 3.

At four weeks after transplanting, the sidedress N materials were applied at two rates (100 and 200 lb N/A). The field sustained moderate wind damage just prior to topping on August 11. The crop was harvested on September 12 and hung in curing barns. The wet start and wind damage tended to have a leveling effect across treatments. There was an effect of sidedress fertilizer to raise yield above the level of the 0-N sidedress check; however, all of the sidedress N materials performed similarly. *KY-11F*

Tennessee

Documenting Nutrient Deficiency and Accumulation Rate in Vegetables

Project Leader: Dharma Pitchay, Tennessee State University, Nashville, TN. E-mail: dpitchay@tnstate.edu

A photo catalog of nutrient deficiency symptoms is being developed for common vegetable crops. The first phase of this research and education project is to induce mineral deficiency symptoms for various hydroponically grown plants in the greenhouse. Using purified nutrient solutions, plants were systematically deprived of each essential nutrient to observe the development of deficiency symptoms.

A complete set of deficiency photographs is now available for lettuce. Photographs for spinach deficiencies will shortly be available. Peppers and eggplant will be grown to produce deficiency symptoms and tissue samples throughout the growing season will be analyzed to determine nutrient accumulation rates. A project to determine a suitable solid phase media for this research was conducted so that root system deficiencies could be measured. Perlite contained sufficient trace concentrations of nutrients to mask some symptoms even after it was washed with acid.

A blueberry experiment was conducted to examine the impact of nitrate (NO_3) or ammonium (NH_4) nutrition on plant growth and root development. Blueberry shoot and root growth virtually ceased when nitrate was the sole source of N nutrition. A portion of the rootzone N must be in the NH_4 form for blueberries to grow. All the images of nutrient deficiencies will be available for educational use from IPNI as the project progresses. *TN-20* ■

IPNI INSIGHTS
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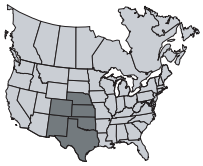
Southern and Central Great Plains Region Research Report



September 2012

CONTINUING investigation into new technologies and improved efficiency is vital to any industry. Accordingly, IPNI continues a tradition of supporting agronomic research for the future of our industry.

This issue of *INSIGHTS* features the brief Interpretive Summaries related to research projects supported by IPNI in the Southern and Central Great Plains Region. This information and even more detail on each project can be found at the research database at our website: >**www.ipni.net/research**<.

Colorado

Contribution of Animal Feeding Operations and Synthetic Fertilizers to Ammonia Deposition in Rocky Mountain National Park

Project Leader: Jessica Davis, Colorado State University, Department of Soil and Crop Sciences, C06 Plant Sciences Building, Fort Collins, CO 80523. E-mail: jessica.davis@colostate.edu

Project Cooperators: Thomas Borch and Jeffrey L. Collett, Jr.

Ammonia (NH_3) deposition has been identified as a concern from both human health and environmental standpoints, and has recently been targeted by Colorado as a primary contributor to atmospheric and ecosystem changes in Rocky Mountain National Park (RMNP). The Colorado Department of Public Health and Environment has estimated that 60% of the NH_3 deposition in RMNP comes from agricultural activities with 40% from animal feeding operations and 20% from fertilizer. However, these estimates have not been verified by scientific measurement, and verification is especially important if future regulations require that agriculture be held accountable for NH_3-related ecosystem damage. One promising way to track N to its original source is via N isotopic signatures ($\sigma^{15}N$) since the ratio between the ^{14}N and ^{15}N isotopes is influenced by source. A major goal of this project is to assess the ability of isotopes as tracers, and in turn to determine sources of NH_3 contributing to N deposition in RMNP. The original objectives of this study were to 1) determine the major sources of NH_3 deposition in RMNP based on N isotopic signatures of different NH_3 sources (i.e., agricultural, natural, and industrial), and 2) quantify the relative contribution of NH_3 to RMNP from animal feeding operations, synthetic fertilizers, and other sources.

Progress over the past year includes completion of an NH_3 field sampling (radiellos) campaign, collection of wet deposition in RMNP, and a RMNP soil emission study. Radiellos were placed at seven sites including animal husbandry, urbanized sources, cropland, foothills, and RMNP. Animal husbandry had the highest average NH_3 concentrations, ranging from 4 to 100 times higher than other sources. Preliminary analysis of N isotopes has shown some variation across studied sources. Wet deposition is similar to previous studies with 1.39 and 2.00 kg N/ha during the spring and summer, respectively. Ammonia contributed 50% and 30% to total N during the spring and summer period, respectively. The findings from the RMNP show that grassland soils have higher NH_3 emissions than forest soils. Support for this work will continue in 2012. *CO-13F*

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Kansas

Effect of Long-term Nitrogen, Phosphorus, and Potassium Fertilization of Irrigated Corn and Grain Sorghum

Project Leader: Alan Schlegel, Kansas State University Southwest Kansas Research and Extension Center, Tribune, KS. E-mail: schlegel@ksu.edu

This long-term western Kansas study was initiated in 1961 to evaluate responses of irrigated continuous corn and grain sorghum to N, P, and K fertilization. Furrow irrigation was used through 2000, and sprinkler irrigation since 2001. No yield benefit to corn from K fertilization was observed in the first 30 years and soil K levels remained high, thus the K treatment in the corn study was discontinued in 1992 and replaced with a higher P rate. Nitrogen treatments for corn and grain sorghum were 0, 40, 80, 120,

160, and 200 lb N/A. Phosphorus treatments for corn and grain sorghum were 0, 40, and 80 lb P_2O_5/A, and 0 and 40 lb P_2O_5/A, respectively. The K treatments for grain sorghum were 0 and 40 lb K_2O/A.

Corn yield was above average in 2011, with maximum yield at about 230 bu/A. Nitrogen applied alone increased corn yield by 87 bu/A, while N and P applied together increased yield up to 139 bu/A. This is similar to the past 10 years where N and P applied together increased irrigated corn yield by about 130 bu/A. Application of 120 lb N/A (with P) was sufficient to produce 95% of maximum yield in 2011. Nitrogen fertilizer alone increased sorghum yield by about 50 bu/A, while N plus P increased yield by up to 75 bu/A. Application of 40 lb N/A (with P) was sufficient to produce about 80% of maximum yield in 2011. Potassium fertilization had no effect on sorghum yield. This is one of the few continuous, long-term crop nutrition studies in the U.S., and support is planned to continue in 2012. *KS-23F*

Effect of Potassium, Chloride, and Nitrogen on Corn, Wheat, and Double-crop Sunflower Grown on Southeastern Kansas Claypan Soil

Project Leader: Daniel Sweeney, Kansas State University Southeast Agricultural Research Center, Parsons, KS. E-mail: dsweeney@oznet.ksu.edu

Project Cooperators: Douglas J. Jardine and Kenneth W. Kelley

Corn acreage has been increasing in southeastern Kansas in recent years because of the introduction of short-season cultivars which enable producers to partially avoid mid-summer droughts that are often severe on the upland, claypan soils of the area. Also, producing a crop after wheat and in rotation with corn may provide producers additional revenue by growing three crops in two years. Recent interest and developments in oil-type sunflower provide an alternative to soybeans for growers to double-crop after wheat. The objective of this project is to determine the effect of N, K, and Cl^- fertilization on yield, yield components, and nutrient uptake of short-season corn, wheat, and double-crop sunflower grown in a 2-year rotation on a south eastern Kansas claypan soil.

Wheat yield, yield components, and leaf rust disease ratings were unaffected by K or Cl^- fertilization in 2011. Increasing N rate from 0 to 120 lb/A increased wheat yield, heads/A, and dry matter production at the soft dough stage, but slightly decreased seed weight. Average yield of double-crop sunflower following wheat in 2011 was low at 650 lb/A, likely because of unusually hot and dry conditions. Sunflower yields were unaffected by K, Cl^-, N, or their interactions, even though K and N fertilization increased the number of seeds per head. Potassium fertilization increased dry matter production at the R1 growth stage. Approximately 50% of the sunflower heads were affected by Rhizopus head rot, but disease incidence was not statistically affected by fertilizer treatments. This study was initiated in 2010, and since crop response to fertilizer treatments has been marginal over the first cycle of this 2-year rotation, the work will not be continued. *KS-40*

Applied Fertility Management for Irrigated Soybean Production

Project Leader: J. Randall Nelson, Kansas State University Department of Agronomy, Courtland, KS. E-mail: jrnelson@ksu.edu

Irrigated soybean yields in North Central Kansas averaged about 53 bu/A over a recent 10-year period from 2000 to 2009. Although yields have trended upward, producers in the area are largely unsatisfied. Past research conducted at the Kansas State University North Central Kansas Experiment Field near Scandia has demonstrated that proper fertility management, including direct application of P and K, has the potential to significantly improve irrigated soybean yield. Despite the findings of this work soybean producers have been slow to adopt intensive fertility management programs. It has been speculated that adoption might be facilitated if these results were demonstrated on farmer fields outside the experiment station. The purpose of this research is to expand upon previous high-yield soybean work by including a field scale, farmer-cooperative component to increase awareness of irrigated soybean yield potential with proper fertility management.

This project will consist of a combination of small fertilizer response plots conducted at the KSU Irrigation Experiment Field and a field scale study on a producer's field. Small plot treatments will include a zero fertilizer control, and all combinations of 30 and 80 lb P_2O_5/A, and 80 and 120 lb K_2O/A. The effects of N and S will also be evaluated at the higher P and K rates. Field scale plots will be simpler, with one P (30 lb P_2O_5) and one K (80 lb K_2O) rate a combination of the two. This work was planned and cooperation established in late 2011, so results are not yet available. The first year of production will be 2012, and the project is expected to continue for three years. *KS-41*

Nebraska

Soil Test Phosphorus Level and Yield Potential

Project Leader: Charles Wortmann, University of Nebraska-Lincoln, Lincoln, NE. E-mail: cwortmann2@unl.edu

Project Cooperator: Tim Shaver

This University of Nebraska-Lincoln project is designed to test whether maintaining high soil P availability is important to corn yield in enough years to justify the cost of building and maintaining high levels of soil P. The research, started in 2011, is being conducted at the Haskell Agricultural Laboratory (HAL), the Agricultural Research and Development Center (ARDC), and the West Central Research and Development Center (WCREC) in Nebraska. The sites have a history of conservation tillage. The HAL site is rainfed and the others are irrigated.

The effect of five P treatments on yield of irrigated continuous corn is being compared under no-till and disk till conditions at all sites. Initial soil Bray1-P level was less than 15 ppm at all sites. The P treatments are: 1) Bray1-P of <15 ppm - no P applied; 2) P applied according to the UNL recommendation; 3) Bray1-P raised and maintained at 25

ppm; 4) Bray1-P raised and maintained at 35 ppm; and 5) P applied based on removal. Phosphorus was applied before planting and tillage in the spring of 2011 assuming 12 lb P_2O_5 was needed to raise Bray-1 P 1 ppm. Zinc was applied to minimize the chance of P induced Zn deficiency. Trials have four replications.

Corn yield in 2011 at the ARDC was less than expected, probably because of high night temperatures in July. Also, there was no consistent response to applied P at ARDC, which may have been due to relatively high deep soil test P; however, early growth and early P uptake were increased with P application. Yield was consistently less with no P applied compared with other treatments at HAL and WCREC. This is the first of a five year study, so substantive conclusions cannot yet be made. Support will continue in 2012. *NE-14*

Texas

Nutrient Removal by Fruit and Vegetable Crops in Texas

Project Leader: John Jifon, Texas A&M Texas AgriLife Research & Extension Center, Weslaco, TX. E-mail: jljifon@ag.tamu.edu

A balance between nutrient inputs and crop removal is required for effective long-term crop production. Although nutrient removal estimates are readily available for many field crops, such values for fruit and vegetable crops are rare. The objective of this project is to determine nutrient removal values for major fruits and vegetable crops grown in South Texas, and to use the information to help refine fertilizer recommendations for yield and quality.

During the spring growing season of 2011, nutrient removal amounts were estimated for muskmelons and onions from fields that were previously investigated in 2009. Removal rates by grapefruits from commercial orchards were also estimated (2011 only). Average melon yield in 2011 was 19.8 tons/A with nutrient removal averaging 92 lb N/A, 18 lb P/A, and 121 lb K/A. Sweet onion bulb yields in 2011 averaged 13.8 tons/A with average nutrient removal of 61, 19, 75 lb/A for N, P, and K, respectively. Grapefruit yields averaged 12.2 ton/A fresh fruit and nutrient removal averaged 29 lb N/A, 8 lb P/A, and 66 lbs K/A.

Continued sampling over multiple years and locations with varying weather conditions, soil types and yield scenarios will be needed to establish realistic nutrient removal values that can be used to develop improved fertilizer management guidelines. Support for this work will continue in 2012. *TX-55* ■

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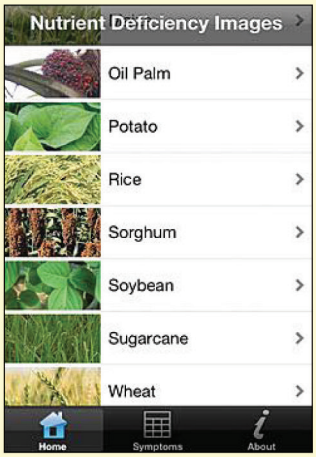
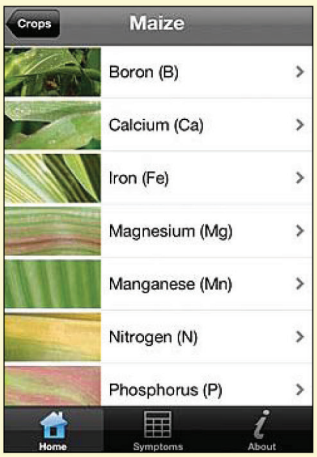
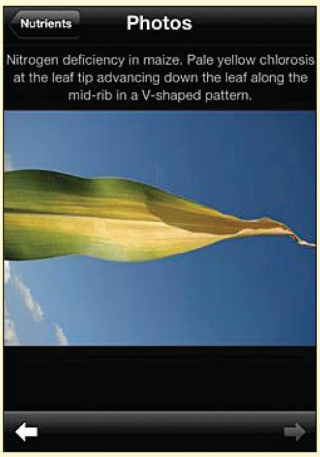
Ref # 12073

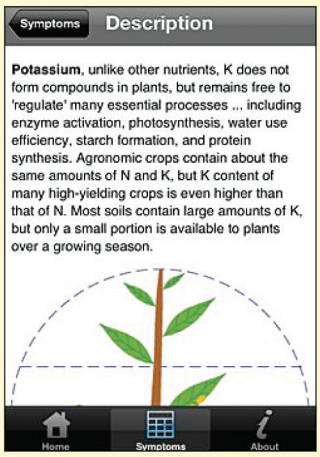
Nutrient Deficiency Photo Application for iPhone/iPad Released

IPNI has released a new Crop Nutrient Deficiency Photo Library app for your iPhone or iPad (see http://info.ipni.net/ndapp). The app contains key photos of classic nutrient deficiency documented from research plots and farm fields for 14 common crops. It also provides supporting text and illustrations of nutrient deficiencies. This mobile app will be a great tool for crop advisers, consultants, farmers, and anyone wanting help in identifying nutrient deficiency symptoms in common crops. BC









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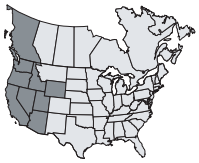


September 2012

Western Region Research Update

Research to Maintain Competitiveness

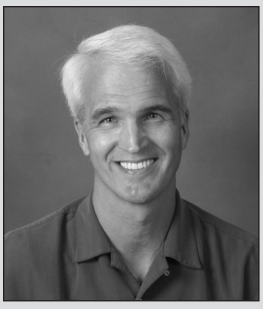
In this tough economic environment, everyone is looking for better and more efficient ways of doing things. Agricultural productivity in Western North America is already amongst the highest and most intensive in the world, but we are always being pressed to squeeze out more profitability in a sustainable way, in the face of tough global competition.

IPNI has been a leader in reminding farmers that using the "4R" concept for nutrient stewardship (Right Source, Right Rate, Right Time, and Right Place) can lead to significant economic, environmental, and social benefits.

While the 4R approach is really nothing new for most experienced farmers, it provides a systematic way to reevaluate traditions and routine management decisions that may be due for a change. We cannot always be satisfied with doing things they way they have been done in the past.

Supporting agronomic research is central to the mission of IPNI to "provide responsible management of plant nutrients for the benefit of the human family". We are fortunate to be able to partner with leading researchers to investigate better ways of using plant nutrients in the most appropriate way.

This issue of INSIGHTS features a brief summary of some of the research projects supported by IPNI in Western North America, but it is only a small fraction of the research projects that IPNI supports worldwide. Further information on these and other global research projects supported by IPNI can be found at the research database of our website: >**ipni.net/research**<.



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Arizona

Improving Nitrogen Fertilizer Management in Surface-Irrigated Cotton

Project Leader: Kevin Bronson, USDA-ARS US Arid Land Agriculture Research Center, Maricopa, AZ.
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Project Cooperator: Pedro Andrade-Sanchez, Doug Hunsaker, and Eduardo Bautista

The first year of this project was devoted to comparing N sources for furrow-irrigated cotton, developing a tool for predicting N fertilizer response using canopy reflectance-based N management in surface-irrigated cotton, and constructing a N balance for surface-irrigated cotton (quantify total N uptake, recovery N use efficiency, NO_3 leaching, and denitrification losses).

High pre-plant soil NO_3 precluded yield response to N this year.

We did collect valuable sets of canopy reflectance/vegetative indices. The total N uptake data at first open boll resulted in valuable internal N use efficiency data (67 lb N/bale). The nitrous oxide emission data was high quality data, some of the first of its kind. Nitrous oxide emissions were barely detectable in all N treatments during the 56-day measurement period following fertilization and fertigation, with the exception of the fertigation treatment. That treatment lost 0.9% of fertigated N as N_2O, which is in the range of N_2O losses measured from drip-irrigated cotton in Texas.

Amber NDVI (amber being 590 nm) using 820 nm had less up or down noise than the other indices. Calculating NDVI with a red edge (i.e. 730 nm) of NIR reportedly has the advantage of not saturating at high leaf area levels. Amber NDVI using 820 nm had the highest correlation among the indices with in-season biomass and N uptake. *AZ-08*

California

Assessment of Alfalfa Yield Monitoring Technology to Improve Nutrient Use Efficiency

Project Leader: Andre Biscaro, University of California, Lancaster, CA. E-mail: asbiscaro@ucdavis.edu

Project Cooperator: Steve Orloff

Yield mapping has been beneficial by demonstrating the degree of yield variability in areas much smaller than whole fields. Although growers recognize this variability, it is difficult to measure and map without a yield monitor. Grain crops have led the way with yield monitoring technology. However, it is not widely used or is still under development for many other important crops. In other crops, like alfalfa, the technology has not even existed until recently. Using bale sampling and tissue testing and then noting the bale locations with a GPS, hay quality and crop nutrition status can be linked with yield data for specific locations in the field. Overall, we expect that the use of yield monitoring data can significantly increase fertilizer use efficiency by meeting specific crop needs, increase hay yield and quality, and reduce potential P and K losses.

In order to assess the accuracy of an experimental yield monitor, biomass samples were collected from three windrows and weighed during the fifth cutting of one alfalfa field, and compared with yield monitor values. Management zones were created based on the previous cutting yield maps, where high yielding and low yielding zones had been established. The comparison of biomass samples and yield monitor values consisted of comparing sections of the alfalfa windrow to the closest bale weight from the yield monitor.

Although the alfalfa yield monitor was simple to install and operate, a considerable amount of data was lost during the baling processes due to different reasons related to equipment malfunction. Of the three fields monitored, we were unable to collect whole field data for any of them for all the five cuttings during the 2011 growing season. This fact made it difficult to advance to the next step of the project: defining management zones and assess the yield monitor accuracy.

Overall, the yield maps created with the yield monitor were able to show clear differences in various parts of the fields, which were confirmed by the grower. However, the biomass weight comparison between the yield monitor and direct measurements showed an unacceptably large difference in dry yield (over 30%). Therefore, we expect to investigate the possible causes of the yield monitor's lack of accuracy during the 2012 growing season and attempt to meet the original objectives. *CA-30*

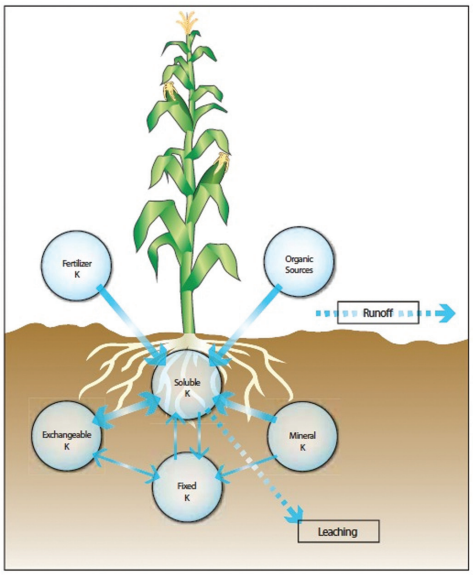
Relationship of Soil Potassium Fixation and Other Soil Properties to Fertilizer Potassium Rate Requirement

Project Leader: Stuart Pettygrove, University of California Department of Land, Air & Water Resources, Davis, CA. E-mail: gspettygrove@ucdavis.edu

Project Cooperator: Randal Southard

Potassium is an essential element in plant nutrition, and a sufficient supply of K is required to maximize crop yield. Some minerals fix K by trapping it in their interlayer region. Vermiculite is commonly found in the silt and fine sand-sized fractions of soils formed from granitic parent materials. For our current research, we selected these K-fixing soils from Central California.

Measuring levels of plant-available K can be challenging, especially in soils with high K fixation potential. Several techniques have been developed, but there is no agreement on the best way to predict the effects of K fixation. The most common laboratory method for measuring plant available K is extraction with ammonium acetate (NH_4OAc). Extraction with sodium tetraphenylboron (NaTPB) correlates closely with K uptake by plants. A new test (Kfix) was developed by Murashkina, which predicts K fixation potential.



To analyze the fate of added K, a potassium chloride (KCl) solution was added to air-dried soil at concentrations equal to the Kfix capacity. Moist soils were incubated for up to 16 days and then analyzed by the NH_4OAc and Kfix methods. The NaTPB method was not consistent for moist soils in this study. Subsamples were allowed to air-dry and extracted. Samples were subjected to four cycles of wetting and air drying after the initial application of K and analyzed after each drying cycle.

Even after adding K equal to their Kfix capacity for these soils, they continued to fix K, though at levels lower than for the untreated soils. The extracted K increased after K addition, but by amounts less than the K that had been added. Kfix was independent of the duration of incubation. Changes to the fixation potential of these soils after the addition of K all took place in the first 24 hours. For all soils, Kfix values for moist samples were lower than for their dried counterparts. Additional cycles of wetting and air drying had no discernible effect on the extractable K. Any

changes that took place upon drying were not enhanced by repeating the wetting and drying process. Further development of this information will be useful in understanding the fate of fertilizer K applied to K-fixing soils, and in developing better fertilizer recommendations. *CA-31*

N_2O Emissions from the Application of Fertilizers: Source Partitioning

Project Leader: Johan Six, University of California Department of Plant Science, Davis, California. E-mail: jwsix@ucdavis.edu

Project Cooperators: Charlotte Decock and Clifford Snyder

Meta-analyis is a relatively new statistical technique for combining the findings of many independent studies to identify consistent trends from various treatments and factors. It draws on findings from many scientific reports to observe patterns among studies instead of drawing inferences from only a few studies, thereby eliminating possible errors due to the small size.

Nitrous oxide (N_2O, a potent greenhouse gas (GHG)) emission reduction protocols are being developed by various entities with different interests, several of which rely only on reductions in N (fertilizer application)rate to achieve reduced N_2O emissions. A project was initiated in late 2011 to perform a meta-analysis of the peer-reviewed published science to determine the effects of all four R's (right source, rate, time, and place of application) on N_2O emissions in corn-soybean or continuous corn systems in North America, with a focus on the U.S.-states of Iowa and Illinois. More than 100 research papers have been assembled for potential inclusion of relevant parameters in the database; including presence and amount of irrigation, soil bulk density, water-filled pore space, and changes in soil organic carbon content or CO_2 emissions where available. The database will also include class variables for N timing (fall, spring, split, side-dress, etc.), placement (surface broadcast, incorporated, banded, etc.) and N source (urea, anhydrous ammonia, ammonium nitrate, urea ammonium nitrate, etc.). The database is completed and actual meta-analyses is underway.

This work helps support the TFI-led USDA Conservation Innovation Grants (CIG) demonstration project which aims to demonstrate that Midwestern corn-soybean producers can be incentivized to adopt new fertilizer management practices that will reduce N_2O emissions, increase crop productivity and nutrient use efficiency through BMP implementation, while also generating revenue from the monetization of carbon-based GHG credits. *CA-32*

Western Nutrient Digest- A Regional Publication to Promote Nutrient Efficiency

Project Leader: Rob Mikkelsen, International Plant Nutrition Institute Western U.S. Region, Merced, CA. E-mail: rmikkelsen@ipni.net

The University of Idaho started a statewide quarterly publication in 2008 to highlight their current research in plant nutrition and fertilizer management. University funding for this publication was eliminated due to budget cuts and distribution of the Nutrient Digest ceased. New funding from IPNI has allowed this valuable electronic publication to begin again and to expand further to include ten states in the Western U.S. region. The range of topics addressed in each issue and variety of crops discussed has significantly expanded to include items of interest throughout the region. Contributing authors are solicited to write on topics that are of current interest or that reports on important new research information. As the Digest continues to become better recognized in the Western U.S., it is anticipated that future funding will come from private industry to support the publication. Past copies of the newsletter are available at: http://www.extension.uidaho.edu/nutrient/newsletter.html. *CA-00D*

Idaho

Root Scans to Document Fertilizer Response

Project Leader: Jared Williams, Brigham Young University, Rexburg, ID. E-mail: williamsj@byu.edu

Project Cooperators: Kevin Anderson and Blake Willis

This rhizotron project to monitor root growth in soil was initiated with two objectives. The first was to develop educational tools with in situ demonstrations of root growth as influenced by nutrients. The second objective was to create still images and videos of root growth that could be posted on the internet. Root systems of growing plants are observed with a flat-bed scanner buried in the soil as part of a laboratory experience for a crop physiology class. The rhizotrons have also been used to conduct undergraduate research projects.

Student's involvement in the project has been important to its success. In the class, the students design independent research projects with various crops (alfalfa, wheat, barley, corn, soybeans, and potatoes), and fertilizer treatments (rate, placement, and nutrient source). Students have posted root images and videos on websites such as Facebook and YouTube. The rhizotron has been an excellent teaching tool and has facilitated students' understanding of root growth and fertilizer response. *ID-11*

Documenting Phosphorus Efficiency for Potato Production

Project Leader: Bryan Hopkins, Brigham Young University, Provo, UT. E-mail: hopkins@byu.edu

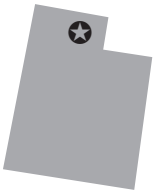
Proper P nutrition is a key component for growing high quality and high yielding potatoes. There is a need to synthesize the existing scientific information and present it in a way that can be used for improved fertilizer management. A significant body of research has now been assembled to review P fertilization practices for potatoes. These diverse reports have been synthesized into the 4R concept to deliver P in the right source and at the right rate, time, and place. A PowerPoint presentation is currently under development that will be added to the on-line library of the IPNI Crop Nutrition Series and made available for a global audience for training agronomists about potato nutrition. *ID-12*

Utah

Can Tart Cherry Yield and Fruit Quality be Increased with Improved Phosphorus and Potassium Management?

Project Leader: Grant Cardon, Utah State University Extension Soils, Logan, UT. E-mail: grant.cardon@usu.edu

Project Cooperators: Brent Black and Earl Seeley



Cherry farmers are rewarded for both high yields and excellent quality (such as fruit size, soluble solids, and acid content). Very little field research has been done on the nutritional requirements of tart cherries and their response to added fertilizer. Because trees have such large root systems and they have a large internal storage of nutrients, it often takes several years before either nutrient deficiencies or fertilizer-induced yield increases are observed. This multi-year study was designed to determine the source, rate and time of P and K application to maximize production of high quality tart cherries in Utah. Field research plots were established in 2010 on five commercial cherry orchards ranging in age from 15 to 20 years. Various rates, sources, and combinations of P and K were applied to the orchards

at annual rates up to 2 lb of material per tree. Applications are made either once or twice per year.

Fruit yields exceeded 200 lb fruit/tree for many of the treatments in 2011. Since tart cherries are alternate bearing, this was a heavy fruit producing year, compared with 2010 when yields averaged only 100 lb/tree. In general, fruit yield responded positively to both P and K application, although K generally had the greatest positive effect. Splitting the applications into two annual doses did not have any yield benefit compared with a single annual application of P and K. There was some difference between the sites (with different soils and fertilization histories), but an overall positive response was measured to added P and K. In general, there was no fruit yield or quality benefits from the specialty P or K fertilizer products compared with more common fertilizer products. However, the use of potassium sulfate consistently increased the soluble solid content of the fruit. It is not clear if this is due to the K or the additional sulfur in this material.

Cherry leaf tissues are being sampled throughout the growing season to develop diagnostic criteria to allow growers to predict the need for additional nutrients. Leaf nutrient concentrations are being measured in the laboratory to correlate with fruit yield and fertilizer additions. This will allow us to provide guidance in the future to cherry farmers on when nutrients may be limiting and how much fertilizer is needed. *UT-07* ■