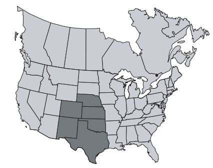
INSIGHTS
INTERNATIONAL PLANT NUTRITION INSTITUTE

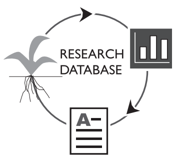
Research in the Southern and Central Great Plains Region



July 2009

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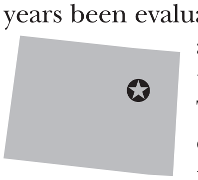
Project Cooperators: Dwayne Westfall, Kim Fleming, and Tim Shaver

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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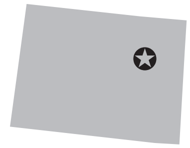

Ammonia (NH_3) deposition has been identified as a concern from both human health and environmental standpoints, and has recently been targeted by Colorado as a primary contributor to atmospheric and ecosystem changes in Rocky Mountain National Park (RMNP). Ecological ramifications, including increased 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

Project Leader: Dr. Alan Schlegel, Kansas State University, Southwest Kansas Research and Extension Center, Rt 1, Box 148, Tribune, KS 67879. Telephone: 316-376-4761. 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.

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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