IPNI INSIGHTS
INTERNATIONAL PLANT NUTRITION INSTITUTE

July 2009

Northcentral Research Report

AGRICULTURE is being asked to solve monumental problems — global warming, hypoxia, eutrophication, food security, and sustainable energy to name a few. The public is clamoring for answers, yet science seems to be moving slowly. However, to truly be of service, science must move at a careful and methodical pace, because the conclusions that it draws must, in fact, be correct. The studies contained in this publication are efforts to that end, focused on improved crop nutrition, 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 supported by IPNI in the Northcentral Region. This information and even 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

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Four conventional plot trials with corn were established at four research farms in 2006, five additional trials were established in 2007, and evaluations continued in 2008 for a total of 22 site-years. Treatments replicated four times were two hybrids and five K fertilizer rates (0 to 180 lb K_2O/A). All sites had histories of rootworm infestation and soil test K ranged from the upper range of the Very Low class to a value between Optimum and High. No root insecticide was applied. Ear leaves and grain were sampled from all plots. At silking time, three contrasting K treatments were selected to sample whole plants (except roots) and to assess rootworm injury. Grain yield and rootworm injury data were summarized from 2006 to 2008, while plant analysis data were summarized for 2006 and 2007.

Average rootworm injury for the susceptible hybrid at each site-year ranged from 0.1 to 2.4 (0.9 on average) on a scale from 0 to 3, while for the resistant hybrid, injury ranged from 0 to 0.4 (0.1 on average). Potassium increased grain yield at three of the nine locations. The rootworm resistant hybrid yielded higher than the susceptible hybrid in most site-years, but the difference was significant only in 6 site-years (where root injury ranged from 0.2 to 2.2). Preliminary statistical analyses showed no significant interaction between hybrid and K rate. Yield trends suggested, however, that in one site-year the rootworm resistant hybrid yielded higher, but also needed a higher K rate to achieve maximum yield while in 3 site-years the susceptible hybrid needed a higher K rate to achieve the maximum yield. Results from the available tissue tests for 13 site-years showed that K fertilization almost always increased leaf K concentration, but the increase was significant at 8 site-years and the increases appeared consistent across hybrids. Tissue tests for above-ground plant parts also showed K uptake increases at these sites. However, effects of hybrid and K rates on plant tissue N or P were small and inconsistent. Work during 2009 will continue by evaluating the last five field trials, analyzing plant tissue samples, and summarizing data from the previous years. *IA-09F*

Effects of Potassium Fertilization on Soybean Grain Yield and Disease Incidence in Iowa

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This project was conducted from 2005 until 2008 at five Iowa locations (20 site-years) to assess the effects of K fertilization and tillage on soybean grain yield and incidence of leaf/stem diseases. Rates of 0, 35, 70, and 140 lb K_2O/A were broadcast at four locations, and the lowest three K rates were broadcast or deep-banded at the other location. Soybean was grown in rotation with corn, and treatments were evaluated each year. Soybean varieties varied across trials and were planted using a 30-in. row spacing.

There was a large grain yield response to K in low-testing soils (< 131 ppm K, 6-in. depth), a small response in soils testing optimum (131 to 170 ppm K, for which only main-

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tenance is recommended), and no response in high-testing soils. Tillage did not affect grain yield or yield response to K fertilization. Potassium deficiency symptoms were obvious on low-testing plots of several site-years. Asian Soybean Rust was not detected at any site. There was light to moderate incidence of Brown Leaf Spot and Bacterial Blight in most locations and years, and less frequent incidence of *Cercospora* Leaf Spot, Frogeye Leaf Spot, and Powdery Mildew. Tillage sometimes influenced disease incidence, but effects were inconsistent across diseases, locations, and years and are not discussed in this summary.

In 2005 disease incidence was low, and K fertilization reduced incidence of Bacterial Blight and Brown Spot at one location, mainly with no-tillage. In 2006, K fertilization significantly reduced diseases at two locations (mainly with no-tillage) and had smaller effects at two other locations. Effects were more consistent on Brown Leaf Spot than on *Cercospora* Leaf Spot, Frogeye Leaf Spot, and Powdery Mildew. In 2007, K fertilization again reduced incidence of most of these diseases at three locations where disease incidence was observed. Results for 2008 showed small or no disease pressure, although K fertilization again reduced disease incidence or severity at three locations. *IA-13F*

Evaluation of Corn Response to Sulfur Fertilization in Iowa

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Project Cooperator: Brian Lang

More than 40 years of prior research in Iowa had rarely noted improved corn yield with S fertilization. Recently, S deficiency was documented through forage yield and plant S increases from applied S fertilizers in northeast Iowa alfalfa fields, especially in field areas with low organic matter, eroded, and side-slope landscape positions. Exploratory work in 2006 indicated significant corn yield increase to S application in specific field areas where early-season corn plant coloration indicated possible S deficiency. In 2007 and 2008, S rate trials were conducted at 45 field sites in central to northeast Iowa. Four S rates were replicated at each field site.

Corn yield response to S application was significant at 28 of the sites (62%), with an average yield increase of 13 bu/A. When grouped by soil texture for the responsive sites, the yield increase was 15 bu/A for the fine-textured soils and 28 bu/A for the coarse textured soils. The optimal S rate was 16 lb S/A for fine-textured soils and 23 lb S/A for coarse-textured soils. This research indicates a change in need for S fertilization, especially in northeast Iowa, and that S application is an economically viable fertilization practice on many soils. However, the research also indicates that corn does not respond to S application in all fields or field areas and chance of S response may decrease outside of the northeast Iowa geographic area. Therefore, diagnostic tools are needed to help producers better decide when S fertilization of corn will be profitable. *IA-18F*

Illinois

Effect of Nutrient Management and Fungicides on Soybeans in Southern Illinois

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Project Cooperator: C.D. Hart

A field study was conducted at two locations – the University of Illinois Dixon Springs Ag. Center (DSAC) and Brownstown Agronomy Research Center (BARC) – from 2005 to 2008. The purpose was to determine the effects of K, Cl^-, B, and Mn nutrition on the response of soybeans to diseases (possibly including Asian soybean rust) with and without the application of fungicides, across Roundup Ready® and conventional herbicide varieties. Pre-plant fertilizers included a comparison of potassium chloride (KCl) and potassium sulfate (K_2SO_4) at a rate of 75 lb K_2O/A plus a check with no K. Foliar treatments included an application of either 0.5 lb chelated Mn/A or Solubor® at 0.25 lb B/A, or both, in addition to the KCl pre-plant treatment. *IL-32F*

South Dakota

A Decision Aid for Fertilizer Placement with Seed

Project Leader: Dr. Ronald Gelderman, South Dakota State University, Plant Science Department. Box 2207A, Brookings, SD 57007. Telephone: 605-688-4770. E-mail: ronald.gelderman@sdstate.edu

"How much fertilizer can I place with the seed?" That is a common planting season question. A spreadsheet decision aid was developed to assist crop advisers in applying current knowledge and pertinent factors to answer this question. A survey of the literature was used to develop relationships between plant stands and fertilizer rates used with the seed. A laboratory study has been conducted to fill in literature gaps, especially with minor crops and fertilizers. A spreadsheet version of the tool can be downloaded at >http://www.ipni.net/toolbox *SD-15F*

Indiana

Comparative Nutrient Use Efficiency by Candidate Biofuel Crops

Project Leaders: Dr. Jeff Volenec and Dr. Sylvie Brouder, Purdue University, Agronomy Department, 915 West State Street, West Lafayette, IN 47907. E-mail:jvolenec@purdue.edu

Switchgrass is a potential second generation biofuel feedstock. However, not much is known about how sensitive this crop is to soil P and K levels. What little nutrient work has been done has primarily focused on N. A new study has been established in an experimental area where differential P and K soil test levels have been developed. The study will examine switchgrass growth, development, and biomass yield and how they are affected by these different soil nutrient supplies, considered separately as well as interacting with one another. *IN-26F* ■

IPNI INSIGHTS
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Northern Great Plains Research Report

EFFICIENCY of applied fertilizers is the theme of this issue of *INSIGHTS*. There are two reasons there is interest in improving the use of fertilizers. One is because the dramatic rise of fertilizer prices during the first half of 2008 has increased growers' interest in making wise use of their fertilizer inputs. The other reason is the increased need for the agricultural community to show the general public that they are doing their part to help protect the environment. There have been technological advancements that significantly reduce the environmental footprint of fertilizer use on our ecosystems, and many of the research projects included in this report are conducted to make further improvements.

This issue of *INSIGHTS* contains brief Interpretive Summaries of research projects supported or arranged by IPNI in the Northern Great Plains Region in 2008. 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 in Alberta

Project Leader: Dick Puurveen, University of Alberta, Sustainable Resources Department, 761 General Services Bldg., Edmonton, AB T6G 2H1. Telephone: 780-988-5454. E-mail: puurveen@ualberta.ca

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

This project consisted of two experiments (each at Ellerslie and Breton, Alberta) evaluating the effect of adding the Avail® polymer to P fertilizers as well as a single experiment at Ellerslie which evaluated the effect of adding the Nutrisphere® polymer to granular urea fertilizer. This study was initiated in April 2008 and repeated again in 2009.

In the P experiments, eight treatments compared two P fertilizer products [granular monoammonium phosphate (11-52-0) and liquid polyphosphate (10-34-0)], two P rates (15 and 30 kg P_2O_5/ha), and P fertilizer product with and without the Avail® fertilizer additive. A check treatment (no P fertilizer) was included to determine the overall response to the addition of P. A modest response to P was observed at both sites. At Ellerslie there was a significant difference between the 30 and 15 kg P_2O_5/ha rates, yielding 94.6 and 85.6 bu/A, respectively. There was no observable difference between the two P fertilizer products, or whether Avail® was added or not. At Breton, there was a significant difference between form of P with 10-34-0 averaging 26.6 bu/A compared to 11-52-0 averaging only 16.6 bu/A. There was no difference between rate of P, or whether or not Avail® was added.

In the N experiment, a similar experimental design was used to compare four forms of N (urea, ESN® or controlled release urea, Nutrisphere®-treated urea, and Super Urea), two rates of N (60 or 120 kg N/ha), and two N placements including side-banded N placed 2 in. to the side of the seed row, and surface broadcast just prior to no-till seeding. A no-N check was included to determine if there was a response to N. Significant responses were found for N rate (46 and 41 bu/A respectively for 120 and 60 kg N/ha), and N placement (45.5 and 41.5 bu/A, respectively, for broadcast and banded N). No difference was noted between the forms of N fertilizer. *AB-26F*

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British Columbia

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

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

This project consisted of two field research experiments. One evaluated the effect of adding the Avail® polymer additive to granular and liquid phosphate fertilizers. The second project evaluated the effect of adding the Nutrisphere® polymer additive to granular urea fertilizer. Both experiments were conducted at a field research site about 10 km northeast of Dawson Creek, British Columbia (BC). The research was conducted by the BC Grain Producers Association research group.

Growing season weather was much drier than nomal and the resulting barley crop grown in both experiments produced low yields, about half of normal for the area. A weather station at the site determined that 117 mm of growing season precipitation, or 38% of normal, was received. Both the P and N experiments showed no significant response to the addition of nutrients, and no observable effect of Avail® or Nutrisphere®. The research is planned to be repeated next year and hopefully the growing season moisture will be closer to normal levels. *BC-17F*

Manitoba

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

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Project Cooperators: Claire Langlois, Dick Puurveen, and Guy Lafond

This project consisted of two field research experiments. One evaluated the effect of adding the Avail® polymer additive to granular and liquid phosphate fertilizers. The second project evaluated the effect of adding the Nutrisphere® polymer additive to granular urea fertilizer. This study was initiated in April 2008.

In the P experiment, eight treatments compared two P fertilizer products [granular monoammonium phosphate (11-52-0) and liquid polyphosphate (10-34-0)], two P rates (15 and 30 kg P_2O_5/ha), and P fertilizer product with and without the Avail® fertilizer additive. A check treatment (no P fertilizer) was included to determine the overall response to the addition of P. No response to P was observed at the test site and thus no observable differences between the two P fertilizer products (with or without Avail®) or rates of P were found.

In the N experiment, a similar experimental design was used to compare forms of N (urea, Nutrisphere®-treated urea, and Super Urea), two rates of N (60 or 120 kg N/ha), and two N placements, including side-banded N placed 2 in. to the side of the seed row, and surface broadcast just prior to no-till seeding. A no N check was included to determine if there was a response to N. A modest response to N fertilizer, with the check treatment yielding less than the 120 kg N/ha rates of Super Urea and Nutrisphere®-treated urea, 20.7, 34.7, and 31.4 bu/A, respectively. However, no statistical differences were observed between the forms of N, rates of N, or N placements.

An alternate site with lower levels of available P and N is currently being located to repeat the experiments in 2009. *MB-21F*

Impact of Traditional and Enhanced Efficiency Phosphorus Fertilizers on Canola Emergence, Yield, Maturity, and Quality in Manitoba

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Project Cooperators: Gerhard Rakow and Jo-Anne Relf-Eckstein

The objectives of this research are to: (1) determine the relative effects of traditional and enhanced efficiency fertilizers in terms of safe rates for seed-row placement, and effects on crop yield, crop maturity, and seed quality and (2) determine if canola cultivars differ in response to seed-placed P fertilizer.

In the first study, a no P control was compared to standard monoammonium phosphate (MAP), a polymer-coated controlled-release product (CRP) MAP product formulated for broadacre agriculture, Avail®-treated MAP designed to sequester antagonistic ions and reduce soil P reactions, liquid ammonium polyphosphate, Avail® liquid P, and Polyon®-coated MAP formulated for horticulture. Each of the P sources was applied at 10, 20, 40, and 80 kg P_2O_5/ha. A single 0 kg P_2O_5/ha treatment was included for a total of 25 treatments per site. Seedling damage occurred with high rates of uncoated P fertilizer, with the damage mainly occurring on a fine sandy loam (FSL) textured soil, but not on the clay loam textured soil. Both the CRP and Polyon®-coated product prevented seedling damage. Seed yield on the FSL soil increased with low rates of liquid P then decreased when rates were increased to 40 kg P_sO_5/ha or higher. Seed yields on the FSL tended to be higher with high rates of Avail® MAP than with the high rates of CRP or uncoated MAP.

In the second study, yellow- and black-seeded canola cultivars were seeded following the methodology described for the previous study. Yellow-seeded canola was slightly more prone to reduced emergence with seed-placed MAP than was the black-seeded cultivar. There appears to be a number of differences in the sensitivity and responsiveness of the black- and yellow-seeded canola cultivars to seed-placed P. Samples have been submitted for quality analysis. *MB-22*

Comparison of Phosphorus-Based Starter Fertilizer Products, Forms, and Rates Affecting Crop Yields in Manitoba

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The objective of this project is to demonstrate that the use of reduced rate (8 lb P_2O_5/A) P-based starter solutions is not a superior strategy compared to the common practice of using granular monoammonium phosphate (11-52-0) or liquid ammonium polyphosphate (10-34-0) at

rates close to that removed within harvested grain product (typically 25 to 35 lb P_2O_5/A). This research will balance strong marketing claims suggesting low rate products are superior in efficacy. It is foreseen that the in-year costs of low P rate strategies may be less, but the actual cost per applied pound may be greater. The concern is that small, short-term cost advantages will be realized, but crop yields will not be improved, and long-term reliance on sub-crop removal P rates will lower yield potential for growers.

The project will begin by installing a liquid fertilizer kit on an existing demonstration-research planter that has the capability of applying granular MAP now. At least three demonstration sites will be established to compare the low-rate liquid starter system against a similarly low rate, and normal rate, of granular or liquid P seed-row applications. One of the sites will be situated within the Diagnostic Field School site at Carman, Manitoba, where 400 agronomists, Certified Crop Advisers, crop consultants, and progressive growers are expected to attend. In-season growth of treatments will be documented and will be inspected by tours of interested growers and crop advisers. *MB-23*

Saskatchewan

The Effects of Potassium and Chloride Nutrition on Seed Yield of Canaryseed in Saskatchewan

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Project Cooperators: Yantai Gan and Sukhdev Malhi

The objectives of this study are to determine the responsiveness of canaryseed seed yield to K and Cl^- and provide better recommendations to producers on the use of potassium chloride (KCl) in canaryseed production.

In 2007, five locations were established at Melfort, Stewart Valley, Regina, and two locations south of Indian Head on Vale Farms. In 2008, another location on Indian Head Research Farm was added. Only the Vale farm sites showed strong yield responses to Cl^-, but a moderate yield response to Cl^- occurred at Regina. The yield components most affected were seeds per square meter and seeds per head, which indicates that the addition of Cl^- may prevent seed abortion from occurring. Grain yield was not affected by Cl^- or K applications at Melfort or Stewart Valley in 2007. The two sites south of Indian Head had low levels of soil Cl^- while the Regina and Stewart Valley sites had moderate levels of Cl^-. Using a conventional soil test, the Melfort site and one of the sites south of Indian Head had low levels of K in the soil, while the other site south of Indian head had moderate levels. The other two sites had high levels of K in the soil. Similar results were obtained when soil K supply rates were measured. However, the Stewart Valley site did have a lower K supply rate than would have been suggested by the conventional soil test.

In 2008, both Vale Farm sites had a Cl^- response which followed the pattern seen in 2007. The yield response at the Vale farm site occurred when yield conditions were quite good (40 to 50 bu/A). *SK-38F*

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

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

This project consisted of three experiments each comparing three forms of N fertilizer including regular granular urea, Nutrisphere®-treated urea, and Super Urea. The three experiments were conducted on spring wheat, barley, and canola. This study was initiated in April 2008 and it is planned to be repeated in 2009.

In wheat and barley, the three forms of N were applied at 45, 90, or 135 kg N/ha. All N was side-banded 2 in. to the side of the seed row using a no-till seed drill. A zero N check was included to determine if there was a response to N at the site. A response to N was found in both wheat and barley, but no difference was found between the three N application rates. The wheat experiment showed a difference between the forms of N with Nutrisphere®-treated urea and Super Urea yielding significantly more than regular urea. There was no difference between Nutrisphere®-treated urea and Super Urea in wheat. In the barley experiment, there was no significant difference between forms of N.

The canola experiment used one rate of N (90 kg N/ha) and four forms of N, including urea, Nutrisphere®-treated urea, Super Urea, and ESN® or controlled-release urea. A significant response to N fertilizer was apparent, but no significant response to the forms of N was observed. *SK-40F*

Montana

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

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Top-dress or surface application of urea is a common practice for Montana's winter wheat producers. However, urea applied to the soil surface is susceptible to volatilization losses as ammonia (NH_3-N). The objective of this study is to quantify the extent of ammonia loss from top-dress urea applications, applied in the early fall, late fall, and early spring to winter wheat using a mass-balance micrometeorological approach referred to as the integrated horizontal flux (IHF) method. This method involves sophisticated calculations based on airflow at the site measured at three heights on a mast located in the center of the 100 m diameter treatment area. Two

research sites were established near Havre, Montana, in the fall and early winter of 2008. Each site had three macro-field applications of urea-N fertilizer including a control with no urea applied, 100 kg N/ha of urea, and 100 kg N/ha using urea treated with Agrotain®.

Ammonia losses were greatly affected by the timing and amount of precipitation received at the respective sites. Weather at the site located west of Havre was initially very dry, with no rain occurring for three weeks following the N application on October 9. During this time, urea granules remained on the soil surface and never dissolved and no ammonia emissions were detected. After 38 mm of precipitation (snow and rain) between Nov 2 and 9, sufficient urea moved into the soil, but ammonia losses from this site have been small (about 3.1% of the applied N rate for the urea treatment). Results were quite different at the second field site located north of Havre. Urea and Agrotain®-treated urea were applied to moist ground on November 14. Urea granules dissolved within the first day and ammonia losses from untreated product over the next three weeks amounted to 29% of application rate. Losses from Agrotain®-treated urea were one-tenth as high so it appears that the addition of Agrotain® can significantly reduce urease activity and the associated volatile ammonia losses. *MT-17*

North Dakota

Development and Implementation of Fertilizer BMP Guides for Six Selected Major Cropping Systems--Suggested Practices for Semiarid North Dakota

Project Leader: Dr. Harold Reetz, Foundation for Agronomic Research, 107 S State St Ste 300, Monticello, IL 61856-1968. Telephone: 217-762-2074. E-mail: hreetz@ipni.net

Good progress was made in finalizing agreements regarding what fertilizer BMPs should be suggested for North Dakota in the Northern Great Plains (NGP). A publication was written and published describing these BMPs and how growers could evaluate their cropping system to see if improvements might be possible. The publication was finalized, printed, and distributed in September of 2008. All committee members were supplied with copies of the publication and they were made available to the North Dakota State University (NDSU) Extension Service and the Agricultural Research Service of the USDA. Copies were distributed throughout the NGP Region. *ND-12F*

Agronomic Evaluation of New Sulfur Sources for Canola

Project Leader: John Lukach, North Dakota State University, Langdon Research Extension Center, 9280 107th Ave NE, Langdon, ND 58249. Telephone: 701-256-2582. E-mail: jlukach@ndsuext.nodak.edu

The objective of this study is to evaluate the effectiveness of various commercially available and potentially available sources of S fertilizer for canola production in North Dakota. Research trials were carried out at two locations near Langdon. The S products included ammonium sulfate (AS), elemental sulfur (ES), compound granules of N, P, and S, gypsum from coal power plant scrubbers, and a plant growth promoting rhizobacteria (PGPR). All treatments were compared against a monoammonium phosphate (MAP) check supplying N and P. Urea-N was added to certain treatments to balance N rates for all seed-row treatments.

Large canola yield responses to S were present at both sites. The N+P check at the two sites yielded 1,319 and 651 lb/A while the highest yielding treatment at each site was 2,378 and 1,642 lb/A, respectively. Averaged over both locations, treatments of AS, AS+ES, or gypsum with 15 lb S/A or higher yielded 182 to 190% more than the MAP check. Similar treatments with 5 to 10 lb S/A yielded 171 to 180% of the check. The treatments supplying 40 lb ES/A, no AS, produced 143% more than the check. Application of PGPR at the three-leaf stage as a foliar spray, with no S, was only nominally (15%) better than the check. Research will continue on this project for at least one more year. *ND-14F*

Nitrogen Recommendation Recalibrations for Wheat in North Dakota

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The current N recommendations for spring wheat in North Dakota (2.5 X Yield Potential less credits) were developed more than 30 years ago when there was no ability to vary rates within a field and N prices were less than 10 cents/lb of N. Our review of old and more modern N calibration data do not support our current recommendations, especially considering cost increases for N fertilizer and grain prices, as well as improved methods of planting and fertilizer application. Growers need updated recommendations to determine required N rates that are economical and relevant to their wheat-growing abilities. The objective of this 2-year study is to add necessary modern sites, complete with modern soil analysis, to our older data in order to develop better, more efficient N recommendations for growers in every corner of North Dakota.

Progress on the field research required to generate the database to recalibrate the N fertilizer recommendations for North Dakota has proceeded well. *ND-15* ■

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IPNI INSIGHTS
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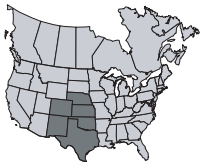
Research in the Southern and Central Great Plains Region



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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

Spatial Removal of Nutrients by Corn in Colorado

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Project Cooperators: Dwayne Westfall, Kim Fleming, and Tim Shaver

Research at Colorado State University has for several years been evaluating the impact of precision nutrient and pesticide strategies on environmental quality and production efficiency. The overall objective of this study was to determine which of the two most prominently used and accepted hand-held active NDVI (normalized difference vegetative index) remote sensors perform the best in Colorado under its unique set of environmental and management conditions. Also of interest was the particular corn growth stage at which these sensors performed best so that the sensor could be used at the most appropriate time to make the best and most accurate management decisions possible. The amber NDVI sensor (Holland Scientific) had slightly higher correlations with application rate than the red NDVI sensor (NTech Industries, Inc). However, the difference between sensors was not great enough to suggest that one performed better than the other.

Each sensor had very high NDVI to applied N rate correlations ($R^2 > 0.89$) and both sensors were able to determine corn N variability across two site years. The highest correlations were observed at the V14 corn growth stage for site year 1 and the V12 corn growth stage for site year 2. However, the V12 and V14 NDVI correlations with N rate were very similar and high for both site years. This suggests that the time to take NDVI readings in Colorado is in the V12 to V14 corn growth stage range for the most accurate determination of N variability.

Overall, this study has shown that the NTech GreenSeeker™ red unit and the Holland Scientific amber Crop Circle™ both perform equally well in the determination of N variability in irrigated corn in Colorado and could be very important tools for reducing potential economic loss and environmental degradation through the over- and under-application of N fertilizers. *CO-12F*

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

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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). Ecological ramifications, including increased forest and grassland productivity, eutrophication and acidification of fresh waters, hypoxia, and loss of biodiversity have been documented in terrestrial, freshwater, and coastal ecosystems worldwide. The Colorado Department of Public Health and Environment estimates 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 financially responsible for NH_3-related ecosystem damage.

One promising way to track N to its original source is via N isotopic signatures ($\delta^{15}N$) since the ratio between the ^{14}N and ^{15}N isotopes is influenced by source. To ensure that agricultural producers are being treated fairly in the matter, this study seeks 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, commercial fertilizers, and other sources.

The first step in achieving the study objectives was to identify the best approach to NH_3 isotope analysis. After extensive study, review, and testing, it was decided that a steam distillation was best suited. To that end, a commercial glass distillation apparatus was constructed and analytical details were established. This first step has required considerable time and effort, thus the work so far has been largely confined to establishment and laboratory techniques. In the coming year, the project is expected to move to field sampling at CAFO operations, waste water treatment plants, and crop land. This study is scheduled for support for two more years. *CO-13*

Kansas

Effect of Long-Term Nitrogen, Phosphorus, and Potassium Fertilization of Irrigated Corn and Grain Sorghum in Kansas

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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.

The 2008 results of this project continue to demonstrate that P and N fertilizer inputs are important to the optimization of irrigated corn and grain sorghum production in western Kansas. Nitrogen alone increased corn yield by as much as 60 bu/A, while N and P applied together increased yield by up to 120 bu/A. Application of 120 lb N/A (with P) was sufficient to produce >90% of maximum yield in 2008. Phosphorus fertilizer increased corn yield by over 80 bu/A at 120 lb N/A. Application of 80 instead of 40 lb P_2O_5/A increased yields by only 3 bu/A. Nitrogen fertilizer alone increased sorghum yield by 54 bu/A, while N plus P increased yield by 72 bu/A. Application of 40 lb N/A (with P) was sufficient to produce >80% of maximum yield, although yields continued to increase with higher N rates. Potassium fertilization had no effect on sorghum yield in 2008, nor has it had any effect on sorghum yield over the course of the study. This is one of the few continuous, long-term crop nutrition studies in the USA. Support will continue in 2009. *KS-23F*

Effect of Nitrogen and Phosphorus Starters on Yield, Yield Components, and Nutrient Uptake of Short-Season Corn Grown in Conservation Tillage Systems in Kansas

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Project Cooperator: David Mengel

Corn acreage has been on the rise in southeastern Kansas in recent years because of the introduction of short-season hybrids. These hybrids reach reproductive stages earlier than full-season hybrids and thus enable avoidance of mid-summer droughts that are often severe on the upland, claypan soils of the region. However, soil fertility and other management options have not been well defined for short-season corn production in southeastern Kansas.

The objective of this project is to determine the effect of N and P rates in starter fertilizers (applied 2 in. to the side and 2 in. below the seed) on yield, yield components, and nutrient uptake of short-season, rainfed corn planted with reduced or no tillage. Soil test characteristics of the site are pH 6.5, P 5 ppm (Bray-1), K 65 ppm (1 M ammonium acetate extract), and 2.8% organic matter. Starter N rates were 20, 40, and 60 lb/A, and the P rates were 0, 25 and 50 lb P_2O_5/A. Total N and P rates in all cases (except control) were balanced to 120 lb N and 50 lb P_5O_5 in order to isolate possible starter effects. All plots received 60 lb K_2O/A.

The first year of this project was 2006, when yields were low due to dry conditions. In contrast, the spring of 2007 was unusually wet, with rainfall frequent enough to interfere with timely planting. This resulted in a decision not to plant in 2007. The experiment was resumed in 2008 with average corn yields near 150 bu/A. Corn yields in 2008 were not improved by use of any combination of starters compared to broadcast N and P. Conversely, average corn yield with starters was more than 8 bu/A less than with all N and P fertilizer applied broadcast prior to planting. Even though early growth appeared to be improved with higher P rates in the starter, this effect did not translate into higher yield. This project will not be continued. *KS-35F*

Manganese Response of Conventional and Glyphosate-Resistant Soybean in Kansas

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Weed control benefits of glyphosate resistant (GR) soybeans have resulted in nearly complete adoption of GR soybean varieties by producers in the USA, despite an apparent yield decrease that accompanies GR soybeans. Although the reasons for the yield decrease are not known, there is some evidence that GR soybeans have reduced Mn uptake compared to conventional soybeans. Manganese additions may help overcome this apparent yield disadvantage. The objectives of this study are to: i) determine differences in Mn tissue concentration in a GR soybean cultivar compared to a non-GR sister line, and ii) determine the response of a GR and non-GR soybean cultivar to soil-applied Mn.

Field plots were established at Ashland Bottoms research field near Manhattan, Kansas, to compare conventional and GR soybean response to six rates of soil-applied Mn (0, 2.5, 5, 7.5, 10, and 15 lb Mn/A). Manganese concentration in leaf tissue was determined at V6, R1, R3, and R6 stages. Grain yield and Mn concentration in the seed was determined at harvest. Preliminary analysis from 2008 data found no significant differences in Mn tissue concentrations between the GR and non-GR varieties. Manganese application did not increase Mn tissue concentrations or soybean yield for either variety. These results confirm results from previous years ... we did not observe soybean response to soil-applied Mn in this environment. This was the final year of a 3-year study. *KS-36F*

Nitrous Oxide Emissions from Bermudagrass Turf Fertilized with Slow Release and Soluble Nitrogen Sources

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Project Cooperators: Jack Fry and Jason Lewis

Nitrous oxide (N_2O) is an important greenhouse gas (GHG) and the majority of emissions in the USA are from agriculture. Most of this comes from the soil and is linked to soil management and nutrient use. Although most attention given this issue has been focused on production agriculture, an important component that is often overlooked relates to the contributions from turfgrass areas. One estimate indicates that there are about 40 to 50 million acres of urbanized land covered with turfgrasses (e.g., golf courses, lawns, parks, sport fields). Because turfgrasses often receive fertilizer N, these areas have the potential for significant contribution to overall N_2O emissions. One best management practice (BMP) that may help achieve the goal of reduced GHG emissions from turf is the use of controlled release N fertilizers. The objective of this work is to quantify N_2O emissions from bermudagrass turf fertilized with a conventional soluble N fertilizer (urea), a slow-release polymer coated N fertilizer, and an organic (manure) source of N.

Emissions of N_2O increased after application of each of the N fertilizer sources in 2007. Emissions from urea, however, were sometimes higher than either of the slow-release sources. In general, N_2O emissions returned to pre-fertilization levels among treatments after 7 to 10 days. Cumulative emissions of N_2O during the first year were statistically similar among N sources. However, numerically, emissions were highest from urea and lowest from the organic source. Emissions also tended to increase after irrigation or precipitation. The relationship between soil temperature and N_2O emissions was weaker than between soil moisture and emissions, although emissions were lower during winter when soils were colder. There were no significant correlations between N_2O emissions and soil ammonium and nitrate levels. The experiment was continued in the 2008 season, but the 2008 data are still being processed.

Strict interpretation of the first year data indicates that fertilizer source did not affect overall N_2O emissions from turfgrass. But, variability is high in this type of data collection and thus complicates statistical detection of differences among treatments. Additionally, emissions of N_2O from turfgrass is complex, and likely is affected partially by all factors including fertilizer type, soil moisture level, temperature, and N level. This study will not be continued beyond the 2008 season. *KS-37F*

Nitrogen Management for No-tillage Corn and Grain Sorghum Production in Kansas

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No-tillage production systems are being used by an increasing number of producers in the central Great Plains because of advantages that include soil erosion reduction, increased water storage and efficiency, and improved soil quality. However, residue left on the soil surface can create N fertilizer management challenges. For example, surface applications of urea-containing fertilizers may be subject to volatilization losses. Leaching can also be a problem on coarse-textured soils when N is applied in a single pre-plant application. Several fertilizer technologies that have the potential to address challenges in N management in no-till are available. For example, polymer-coated urea products have become increasingly available for agricultural use. The polymer coating allows the urea to be released at a slower rate than uncoated urea. Urease inhibitors such as Agrotain® are applied with urea-containing fertilizers to reduce the potential for losses via volatilization. Recently, a co-polymer product (NutriSphere-N®) has shown potential for reducing urea-N losses. The objective of this study is to evaluate the effectiveness of specific enhanced efficiency fertilizer technologies for no-till, irrigated corn production.

This study was conducted on a Crete silt loam soil

in north central Kansas and compared urea (46% N), UAN (28% N), ESN® (controlled release polymer coated urea), Agrotain® Plus (urease plus nitrification inhibitor), NutriSphere-N®, and ammonium nitrate at three N rates (80, 160, and 240 lb N/A). A zero N check plot also was included. Fertilizer was applied pre-plant broadcast. However, additional pre-plant surface banded treatments for urea and UAN were included to evaluate the effect of placement. Corn was planted without tillage into residue from the previous year's corn crop.

The treated urea products yielded better than the untreated urea, but were similar to ammonium nitrate. There were no significant differences in yield among ESN®, Agrotain® Plus, or NutriSphere-N®. Yield of UAN treated with Agrotain® Plus or NutriSphere-N® was greater than that of untreated UAN. Banding urea and UAN was more effective than broadcasting, but the greatest yields were achieved with the use of the additive products. The first year results indicated that if producers wish to broadcast urea-containing fertilizer on the soil surface in no-tillage production systems, enhanced efficiency fertilizer products can be effective in limiting N losses and increasing N-use efficiency. *KS-38*

Nebraska

Ecological Intensification of Irrigated Corn and Soybean Cropping Systems in the United States

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In 1999, an interdisciplinary research program on ecological intensification of irrigated maize-based cropping systems was established at the University of Nebraska to: (i) improve understanding of the yield potential of corn and soybean and how it is affected by climate and management; (ii) develop approaches for managing continuous corn and corn-soybean systems at 80 to 95% of the yield potential; (iii) conduct integrated assessment of productivity, profitability, input use efficiency, energy balance, and environmental consequences of intensified cropping; and (iv) develop a scientific basis and decision support tools for extrapolation to other locations.

Two workable models for estimating maize N fertilizer need under best management practices have been developed: (1) a "Generic Maize-N" model and (2) a "Systematic Maize-N" model. The Generic Maize-N model follows a previously described empirical framework. Preliminary tests indicated that this model performs satisfactorily in simulating EONR (economically optimum N rate). However, the general applicability of this model may be restricted because of its dependency on actual measurement of yield without N fertilizer or some reasonable estimation thereof. The Systematic Maize-N model on the other hand offers a more mechanistic approach as it simulates indigenous N supply by considering N mineralization with details of N credit calculations. This later model offers a more robust option for forward looking simulations, but still requires some critical fine-tuning.

The new soybean model (SOYSIM, previously called SOYGRADE) has nearly reached a beta testing version. The SOYSIM model has the capability of simulating yield, leaf area index, and biomass accumulation. It can be used for evaluating a previous single year growing season, long-term simulations, and current season/forward looking mode. An additional practical output of the model includes irrigation requirement as estimated from the crop evapotranspiration requirements.

In 2008, the Ecological Intensification study entered a residual phase whereby maize and soybean is planted without input of fertilizer. This phase will test the carryover effect of changes on soil quality and indigenous soil N supply measured as a result of intensification strategies and the impact on subsequent maize and soybean yield. This study is set to terminate in 2009. *NE-11F*

Texas

Nutrient Uptake and Removal Dynamics in Muskmelon and Other Vegetable Crops Grown in South Texas

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Project Cooperator: Gene Lester

Cantaloupe (muskmelon) fruit quality attributes such as sugar content, aroma, and texture are directly related to K-mediated processes. However, during fruit growth and maturation, soil K supply alone may be inadequate to satisfy K requirements. In the first phase, and first few years of this study, both glasshouse and field studies in south Texas have shown that the apparent K deficiency caused by inadequate uptake can be alleviated by supplemental foliar K applications and that the effectiveness of foliar K fertilization depends not only on source of fertilizer K, but also on environmental conditions affecting plant growth and development. More specifically, the results have demonstrated that supplementing soil K supply with foliar K applications during fruit development and maturation can improve muskmelon fruit quality by increasing soluble solids concentrations, firmness, and sugar contents.

This work was extended in 2008 to evaluate nutrient removal and uptake dynamics of cantaloupe and several other melon and vegetable crops. Soil nutrient depletion through crop removal can be a major limitation to long-term sustainable production, especially for horticultural crops which tend to have high input requirements. In the

long-term, a balance between nutrient inputs and crop removal is required. Although nutrient removal amounts for most major field crops are available, such values for fruit and vegetable crops are often harder to find. Knowledge of nutrient uptake and removal dynamics is critical in developing fertilizer management practices to sustain yields and quality while maintaining soil fertility. This second phase of the work was initiated in 2008 to quantify the nutrient accumulation and removal rates of diverse commercial vegetable crops in relation to different yield expectations and soil types in south Texas. Tissue samples and data from the 2008 year of the study are still being analyzed. *TX-52*

Evaluation of K-Mag and K-Mag plus Phosphorus Compared to Potassium Chloride for Production of Tifton 85 Bermudagrass on Coastal Plain Soils

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Coastal bermudagrass has been the standard against which other hybrid forage bermudagrasses are evaluated. However, Tifton 85, a recently introduced hybrid bermudagrass, has better nutritive value, is more digestible, and has greater yield potential than does Coastal. Data on response of Tifton 85 to nutrient application are limited. Texas A&M at Overton (East Texas) is addressing this need. A 6-year study was completed in 2006 where response to N, K, S, and Cl^- were evaluated. The current study began in 2007 and was adapted from the earlier effort. The experiment was originally rainfed, but irrigation was added in 2008. The objectives of this work are to determine the effects of N and K rates, and K source [sulfate of potash magnesia (SPM, 0-0-22-11Mg-22S), potassium chloride (KCl, 0-0-60), and a specialty fertilizer (ACT 62D, 8-37-4-10S-1Zn-2Mg)] on Tifton 85 bermudagrass production, nutrient uptake, and changes in extractable nutrient content.

Nitrogen was applied at 60 and 120 lb of N/A for each harvest. Potassium rates were 0, 134, 268, and 402 lb K_2O/A. There were two split applications: early and mid-season. Single P (120 lb P_2O_5/A) and Mg (32 lb Mg/A) rates were applied early in the season. Four harvests were made in 2008. In a variable rainfall year, but with supplemental irrigation as needed, 120 lb of N/A applied for each harvest failed to significantly increase total bermudagrass dry matter (DM) yield compared to the 60 lb N/A rate. The rate of 134 lb K_2O/A significantly increased yield the first harvest, as did each succeeding K rate increase. In the second, third, and fourth harvests, and in total DM yield, production was significantly increased by 268 lb K_2O/A, but not at the highest K rate. There were no significant effects of K source on yield in 2008. In the first and second harvests, there were significant N rate x K rate interactions. Nutrient concentrations in plants and soils were not available at the time of this reporting. This study is scheduled to continue for one more year. *TX-53* ■

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INSIGHTS

Southern and Central
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Research Supporting Nutrient Stewardship

July 2009

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

Potassium Fertilizer Requirements of Corn and Soybean on Delaware Soils

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This study was initiated in 2006 in response to producer concerns of whether current recommendations maintain soil K. Objectives were to evaluate corn and soybean yield responses, K removal, and soil test K changes over time. In 2006, corn responses were evaluated at three sites ranging in K fertility. Soybean responses were evaluated at one high K site and one low K site. Neither corn nor soybeans responded to applied K in 2006, even though yields were high at four of the five sites. Concentrations of N, P, and K in the grain were generally lower than book values for both corn (20 to 30% lower) and soybean (11 to 16% lower). In 2007, the same sites received the same K fertilizer treatments. Owing to record drought conditions from June through mid-August, irrigation was unable to keep up, and yields were modest and did not respond to applied K.

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In 2008, three of the sites were planted to corn and one site was planted to wheat. Despite below-average rainfall from June onwards, availability of irrigation ensured high yields ranging between 205 and 220 bu/A for corn and 99 bu/A for wheat. Potassium produced a yield response at only one site, where corn yield was boosted by 31 bu/A with 70 lb/A of K_2O, the most economic rate.

These values are lower than traditional book values, reflecting gains in nutrient use efficiency for all three crops. A few more years will be required to answer producer questions about declining soil test levels. This project is expected to continue at two of the five original sites. *DE-04F*

Maryland

Building a Maximum Yield Cropping System for Corn, Wheat, and Doublecropped Soybeans in Maryland

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Project Cooperator: William Kenworthy

The goal of this study is to develop a management program that increases crop yield, input efficiency, and profit potential in a predominantly no-till cropping system. This cropping system consists of four crops planted over 3 years, including: no-till soybeans in corn stubble, followed by minimum-till wheat doublecropped with no-till soybeans, and then no-till corn.

In research on the Eastern Shore of Maryland, N use efficiency in corn and wheat has improved when ammonium sulfate (AS) was blended with either urea or ammonium nitrate (AN). Research in 2008 again confirmed that blends containing an amount of AS sufficient to supply 30 lb/A of S, whether applied pre-plant or sidedressed at the six-leaf stage, produced corn yields as high as or better than those achieved with granular urea or liquid urea-ammonium nitrate (UAN). Despite a drought year, these blends produced corn yields of around 130 bu/A with a total application of 130 lb/A of N. Under zone tillage, corn yielded up to 147 bu/A with only 120 lb/A of N applied. Two products designed to enhance N use efficiency increased yields slightly at a normal N rate, but did not make up for yield losses caused by a 25% reduction in N rate. *MD-06F*

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

Evaluation of Fertilizer Nitrogen Applications with and without Ammonium Sulfate in Selected Vegetable Crops in Maryland

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The objective of this study is to evaluate the effectiveness of ammonium sulfate (AS) in a rotation of potatoes with wheat/doublecrop soybeans, corn, and single-crop soybeans under irrigation with different levels of tillage.

Fertilizers containing AS produced slightly lower potato yields in 2006 and, at best, 1 to 2% higher yields in 2007, compared to conventional N sources. However, fertilizer containing AS boosted wheat yields by 17% in 2007 compared to sources containing urea and ammonium nitrate. Applied to corn in 2007, AS modestly increased yields. Nitrogen fertilizers applied to doublecrop soybeans resulted in no yield benefits in 2007.

In 2008, fertilizers containing AS boosted wheat yields by 36% (to 95 bu/A) compared to those containing only urea and urea ammonium nitrate. *MD-11F*

Ohio

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

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Project Cooperator: Edwin Lentz

Growers in the eastern 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 proved to be a viable option for corn-soybean rotations on soils with adequate nutrient levels, but questions arise for producers in a 3-year rotation of corn-corn-soybean.

In 2008, K treatments boosted soybean yields by 7 to 10 bu/A, and the high rate of P increased corn yields by 22 bu/A at the Western Research Station, the only location not affected by drought. At the East Badger location, P treatments increased corn yields by 9%. At the Northwest Research Station, drought reduced corn and soybean yields to about half of normal, and there were no responses to P or K treatments.

These current yield response observations provide useful support for extensionists receiving questions from producers in light of their concerns with fertilizer prices. The experiment is continuing in 2009. *OH-16F*

Ontario

Optimizing Application of Phosphorus and Potassium to Processing Tomatoes under Drip Irrigation in Ontario

Project Leader: Dr. Tiequan Zhang, Research Scientist, Agriculture and Agri-Food Canada, Greenhouse and Processing Crops Research Center, Harrow, Ontario N0R 160. Telephone: 519-738-2251, 476. E-mail: zhang@agr.gc.

Recent research has indicated that processing tomatoes require higher rates of N when grown with fertigation. The objective of this research is to determine optimum rates of P and K for the higher yields obtained in this production system. Four rates of P, from 0 to 180 lb P_2O_5/A, were applied in a factorial combination with four rates of K from 0 to 640 lb K_2O/A, starting in the spring of 2006. Soil test levels in 2008 were higher than in 2007 ... 65 ppm Olsen-P, and 216 ppm ammonium-acetate K.

In 2008, in contrast to previous years, the marketable yield of tomatoes responded to P, but not to K. An optimal rate of 110 lb P_2O_5/A produced 121 ton/A of marketable yield, but nutrient use efficiency was low. Phosphorus fertilizer increased vitamin C levels by 12% in 2008, though there was no effect in 2007. Rates of 200 to 350 lb K_2O/A caused a slight increase in soluble solids content, though not large enough to compensate for the lower soluble solids under drip irrigation. Lycopene analysis remains to be completed. This project is planned to continue in 2009. This project is demonstrating that high yields of high quality tomatoes can be produced with improved nutrient use efficiency for N, P, and K by using drip irrigation. *ON-28*

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

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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 on productivity, environmental impact, profitability, and cropping system sustainability; and (2) validation of crop models, such as Hybrid Maize, for simulating yield potential, seasonal growth and yield, and fertilizer N management requirements.

The project began with a uniformity trial conducted in 2008 at Elora, Ontario. Long-term and short-term N rate treatments commence in 2009. *ON-29* ■

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Southeast Region 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 Rates and Timings of Liquid Nitrogen Fertilizer to Optimize Alabama Wheat Yields with and without Fall Tillage

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Project Cooperator: Kip Balkcom

This project was started in the fall of 2008 at the Tennessee Valley Research and Extension Center in northern Alabama. The objectives of the study were to: (1) determine the optimum N fertilizer rate for Alabama wheat production; (2) evaluate timing of N fertilizer treatments on wheat yield; (3) determine if fall tillage is necessary to optimize wheat yields; and (4) evaluate the usefulness of leaf N content in determining N fertilizer requirements.

The wheat response to N rates in this test supported the current Auburn University recommendation of 20 lb of N fertilizer applied in the fall followed by 60 to 80 lb of N applied in the spring. Splitting N rates in the spring showed very little benefit except at the low (60 lb N/A) rate with no fall N application. Fall N fertilizer application was especially beneficial when total N fertilizer rates of 60 and 90 lb N/A were applied. Fall tillage had no significant effect on wheat yields in 2008. Low N recommendations were generated in this study using Virginia's relationship between wheat tissue N and fertilizer N requirement where no N had been applied. This method accurately predicted no additional N fertilizer requirement where 120 lb N had been applied. Gathering more data on this relationship under Alabama conditions may provide a useful tool for Alabama wheat growers. *AL-19*

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Arkansas

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

Project Leader: Dr. Charles West, University of Arkansas, Crop, Soil and Environmental Sciences, 1366 W Alteimer Dr., Fayetteville, AR 72704. Telephone: 479-575-3982. E-mail: cwest@uark.edu

Two switchgrass production field studies were established at the University of Arkansas Agricultural Research and Extension Center in July 2008. Switchgrass generally produces very little above-ground growth in Year 1 as it allocates a large amount of energy to its strong root systems. Harvestable biomass accumulates in Year 2, while maximum yields occur from Year 3 onward. Thus, data from these studies will be collected in Years 2 and 3 (May 2009 to February 2011). One study will describe growing-season biomass accumulation and NPK uptake curves for switchgrass grown for biomass and the other will determine N response curves for biomass yield in second- and third-year switchgrass stands. The first study will consist of 12 harvest dates, ranging from May to February. Trends in cumulative growth, moisture concentration, and nutrient concentration and removal will be fitted to regression models as a function of day of year and accumulated growing-degree days. Regressions will be tested on two phases of the year, in-season from May to September, and post-season from October to February. The second study will include treatments of urea applied on April 1 at the rates of 0, 35, 70, 105, and 140 kg N/ha. One harvest per year will be taken in early October for moisture content and biomass yield. Plant

biomass will be sampled to determine N concentration and to calculate N removal and apparent N recovery. *AR-33*

Florida

Effect of Potash, Manganese, and Boron on Asian Soybean Rust in Soybean Grown in Florida

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Project Cooperators: Jim Marois and Tristan Mueller

The objective of this experiment was to determine the efficacy of in-furrow application of Cl^-, through either potassium chloride (KCl) or calcium chloride ($CaCl_2$), plus foliar application of B at 0.25 lb B/A and Mn at 0.5 lb Mn/A for the control of soybean rust. Soybean variety Asgrow 6301RR was planted at the North Florida Research and Education Center in Quincy in 4-row plots with a 2-row border between plots. Plots were 18 ft. long, with a 36-in. row spacing.

A platform sprayer using 16 gallons of water per acre applied B and Mn on August 5. Soybean plants were rated for soybean rust on September 12 and again on September 22. The middle two rows of each plot were harvested on October 28 and yield was adjusted to 13% moisture. Soybean rust was severe in all plots (69 to 75% infected plants). There were no significant differences in soybean rust severity, leaf area index, defoliation, yield, or seed weight with any other treatment compared to the control. *FL-23F*

Natural Climatic Forcing and Mississippi River Discharge as a Control on the Development of the Louisiana 'Dead Zones'

Project Leader: Dr. David Hollander, University of South Florida, College of Marine Science, 140 7th Ave S, St. Petersburg, FL 33701. Telephone: 727-553-1019. Fax: 727-553-1189. E-mail: davidh@marine.usf.edu

The objectives of this research, initiated in 2007, have been to evaluate the roles that natural climate variability and Mississippi River (MR) discharge have on controlling the development, intensification, and expansion of hypoxic "dead zone" conditions on the Louisiana (LA) continental shelf. The geochemical and faunal analyses from a series of sediment cores show that low-oxygen conditions occurred repeatedly prior to anthropogenic influences and that these events are directly associated with times of enhanced MR discharge and the dominant input of terrestrial organic matter (OM) and sediments. Further examination of this suite of sediment cores, albeit geographically limited, suggests that the aerial extent of the pre-anthropogenic low-oxygen events were similar to that observed in recent times. These preliminary results strongly suggest that climate variability and its control on MR discharge volume are important processes that need to be considered when evaluating the causes and consequences of the recent development and expansion of hypoxic conditions.

Climate variability is known to influence atmospheric circulation patterns, the transport of evaporated moisture from the Gulf of Mexico to North American regions (as precipitation) and the volume of MR discharge. Precisely correlating the timing of the pre-anthropogenic low-oxygen events to known climatic conditions using the LA shelf cores is impossible due to the effects of storm events on sediment transport, deposition, and age dating. To address this problem we initiated a parallel study on a well-dated sediment core from the Pigmy Basin (PB), located in deeper water (1,800 m) on the continental slope. Well-defined temporal changes in the input of terrestrial OM and specific sedimentary components provide a direct proxy for the MR discharge volume, variations in regional patterns of precipitation and input, and the temporal frequency of major MR discharge events. Results indicate that MR discharge volume regularly varied significantly over the past 1,400 years with multi-decadal frequency. *FL-26F*

Influence of Sulfur Fertilization in Peppers and Tomatoes in Florida

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Project Cooperator: Henner Obregon

A field study was conducted at the Gulf Coast Research and Education Center, University of Florida, between February and May 2008 to determine the effect of different pre-plant N and S fertilizer sources and rates on the growth and yield of 'Aristotle' bell pepper. Fertilizers were applied two weeks after transplanting (WAT) in two bands on bed tops at 6 in. from either side of the planting row and incorporated to a 1 in. depth. Fertilizer sources were ammonium sulfate (AS; 21% N, 24% S), ammonium nitrate (AN; 34% N), and fusion ammonium sulfate nitrate (FASN; 26% N, 14% S) – a possible replacement for AN that can provide proper amounts of plant available S. Fertilizer rates were 100, 200, and 300 lb/A of N, AS, and FASN which supplied 114, 228, and 342 lb S/A and 54, 108, and 162 lb S/A at their corresponding N rates, respectively.

Data showed no significant differences in plant vigor and height at 6 WAT, nor in petiole sap nitrate-N (NO_3-N) concentration at 8 WAT. However, there were significant effects of N sources and rates on bell pepper fruit weight. When N rates increased from 100 to 200 lb N/A, bell pepper yields increased 14%, regardless of N source, with no further yield change with higher N rates. However, AS and FASN improved bell pepper yields by 9% and 10%, respectively, in comparison to AN at 200 lb N/A. There were no significant differences on bell pepper yield when AS or FASN were used at rates of 200 or 300 lb N/A. More research is needed to confirm these preliminary results. *FL-27F*

Georgia

Loblolly Pine Stand Fertilization at Mid-Rotation to Increase Small and Large Sawtimber Volume in Georgia

Project Leader: Dr. E. David Dickens, University of Georgia, Warnell School of Forest Resources, PO Box 8112, Statesboro, GA 30460. Telephone: 912-681-5639. Fax: 912-681-0180. E-mail: ddickens@arches.uga.edu

Project Cooperator: David Moorhead

Two fertilizer trials and an untreated control were established in 2004 near Bullard, Georgia, within a loblolly pine tree stand planted in 1978 and thinned in 2002-03. The objectives of the study were to: (1) quantify the magnitude and duration of wood volume response to various fertilizer combinations, (2) determine changes in product class distribution, (3) determine the cash flow and rate of return for each fertilizer combination compared to unfertilized control plots, and (4) discern when fertilizers are to be re-applied to maintain wood volume gain. Fertilizer treatments examined NP, NPK, and NPKSCu in one trial and NP, NPCu, NPKCu, and NPKSCu in a second trial. The one-time fertilizer applications were applied in February 2005. Fertilizer levels applied per acre were 200 lb N, 50 lb P, 80 lb K, 60 lb S, and 5 lb Cu.

There was a significant difference in 2-year wood volume per tree increment. The loblolly pine trees within control plots grew an average of 2 cubic ft., significantly less (50%) than the NP treatment which grew 3 cubic ft., and the NPKCu treatment which grew 2.6 cubic ft. Although non-significant, other growth increment differences are of interest. Control plot mean height increment was 3.4 ft., whereas the NP treatment was 5.1 ft. (50% greater height increment) and the NPCu, NPKCu, and NPKSCu treatments grew by 4.9, 4.8, and 4.7 ft., respectively, within the 2-year period. Total volume per acre growth increments were 323 cubic ft. for the control to 449 cubic ft. for the NPKCu treatment, a 39% gain in 2 years.

It is too early to pass major judgment on a crop with a 30 to 40 year rotation, but some trends are showing promise. Mean height increment, volume per tree, and volume per gains are large for just a 2-year period. We will know more after our 4-year measurements (collected in late-January 2009) where fertilizer gains (diameter and volume) typically tend to peak. *GA-26F*

Louisiana

Effects of Potassium and Chloride with and without Manganese and Boron on Asian Soybean Rust in Louisiana

Project Leader: Dr. Raymond Schneider, Louisiana State University, Department of Plant, Pathology & Crop Physiology, 302 LSB, Baton Rouge, LA 70803. Telephone: 225-578-4880. E-mail: rschnei@lsu.edu

Project Cooperator: Jim Wang

The objective of this project was to determine if Asian soybean rust (ASR) is affected by soil amendments of potassium chloride (KCl) or calcium chloride ($CaCl_2$) or foliar applications of Mn and B. Three rates of Cl^- (27, 40, and 53 lb Cl^-/A) were applied immediately after planting in late-June as a 12-in. band over the seed furrow. Foliar applications of Mn and B were made at the first flower stage (R1). Soybean rust was rated within the mid and upper canopy in early October. The disease begins in the mid canopy and progresses most rapidly on these older leaves. Therefore, these ratings reflect the most severe aspect of the disease, while upper canopy ratings are related to the spread of the disease from the lower part of the plant. Upper canopy leaves are younger and more resistant to infection and would have been infected for a shorter period than mid canopy leaves.

For soybean rust at mid canopy, the most effective treatments were high rates of KCl and $CaCl_2$. This confirms findings from previous years in which Cl^- appears to be the active agent rather than accompanying cation. The same trend was observed in upper canopy disease development. Foliar applications of Mn, either alone or in combination with other treatments, appeared to reduce disease severity. The study was affected by Hurricane Gustav to the point that the plots could not be harvested. However, rust severity evaluations are reliable because the disease was readily quantifiable, and only those sections of row that were not physically damaged were rated. *LA-22F*

Precise Mid-Season Nitrogen Rate Determination for Use Efficiency and Yield Optimization of Rice in Louisiana

Project Leader: Dr. Dustin Harrell, Louisiana State University, Rice Research Station, 1373 Caffey Road, Rayne, LA 70578.

Project Cooperators: Brenda Tubana and Tim Walker

Nitrogen fertilizer is one of the major agricultural inputs in rice production and development of a more profitable and environmentally-sound production system is essential to maintain a competitive rice industry in the Mid-South. This project was initiated in 2008 to develop an optical sensor-based functional algorithm that will be used for estimating mid-season N requirement of rice. Essential components of the algorithm that need to be established for this region include: (1) a yield potential predictive equation; and (2) an in-season estimate of responsiveness of rice to N fertilization. Sensor readings were collected from seven variety x N trials established at three sites in Louisiana. For different growth stages, the association of in-season estimated yield (using an experimental predictive equation) and actual grain yield was evaluated.

Between 70 to 90 days after seeding (DAS), strong associations between the predictive equation (developed from sensor data collected at 70 to 75 DAS) and grain yield were obtained. While there was a strong relationship between sensor-based estimates of response to N fertilization and actual increase in grain yield attributed to N fertilization at 76 to 80 DAS, more data points are needed to obtain a

better estimate of N responsiveness earlier in the season. The preliminary results showed that both in-season yield potential and response to N fertilization of rice can be estimated using optical sensor measurements collected between 70 to 90 days after seeding. With a promising start, additional research is needed to refine the components of the proposed need-based N management scheme using remote sensors. *LA-23*

Missouri

Crop Sensors for Variable-Rate Nitrogen Application to Cotton in the Mid-Southern United States

Project Leader: Dr. Peter Scharf, University of Missouri, Department of Agronomy, 210 Waters Hall, Columbia, MO 65211-6140. Telephone: 573-8825-0777. E-mail: scharfp@missouri.edu

Previous work has shown that the most profitable N fertilizer rate for cotton in Missouri can range from 0 to 200 lb N/A. A typical producer fertilizer rate is 100 lb N/A, with little or no adjustment for different fields or different places in fields. When a producer's fertilizer rate is less than what the crop needs, potential yield is lost. When a producer's fertilizer rate is more than what the crop needs, excess vegetative growth can occur and cause harvest delays, increased insect or disease pressure, and/or increased expenses for growth regulators and defoliants. Crop sensors are a promising new way to diagnose how much N a crop needs. This research project has demonstrated over the past 3 years that there is a good relationship between optical sensor measurements collected mid-season and N need in cotton. This relationship was evaluated in a 40-acre demonstration field in southern Missouri in 2008.

Sensors were mounted on the front of a fertilizer applicator and sensors sent a signal once per second related to how much fertilizer the cotton crop needed. The applicator varied the fertilizer rate applied according to these signals. Good yields were produced with less N fertilizer than the producer would have used normally. Further analysis of the yield map from the demonstration field will allow conclusions to be drawn regarding the economic impact of variable-rate N fertilization in cotton. *MO-33*

Mississippi

Precise Mid-Season Nitrogen Rate Determination for Use Efficiency and Yield Optimization of Rice in Mississippi

Project Leader: Dr. Timothy Walker, Mississippi State University, Delta Research and Extension Center, PO Box 197, Stoneville, MS 38776.

Project Cooperators: Dustin Harrell and Brenda Tubana

Nitrogen fertilizer is one of the major agricultural inputs in rice production and development of a more profitable and environmentally-sound production system is essential to maintain a competitive rice industry in the Mid-South. This project was initiated in 2008 to develop an optical sensor-based functional algorithm that will be used for estimating mid-season N requirement of rice. Essential components of the algorithm that need to be established for this region include: (1) a yield potential predictive equation; and (2) an in-season estimate of responsiveness of rice to N fertilization. Sensor readings were collected from seven variety x N trials established at three sites in Mississippi. For different growth stages, the association of in-season estimated yield (using an experimental predictive equation) and actual grain yield was evaluated. *MS-16*

South Carolina

Incorporating Soil Electrical Conductivity in Developing Variable Nitrogen Application for Corn in the Southeastern U.S.

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Project Cooperators: Ahmad Khalilian, David Wallace, and Ymene Fouli

This study was conducted in 2008 at the Clemson University, Edisto Research and Education Center near Blackville, South Carolina, to develop procedures for a variable N application strategy for corn based on spatial variability in soil texture. The specific objectives are to: (1) determine the optimum N rates for corn in relation to soil spatial variability; (2) quantify nitrate-N (NO_3^--N) and other nutrient leaching in the soil; and (3) work with farmers to evaluate the effectiveness of the site-specific N application technology in increasing profitability and preserving soil environmental quality. Prior to planting, soil electrical conductivity (EC) measurements were used to identify variations in soil texture across the field and create soil zone maps using GPS and Geographic Information Systems (GIS). Fields were divided into four different soil zone areas based on the EC measurements. Each soil zone area was split into three tillage systems (conventional, strip-till, and no-till), two methods of N application (all at once at planting and as a split application with 30 lb N/A applied at planting and the rest as a sidedress application), and five N rates (0, 40, 80, 120, and 160 lb N/A). *SC-14* ■

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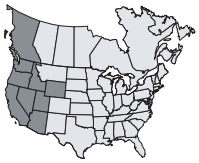

July 2009

Western Region Research Update

Aiming for Productivity and Efficiency

The productivity of agriculture in Western North America is among the highest in the world. Farmers in the region are eager to embrace new techniques and technology in the search for greater efficiency. Environmental pressures and chronic water shortages add extra incentive to continue the search for better ways of farming. The link between research and agricultural innovation remains strong, even as public funding for research decreases. IPNI is pleased to be able to partner with leading researchers to discover better ways of using valuable plant nutrients in the most appropriate way.

The reports provided here reflect only a small fraction of the research projects that IPNI supports worldwide. Supporting important agronomic research is central to our mission of responsible management of plant nutrients for the benefit of the human family.

This issue of *INSIGHTS* features a brief summary of research projects supported by IPNI in the Western North America Region. Additional information on each project can be found at the research database on our website: **>www.ipni.net/research<**.

California

Evaluation of Improved Methods for Tissue Testing of Alfalfa in California

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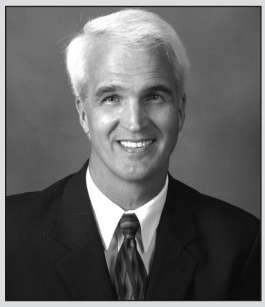
Project Cooperator: Dan Putnam

Despite the reliability of plant tissue tests, most alfalfa growers do not conduct regular tissue testing to assess fertilization needs. The current recommendations for alfalfa sampling are cumbersome for routine analysis and can be expensive. However, many growers routinely take cored samples of haystacks to measure forage quality for animal nutrition. This project is evaluating the feasibility of using cored-hay samples taken from the bales for analysis of both nutrient concentration and forage quality.

Hay samples were collected from over 20 cooperating farmers during the past 2 years to compare soil nutrient concentrations, whole plant and mid-stem nutrient concentrations, and baled-hay samples. Results found an excellent correlation between whole plant P and whole plant K and their respective concentrations in baled hay ($r^2 = 0.94$). The same relationship for S contained within fresh and baled samples was not as strong ($r^2 = 0.73$). These results indicate that the cored bale sampling technique could be used in place of the currently recommended analysis of fractionated stem samples.

Current tissue standards are based on alfalfa measured at the "one-tenth" bloom growth stage. To produce highly digestible alfalfa for the dairy industry, growers routinely harvest alfalfa in the bud stage and fields never reach the one-tenth bloom stage. These data document a rapidly declining P concentration in alfalfa with advancing maturity. Thus, the stage of growth is important to consider when interpreting plant tissue tests. For example, a sample collected at one-tenth bloom may appear to have adequate P, but that same concentration would be considered deficient at early bud stage. A further evaluation of critical plant tissue concentrations during the growing season is underway. *CA-26F*



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Improving Yield and Quality of Sweet Potato in California with Proper Fertilization

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California sweet potatoes are well known for their excellent quality and high yields. However after being stored for many months, their quality begins to deteriorate. Sugar accumulation during storage is problematic for processing because it creates darker colors and changes

in texture. A project was conducted in 2008 to observe the effect of in-season N and K management on crop response, yield, and storage quality in orange-flesh sweet potatoes.

The test area for this trial was located in a sandy-textured commercial field that had been cropped to sweet potatoes the previous year. Beauregard sweet potatoes were transplanted in early June in drip-irrigated plots. In the first experiment, N fertilizer was applied in two forms and two application methods. Potassium was applied as potassium chloride (KCl) or potassium sulfate (K_2SO_4). In a second experiment, K was applied as K_2SO_4 or as potassium nitrate (KNO_3) directly to soil or with irrigation water. Plants were analyzed for nutrient content, yield, and storage properties.

In the first experiment, differences were measured in N tissue concentrations, but there was no consistent response in root yield due to the treatments, unlike the previous year. No significant yield differences between K sources were observed, though there was a small improvement in yield with the K_2SO_4 source. Initially low concentrations of soil K indicate that a response to fertilizer K would be expected. *CA-27F*

Idaho

Response of Potato to Ammonium Sulfate Nitrate in Idaho

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Potatoes are sensitive in their requirement of an adequate and steady supply of N. In the past, ammonium nitrate (AN) was commonly used since it is not susceptible to ammonia volatilization under hot, humid, and windy conditions. Ammonium nitrate is no longer readily available in the region and although its substitution with ammonium sulfate (AS) provides one option, AS is more expensive per unit N and it may supply more S than is required. A new fertilizer product (Sulf-N 26), a fused combination of AN and AS, offers one more possible alternative source of potato nutrition. Two controlled-release fertilizers based on AS (SRAS15 and SRAS20) are also of interest. A field experiment was conducted near Paul, Idaho, on irrigated potatoes to compare these experimental N fertilizers with conventional farmer practices that primarily rely on the use of urea ammonium nitrate (UAN).

Petiole nitrate concentrations were monitored weekly, but no differences were noted between the N sources. The potato harvest occurred on September 10 when the middle 20 ft. of the two center plot rows were sampled, weighed, and graded for size and quality. Later analysis included potato defects, specific gravity, and storage quality. As observed in the 2007 growing season, no significant differences in yield or properties were found among the soluble N fertilizers. Tuber size was greatly increased with fertilization, compared with the unfertilized control. However, N fertilization also caused a drop in specific gravity. The controlled-release N fertilizers performed very well. Both SRAS15 and SRAS20, applied at only two-thirds the rate used for conventional products, had larger yields than those obtained with UAN or Sulf-N 26. The first year of data on these new fertilizer products appears very promising, similar to results obtained previously with other controlled-release fertilizers. *ID-09F*

Washington

Spatial Variability in Soil Phosphorus in Eastern Washington

Project Leader: Dr. Richard Koenig, Washington State University, Department of Crop and Soil Sciences, PO Box 646420. Pullman, WA 99164-6420. Telephone: 509-335-2726. E-mail: richk@wsu.edu

Considerable spatial variability exists in soil P concentrations across the variable topography and climatic zones of eastern Washington. Reasons for this variability are numerous and must be understood in order to implement appropriate P management practices in this unique environment. The objectives of this study are to: 1) characterize the mineral forms of P in soil samples representing different positions on a typical Palouse landscape; 2) evaluate the effectiveness of conventional soil test extractants in providing an index of plant-available P; and 3) evaluate the response of wheat to P fertilizer.

Geo-referenced soil samples (n = 25) from an 80-acre field located near Pullman, Washington, and samples collected in a 100 mile east-west transect in eastern Washington, were analyzed for total, organic, and soil test-extractable P (Morgan and Olsen methods). Phosphorus concentrations varied widely in these samples. Total, mineral, and organic P fractions were correlated with Olsen P, but not with Morgan P. Olsen and Morgan P were also not well correlated. Fractionation analysis (Ca, Al, and Fe forms) indicate the majority of P is still present as Ca minerals even in samples with pH as low as 5.2. A working hypothesis is that P minerals are currently in various states of transition from Ca to Fe/Al forms; however, equilibrium chemistry suggests that Ca-P minerals are not controlling solution concentrations of P. *WA-13F* ■

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