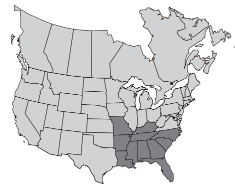
INSIGHTS
International Plant Nutrition Institute

2006 Research Program Summaries – Southeast Region

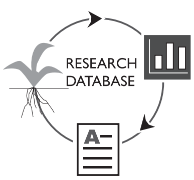


August 2007
Part 2 of 2

Cotton, Citrus, Forages, Forestry, and More

CHANGE is inevitable and has become an integral part of our world today. With this new issue of *INSIGHTS,* we have some important information on recent changes to highlight. The Potash & Phosphate Institute (PPI) ceased to exist at the end of 2006 and the International Plant Nutrition Institute (IPNI) was introduced at the beginning of 2007. At that time, **Dr. Cliff Snyder** was named Nitrogen Program Director for the new organization, with responsibility across North America and other IPNI program regions. He had served as Southeast Region Director for PPI over the past several years. Effective June 1, **Dr. Steven B. Phillips** joined the IPNI staff and is now the Southeast Region Director for IPNI. Contact information for both Dr. Snyder and Dr. Phillips appears with their photos.

In the past, you have probably received information from PPI through a publication called *News & Views.* That title has been discontinued and *INSIGHTS* is a new publication from IPNI.



Economic and environmental pressures have increased in recent years, making it more important than ever that nutrient rate, source, timing, and placement decisions are made correctly. Sound economic and environmentally responsible decisions are impossible in the absence of current nutrient management research. This report (Part 2) and its companion (Part 1) advance the science of nutrient management for the variety of food, fiber, and forestry crops produced in the Southeast U.S. The Foundation for Agronomic Research (FAR) is now affiliated with IPNI. The research projects reported here are supported in part by IPNI, FAR, and other cooperators. More information about the projects summarized here is available at these websites: >**www.ipni.net/research**< or >**www.farmresearch.com**<.

Please refer to the first INSIGHTS (Part 1 of 2) for a report from other studies conducted in the Southeast Region in 2006.

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Arkansas

Cotton and Soil Response to Application of Potassium

***Project Leader:** Dr. Morteza Mozaffari, University of Arkansas, Soil Testing and Research Laboratory, PO Drawer 767, Marianna, AR 72360. Telephone: 870-295-2851. e-mail: mmozaff@uark.edu*

This field study evaluated the effect of cotton cultivar (short and long-season) and K fertilization on seedcotton yield, petiole K concentration, and Mehlich-3 extractable K. The experimental design was a randomized complete block with a split-plot treatment where cotton cultivar (Stoneville 5599 and DeltaPineland 445) was the main-plot factor and K rate (0, 30, 60, 90, 120, and 150 lb K_2O/A) was the subplot factor. Initial soil test K was 96 ppm.

Cotton cultivar or cultivar x K rate did not have any significant effect on seedcotton yield, petiole K concentration, or post harvest soil test K within the 0 to 6-in. depth. Averaged across both cultivars, seedcotton yield ranged from 2,347 to 3,261 lb/A and was significantly ($p = 0.04$) increased as K application rate increased. Numerically, the highest yield was produced with application of 150 lb K_2O/A. Seedcotton yield of all treatments that received > 90 lb K_2O/A (2,965 to 3,261 lb/A) was significantly higher than the zero-K check (2,347 lb/A). Averaged across both cultivars, petiole K increased with increasing rate of K application and tended to decrease as the cotton plant developed. Potassium application rate significantly ($p = 0.0003$) and linearly increased Mehlich-3 extractable K within the 0 to 6-in. depth. Mehlich-3 extractable K in the control and plots that received 150 lb K_2O/A were 66 and 97 ppm, respectively. The data indicate that K fertilizer application was needed to increase seedcotton yield and petiole K levels and to improve soil K availability. *AR-29F*

Florida

Phosphorus/Potassium Soil Test Calibration and Effects on Fresh Citrus Fruit Quality

Project Leader: ***Dr. Thomas Obreza, University of Florida/IFAS, Soil and Water Science Dept., 2169 McCarty Hall, Box 110290, Gainesville, FL 32611. Telephone: 352-392-1951, Ext. 243. Fax: 352-392-3902. e-mail: taob@mail.ifas.ufl.edu***

Project Cooperator: *Robert Rouse*

Some Florida citrus growers apply P fertilizer on a regular basis, but tree response is rare because residual soil P is usually sufficient. It is important to judiciously use P fertilizer due to environmental concerns of P loss. Citrus producers want to use soil testing to guide fertilization, but no true calibration exists. Unlike P, K leaches readily in Florida's sandy soils, so K fertilization almost always provides a positive response. The objectives of this project are to calibrate a citrus soil P test and to determine the effects of K fertilizer rate on yield and fresh fruit quality of grapefruit and oranges. Our research grove was planted in November 1998 and we have monitored it annually.

The 2005-2006 growing season was severely impacted by Hurricane Wilma, which crossed south Florida on October 23 to 24, 2005. Leaf tissue was sampled as usual during the summer, but the hurricane removed most of the fruit from the grapefruit trees. The trees also suffered considerable leaf loss, but they were not permanently damaged. The orange trees also lost fruit, but enough was left to obtain a juice sample. The relationship between grapefruit leaf tissue P and soil test P in 2005 revealed a critical soil test P value of 9 mg/kg. Grapefruit leaf P was in the low range only when soil test P was below the critical value, which is interpreted as very low in the current UF-IFAS system. Orange tree leaf P was not related to soil test P, and all orange leaf P values were optimum or greater. Neither orange juice Brix nor acid were sensitive to soil test P. Potassium fertilizer response data (i.e., leaf K analysis, juice quality) confirmed that the optimum annual K_2O rate for oranges is 200 lb/A, but the optimum may be higher for grapefruit (in the range of 250 to 300 lb/A) if the response variable considered is leaf tissue K. *FL-19F*

Soil Fertilization of Perennial Pasture Systems

Project Leader: ***Dr. Cheryl Mackowiak, University of Florida, NFREC, 155 Research Rd, Quincy, FL 32351. Telephone: 850-875-7126, e-mail: clmackowiak@ifas.ufl.edu***

Project Cooperator: *Ann Blount*

Adoption of comprehensive forage fertilization practices can improve dryland forage hay production, quality, and tolerance to diseases without compromising environmental quality. Field studies are being conducted at three Florida locations, using three forage species (i.e., bermudagrass, bahiagrass, and perennial peanut) to compare K as potassium chloride (KCl) with and without supplemental potassium magnesium sulfate ($K_2SO_4{\cdot}2MgSO_4$, as K-Mag®) on forage yield, quality, and tissue mineral content. In addition, soil cores are being collected to determine fertilization effects on soil nutrient status over time. The K is applied at two rates (24 lb or 48 lb K_2O/t of hay removed) following each cutting. All plots, excluding the check plots, receive N at 60 lb/t hay removed and P fertilizer rate was based upon Florida IFAS recommendations. Control plots receive N without any K.

Bermudagrass has shown the greatest response to fertilization treatments, where plots not receiving $K_2SO_4{\cdot}2MgSO_4$ had declining yields. Low soil S, and plant tissue S less than approximately 0.18%, resulted in chlorotic plants, with yields nearly 50% lower than yields from plots receiving $K_2SO_4{\cdot}2MgSO_4$. Sulfur deficiency in bermudagrass presented itself in the first year on the Spodosol soil and the third year on the Entisol soil. The Ultisol soil contained enough residual S to support bermudagrass growth during the 3 years of this study. Bermudagrass had declining yields on plots excluding K if soil K was low and tissue K fell below approximately 1.5%. Additionally, Helminthosporium (leaf spot disease) infection was much greater on K-deficient bermudagrass. Bahiagrass and perennial peanut have larger root/rhizome nutrient storage capacity than bermudagrass, so treatment differences did not appear as quickly. Low tissue S and K began to result in declining bahiagrass yields at some locations in 2006. Perennial peanut has yet to show a yield response to fertilization practices. However, tissue K and S contents in perennial peanut approached critically low values in 2006, suggesting that nutrient-related yield declines may occur in 2007. *FL-22F*

Comparing Nitrogen and Sulfur Fertilizer Sources for Tomato Production

Project Leader: Dr. Bielinski Santos, University of Florida, Gulf Coast Research and Education Center, 14625 Co Rd 672, Wimauma, FL 33598. Telephone: 813-633-4128. e-mail: bmsantos@ufl.edu

Project Cooperator: Jack Rechcigl

The objective of this research is to evaluate the effect of ammonium sulfate nitrate (ASN) as a source for N and sulfur (S) compared with other commercially available fertilizers in tomato production near Balm, Florida. The study was initiated in the fall of 2006 at the Gulf Coast Research and Extension Center in 30 ft. plots having 5 ft. alleys and 15 tomato plants per plot. The soil belonged to the Zolfo series (sandy, siliceous, hyperthermic Oxyaquic Alorthods). The fertilizer sources were: (ASN- 26% N, 14% S), ammonium nitrate (AN- 34% N), ammonium sulfate (AS- 21% N, 24% S), and potassium sulfate (PS- 23% S, 55% K). Treatments compared a control to AN, AS, AN+PS, and ASN+PS at both 200 and 300 lb N/A. These treatment combinations also resulted in S rates of 0, 229, and 334 lb/A. Total marketable fruit weight from two harvests was measured and tissue S concentration assessed at 14 weeks after treatment.

There were significant treatment effects on both total marketable fruit weight and S concentration in the tissues. Orthogonal contrasts of both the N and S variables revealed that addition of S, either as PS or as ASN, increased tomato yield and S concentration in the leaf tissues. Interestingly, the same treatments (AN + PS and ASN + PS) which had higher yields than AN alone also had higher tissue S. There were no differences in yields or tissue S concentrations between: 1) AN and AS, and 2) AN + PS and ASN + PS. These preliminary results indicate that S fertilization has a significant effect on tomato yield at this location in Florida. Further research will be conducted in spring 2007 to confirm these findings. *FL-24F*

Georgia

Enhancing Thinned Slash Pine Volume Production and Product Class Distribution with Competition Control and Fertilization on Flatwoods Spodosols

Project Leader: Dr. E. David Dickens, University of Georgia, Warnell School of Forest Resources, PO Box 8112 GSU, Statesboro, GA 30460. Telephone: 912-681-5639. Fax: 912-681-0376. e-mail: ddickens@arches.uga.edu

Project Cooperators: David Moorhead, Coleman Dangerfield, and Bryan McElvany

Fertilization and competition control studies were installed in two thinned slash pine stands in southeast and south Georgia (Ware and Wayne counties) in 2001. The objectives are to: 1) quantify the magnitude and duration of response to lime, fertilization with 200-115-65 lb N-P_2O_5-K_2O/A , and competition control using herbicides, mowing, or burning; 2) measure diameter distribution and tree product class volume changes over time, and 3) evaluate the economics of these activities over a 5 to 8-year period. Both thinned slash pine stands are growing on low pH (3.8 to 4.2), low fertility Spodosols that are deficient in N, P, K, and magnesium (Mg) based on soil P and foliar N, P, K, and Mg measurements.

There were no significant differences between treatment means at Ware County for all growth parameters tested for 2 years (3 years in the case of limed plots) after treatment. This may be due to the slash pine stand being thinned later (i.e., at 23 versus 16 years) and a low live crown ratio of 24 to 27%, versus 36 to 38% for the younger Wayne County slash pine site. We plan to re-measure the trees in January and February of 2007, 4 years after the fertilizer and herbicides were applied.

It is early to draw any major conclusions from the Wayne County study after 4 years, but some trends are developing. The dbh (i.e., diameter at 4.5 ft.) response in the first 2 years (2001 to 2003) was slightly greater (54% of total) than the second 2-year period (2003 to 2005, 46% of total) for all treatments, whereas the total height increment during the first 2-year period was less than the second 2-year period (61% of the 4-year total). Height and volume per acre increment (as % of the 4-year total) for the herbicide treatment was greater than the NPK treatment during the second 2-year period. Therefore, in this case, the diameter response tended to occur before the height response, and the height response to NPK tended to be before the herbicide response. The response to herb+NPK was slightly greater than additive [(fert – control) + (herb – control)] for dbh, volume/tree, volume/A, and chip and saw (CNS) volume/A increment. There were significant CNS and pulpwood volume 4-year shifts, with herbicide+NPK and mow+NPK producing significantly more CNS volume than the control, herbicide, and mow only, and the herbicide+NPK producing significantly less pulpwood volume than the control and herbicide only. The NPK fertilizer, herb+NPK, and mow+NPK treatments produced an extra $162, $265, and $258/A wood revenue when compared to the control over the 4-year period. *GA-24F*

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

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: 912-681-0376. e-mail: ddickens@arches.uga.edu

Project Cooperator: David Moorhead

The University of Georgia (UGA) Warnell School of Forestry and Natural Resources (WSFNR) installed a replicated fertilizer study on Chuck Leavell's Charlane Plantation, located in Twiggs County, Georgia, in 2005. Seven of nine thinned loblolly pine stands showed NP, NPK, NPKS, and copper (Cu) deficiencies based on soil and foliar sampling on February 27, 2004. Leaf area index (LAI) estimation taken in July 2004 showed that these stands also had LAIs below optimal levels, indicating a good probability of response to N. Two fertilizer trials using fertilizer treatments and an untreated control (planted in 1978, thinned in 2002-03) were established February 15 and 16, 2005. One-time fertilizer application levels were 200 lb N/A + 50 lb P + 80 lb K + 60 lb S + 5 lb Cu/A. The Bullard Bluff East tract had 8 plots with two replications of NP, NPK, NPKSCu, and a control. The Bullard Bluff West tract had 15 plots with three replications of NP, NPCu, NPKCu, NPKCu, NPKSCu, and a control. The N and P sources were urea and diammonium phosphate (DAP), the K source was potassium chloride (KCl), the Cu source was copper sulfate, and the S source was ammonium sulfate. Untreated control plots will serve as reference plots.

The major objectives are: 1) quantify the magnitude and duration of wood volume response to the 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. Baseline soil (10 core samples to make a composite sample, with one composite sample/plot at 0 to 6 in. depth) were taken in each plot prior to treatment and annually post-treatment. All living crop trees in each plot were aluminum tagged, numbered, and measured for diameter at 4.5 ft. (dbh), total height, live crown length, and defect(s) prior to treatment (January 2005), with repeated measurements planned 2 and 4 years post-treatment. Rainfall patterns were excellent the year after fertilization, but there was drought in 2006. A low-cost ($15/A for product) foliar-active herbicide (glyphosate with a surfactant) was applied at a rate of 3 qts/A with an ATV and boomless sprayer at 15 gpa in August 2004 on BBE (pre-fertilization) and in August 2005 on BBW (post-fertilization). Plot LAI is being estimated annually, and foliage samples are being collected each dormant season for nutrient analyses. A field day is being planned for the spring of 2008 to share 2-year post fertilization findings and economic fertilization guidelines. It is anticipated that many forest landowners will be able to make educated and informed fertilization decisions in thinned loblolly pine plantations from this project. *GA-26F*

Missouri

Fescue Sulfur Fertilization—Hay and Pasture

Project Leader: Dr. Gene Stevens, University Delta Center, PO Box 160, Portageville, MO 63873-0160. Telephone: 573-379-5431. e-mail: stevensw@missouri.edu

Project Cooperator: David Dunn

In 2004, a sulfur (S) fertility study was begun on a non-renovated Ozark fescue pasture located in south central Missouri near West Plains. A fence was constructed to keep cows out of a hay test area which was used for evaluating 0, 9, 12, and 24 lb S/A as ammonium sulfate applied in late March each year from 2004 to 2006. At the same time as S application, rates of ammonium nitrate were applied, crediting N from ammonium sulfate, to provide a total of 50 lb N/A total for all treatments except check plots. Diammonium phosphate and potassium chloride (KCl) were applied with S treatments as part of an 8-year P and K buildup program. In late August, a rate of 30 lb N/A from ammonium nitrate was applied to all plots except the check. Plots were harvested three times in 2004, and twice in 2005 and 2006. Grab samples were collected from each plot for laboratory nutrient analyses.

Tissue tests of hay from the first harvest each year showed fescue S concentration was increased significantly with the 12 and 24 lb S/A rates. Averaged across years, leaf tissue in plots without S fertilizer contained 0.167 to 0.181% S. South central Missouri had low rainfall conditions in the summer months of 2005 and 2006. Although tissue S was increased from fertilization, no significant fescue dry matter hay increase was found at this location. Significant hay yield increases were found from N and P/K fertilization compared to the non-fertilized check. *MO-27F*

Use of Ammonium Sulfate on Tall Fescue Pastures to Reduce Costs and Improve Forage Quality in Missouri

Project Leader: Dr. Robert Kallenbach, University of Missouri, Plant Science, 210 Waters Hall, Columbia, MO 65211. Telephone: 573-882-2801. Fax: 537-882-1467. e-mail: kallenbachr@missouri.edu

About half of Missouri's 12 million acres of tall fescue receive N fertilizer either in the spring or late summer to increase yields. Because ammonium nitrate production is being phased out and urea has ammonia volatilization problems, growers need comparative information on new N products for pastures. Our primary objective was to compare ammonium sulfate, ammonium nitrate, urea, ESN® coated urea, Nurea®, Nurea with a 10% polymer coating, and mixtures of ammonium sulfate with urea and ESN as N sources for tall fescue in spring and late-summer applications. In 2006, plots established at the Bradford Research and Extension Center replaced those at the Forage Systems Research Center (FSRC). Another year of data was collected at the Southwest Missouri Research and Education Center (SWC). Each of the fertilizer sources were applied in mid-March (spring, Experiment 1) and mid-August (late-summer, Experiment 2) at each location. The N fertilizer application rate was 75 lb N/A. For the spring application, forage was harvested in late May, late July, and mid-October to measure season-long pasture production. For the late-summer application, plots were harvested in early December and indicate the suitability of each source for growing "stockpiled" forage for winter grazing.

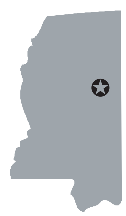
In experiment 1, our preliminary data for the first two years indicate that only the initial harvest responded to N applied in March. Nearly 80% of the annual dry matter was harvested at the first sampling date in May. No product was overwhelmingly consistent in producing high yields. Ammonium sulfate ranked in the top producing group at nearly all harvests and locations and its performance is perhaps the most surprising data from this experiment. Another somewhat surprising result was that ammonium nitrate, urea and ammonium sulfate proved to be nearly equal N fertilizer sources for tall fescue in spring. Each year, both locations received ample moisture within 5 days of the fertilizer application to get urea into the soil solution. Preliminary data show that a spring application of 75 lb N/A increased yields by approximately 2,250 lb/A over the unfertilized control or about 30 lb of additional forage for each pound of N fertilizer applied. Soil moisture affected this relationship drastically as the range was 987 to over 4,800 lb/A.

In experiment 2, for N applied in late-summer, many of the products yielded similarly and in most cases 10 or more of the products showed equal yields. Consistently, ammonium sulfate, ammonium nitrate, and urea had comparable yields in 3 of 4 site-years. Tall fescue fertilized with urea yielded 35% less than plots fertilized with ammonium nitrate during the dry autumn of 2005 in Mt. Vernon. This is a classic example of the risk associated with using urea for late-summer applications. The polymer coated urea has not shown much promise as a substitute for urea or ammonium nitrate for spring or late-summer N applications at this location. *MO-30F*

Mississippi

Determination of Potassium, Magnesium, and Sulfur as Limiting Factors in Cotton Production on Blackland Prairie Soils

Project Leader: Dr. Jac Varco, Mississippi State University, Plant & Soil Science, Box 9555, Mississippi State, MS 39762. Telephone: 662-325-2737. e-mail: jvarco@pss.msstate.edu



The objectives of this study are to: 1) determine individual response functions of cotton leaf K, magnesium (Mg), and sulfur (S), and cotton lint yield, to varying rates of applied K, Mg, and S, and 2) compare these individual responses to those obtained as a result of potassium magnesium sulfate ($K_2SO_4 \cdot 2MgSO_4$) application, supplied as KMag®. This project was established in April 2004 and the proposed length of study was through the 2006 growing season. Treatments included 0, 36, 72, and 108 lb K_2O/A as potassium chloride (KCl); 0, 9, 18, and 27 lb Mg/A as magnesium nitrate; 0, 18, 36, and 54 lb S/A as ammonium sulfate; and K_2O-Mg-S at 0-0-0, 36-9-18, 72-18-36, and 108-27-54 kg/ha as $K_2SO_4 \cdot 2MgSO_4$, with 50% of the K derived from KCl. Total N applied to all treatments was 120 lb N/A.

Lint yield increased linearly from 685 to 1,243 lb/A with an increase in K fertilizer input from 0 to 108 lb K_2O/A. Response to Mg was inconsistent, but treatments with Mg yielded an average of 1,085 lb lint/A compared to 958 lb/A for the no Mg check. Yield responded quadratically to increasing S rates with a maximum lint yield of 1,187 lb/A at 36 lb S/A and 863 lb/A with no S. Lint yield response to $K_2SO_4 \cdot 2MgSO_4$ was similar to the response to applied K rates, but with a slight curvature. Yields were 751 lb lint/A with no $K_2SO_4 \cdot 2MgSO_4$ and 1,163 lb/A with the largest $K_2SO_4 \cdot 2MgSO_4$ rate. The dramatic response to applied K rates from either source (KCl or $K_2SO_4 \cdot 2MgSO_4$) provides more evidence on the importance of K in no-tillage cotton, especially in dry years. Leaf sampling was not possible due to a herbicide spray mishap one week prior to the scheduled leaf sampling at early bloom. *MS-13F*

Tennessee

Nitrogen and Potassium Effects on Physiology and Yield of Contrasting Cotton Varieties

Project Leader: Dr. C. Owen Gwathmey, University of Tennessee, West Tennessee Exp. Station, 605 Airways Blvd., Jackson, TN 38301-3200. Telephone: 901-424-1643. e-mail: cogwathmey@utk.edu

Project Cooperators: C.C. Craig, Jr., Carl Michaud, and Tracy Bush

Cultivar differences in yield response to N and K nutrition have been observed in modern cultivars, but the underlying reasons for these differences are needed to improve fertilizer recommendations. For this reason, we continued three interrelated studies within long-term soil fertility plots in a Memphis-Loring silt loam at Jackson, Tennessee. They include: 1) variety response to K, 2) variety response to N at different K levels, and 3) response of an indeterminate cultivar to extremes of K fertility. Two cultivars with contrasting growth habits, FM 960BR and DP 555BG/RR, were planted with no-tillage in replicated 4-row plots on May 3, 2006. In plots receiving 60 and 120 lb K_2O/A/yr, dry matter partitioning was determined at early bloom and cutout. All plots were spindle-picked at 140 and 156 days after planting, and earliness was measured as percent of total yield picked at first harvest.

Applying K fertilizer in excess of recommended rates affected the two cultivars differently in this year of the study. Total lint yield of the more indeterminate DP555 responded less to K than the more determinate FM960, but maturity of DP555 was delayed with excess K fertility. This delay was presaged by increased partitioning to leaf tissue during early bloom, and reduced partitioning to reproductive organs in DP555 by cutout, relative to FM960. This pattern suggests that the more indeterminate cultivar responded to additional K by partitioning more biomass to vegetative organs at the expense of reproductive development, unlike the determinate cultivar. Yield of the more determinate cultivar, FM960, responded to higher K rate only at a higher than recommended N rate, suggesting that its yields may have been N-limited at 80 lb N/A. In a companion study, very high K rates increased total lint yields of DP555 by 88% over the zero-K treatment, but significantly delayed maturity and increased micronaire. Additional research is needed in Tennessee to improve K fertilizer recommendations for cotton and to determine the yield and fiber quality effects of this delay in the event of cool weather before harvest. *TN-19F*

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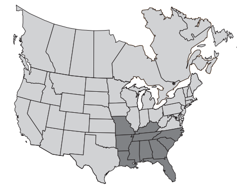

August 2007
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2006 Research Program Summaries – Southeast Region

Soybeans, Rice and Wheat

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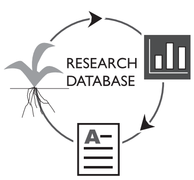

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Arkansas

Soybean and Rice Response to Boron Fertilization in Arkansas

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Project Cooperator: R. DeLong, S. Clark, M. Mozaffari, J. Schaeffer, and R. Thompson

The objective of five studies conducted in 2006 with soybean was to evaluate boron (B) fertilizer application time and rate on the seed yield of soybean grown on alkaline silt loams in northeast Arkansas. Also, we sought to evaluate whether trifoliate leaf B concentrations changed appreciably with time during the growing season. Boron fertilizer was applied before emergence using granular B at 1.0 and 2.0 lb B/A, at the V5 stage using foliar-applied B at 0.37 and 0.75 lb B/A, or at the R2 stage using foliar-applied B at 0.37 and 0.75 lb B/A. These treatments were compared with an unfertilized control. Several different B fertilizers were used, but most treatments were with Granubor® or Solubor DF®. Each study was a randomized complete block with six replicates of each treatment. Recently matured trifoliate leaves (15 to 20) were collected at and between the V5 and R3 stages and grain yield was measured at maturity. One additional study was conducted to evaluate yield response of B deficient soybean to foliar B applied at one week intervals, which would hopefully provide information concerning the benefit of (or lack of) mid- to late-season B fertilization to stressed soybean plants.

One site has not yet been harvested due to wet soil conditions. Soybean yields were increased by B fertilization at only one site in 2006 and showed a non-significant positive at one other site. At these two sites, soybean yields were greatest when B was applied at planting, or the V5 stage, and showed little or no response to B applied at R2. Both sites had tissue B concentrations between 11 and 19 ppm during the growing season (V5 to R3 stage). The unresponsive sites all had tissue B concentrations >20 ppm and sometimes exceeded 60 ppm depending on B rate, but B fertilization had no significant negative influence on soybean yield. In general, leaf B concentrations were increased more by granular B applied at planting and at higher rates than by B sprayed to soybean foliage at the V5 stage. Tissue B concentrations increased as B application rate increased. Collecting trifoliate leaf samples during early vegetative growth is not currently recommended as a means of identifying fields that need B fertilization. Data from the last 3 years of research suggest that tissue B concentrations may increase or decrease during soybean development, which is due in part to development of the plant's root system and B uptake as a function of soil moisture status. *AR-23F*

Glyphosate Effects on Soybean Phosphorus Response and Soil Microbiology

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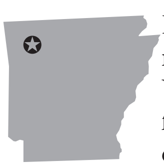

Roundup Ready® (RR) crops account for the majority of soybean, corn, and cotton in the United States. Although glyphosate has no effect on RR crops, beneficial microorganisms can be sensitive to glyphosate. Our research addresses whether glyphosate effects on mycorrhizae in roots of RR crops changes P nutrition. RR soybean, corn, or cotton seeds were planted in low P (22 lb/A Mehlich 3 P) silt-loam soil in 2.4 gallon pots. Treatments included two levels of P nutrition: (i) no additional P, and (ii) the equivalent of 90 lb P_2O_5/A. There are two glyphosate treatments: (i) no glyphosate (control), and (ii) glyphosate [1 lb active ingredient (a.i.)/A] applied at 10 and 20 days after emergence. Treatments were replicated six times. Soil was not pasteurized, and mycorrhizal infection was dependent on the indigenous community. Soybean was inoculated with *B. japonicum* and did not receive N fertilizer; corn and cotton received 100 lb N/A. Six weeks after emergence, plants were harvested, dried, ground, and analyzed for N and P. Root colonization by mycorrhizal fungi was measured after washing, clearing, and staining roots.

Phosphorus fertilization significantly decreased mycorrhizal infection in soybean and significantly increased shoot biomass and plant P in all three crops as compared to no P additions. No significant effects of glyphosate or interactions of P and glyphosate were apparent for any variable. These results are in contrast to a previous study on pasteurized and inoculated soil where mycorrhizal infection in corn was 40% lower, while mycorrhizal infection in cotton was twice as high, following one glyphosate application. Thus, while glyphosate may affect mycorrhizal infection in soil with a compromised microbial community (i.e., pasteurized soil), these greenhouse results indicate that glyphosate application to RR plants in a healthy soil may not need to be considered in management decisions related to P nutrition. *AR-28F*

Soybean Response to Phosphorus and Potassium Fertilization in Arkansas

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Project Cooperators: R. DeLong, J. Branson, S. Clark, M. Mozaffari, R.J. Norman, J. Schaeffer, and R. Thompson

The objective of studies conducted in 2006 was to evaluate yield response of soybean grown on silt loam soils in eastern Arkansas to P and K fertilization rate. Seven short-term study sites were established for P and K fertilization trials. Before or shortly after soybean was planted, P (triple superphosphate) or K (potassium chloride) fertilizers were applied at rates of 0, 40, 80, 120, and 160 lb K_2O or P_2O_5/A. At each site, P and K studies were in adjacent plot areas. Each experiment was a randomized complete block with six replicates. Other fertilizer nutrients besides the nutrient being studied... i.e., boron (B), P and/or K...were added to each study site. A composite soil sample (0 to 4 in. depth) was collected from each replicate and extracted with Mehlich-3 solution. Recently matured trifoliate soybean leaves (15 to 20) were collected at the R2 growth stage for elemental analysis. Grain yield was measured at maturity.

Soybean yields were significantly increased by K fertilization at three sites, which had <102 ppm Mehlich-3 extractable K, the lowest soil test K values of the 2006 research sites. Yields at a site testing 104 ppm were not significantly different, but were consistently and numerically higher when K was applied, a trait common to all harvested sites in 2006. At the responsive sites, yields of soybean receiving K fertilizer rates >80 lb K_2O/A were similar, but significantly greater than yields of soybean receiving 0 lb K_2O/A. Application of >80 lb K_2O/A increased soybean yields by 14 to 53% compared to the unfertilized control. Potassium concentrations in recently matured trifoliate leaves at the R2 growth stage were significantly affected by K rate at six of 7 sites. Tissue K concentrations increased linearly as K rate increased with the greatest range of tissue K among K fertilizer rates occurring at the two sites with the lowest soil test K (46 and 86 ppm) values and greatest yield responses. The K concentrations of the unfertilized control were <1.5% for both sites.

Soybean yields were significantly affected by P fertilization rate at only two of six harvested sites which had soil test P values of 3 and 12 ppm. At both sites, near maximal yields were produced by application of 40 lb P_2O_5/A which represented yield increases of 19 to 20% above the unfertilized controls. Other sites had Mehlich-3 P from 8 (unharvested site) to 46 ppm and showed no tendency to respond to P fertilization. Phosphorus concentrations in recently matured trifoliate leaves at the R2 growth stage were significantly affected by P application rate at two of seven sites. The two sites with different tissue P concentrations were the same sites that showed positive yield responses to P fertilization. Trifoliate leaf P concentrations of the unfertilized control treatments were 0.22 and 0.40%, suggesting the critical P concentration at R2 may need to be refined.

The revised University of Arkansas (2006) K fertilizer recommendations for soybean appear to be reasonably accurate in identifying soils that respond to K fertilization. Recommendations for P require some adjustments to improve their accuracy for predicting soybean yield response to P fertilization. *AR-30F*

Agronomic Evaluation of Two New Sulfur Sources for Direct-Seeded, Delayed Flood Rice in Arkansas

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Most sulfur (S) deficiencies in rice are found on: 1) sandy and sandy loam soils which possess very low amounts of organic matter (OM) and have high permeability, 2) precision graded fields which have had their topsoil removed and consequently have low OM, and 3) fields that are continuously flooded for rice production and waterfowl habitat. The objective of this study was to compare two new S fertilizers to ammonium sulfate for alleviating S deficiency on a permeable, sandy soil. The study was conducted in a commercial rice (Wells variety) field on a Ruston fine sandy loam soil (thermic Typic Paleudult) in Lincoln County, Arkansas, during the 2006 cropping season. Plots were flooded on May 22 at the 4 to 5-leaf growth stage and remained flooded until mature. Nitrogen was applied as urea using a split application of 105 lb N/A at pre-flood and 45 lb N/A at mid-season. Phosphorus and K were applied pre-plant by the farmer according to University of Arkansas recommendations. The experimental design used was a three source x three rate factorial with four replications. The S sources, applied a few days before establishment of the permanent flood, were a Simplot 13-33-0-15 (N-P_2O_5-K_2O-S), a Mosaic 13-33-0-15, and ammonium sulfate (AMS, 21-0-0-24) at 0, 15, and 30 lb S/A. All treatments, including the untreated control, were normalized for N and P rates by applying the appropriate amounts as urea and triple superphosphate, respectively.

Results found no interaction of S fertilizer rate with S fertilizer source. Rice grain yield increased significantly from 127 bu/A when no S was applied to 146 and 154 bu/A when 15 and 30 lb S/A were applied, respectively. Rice grain yield response to S was statistically similar for the three different S sources at the p = 0.05 level of confidence, but at p = 0.10 a higher rice grain yield was achieved using the 13-33-0-15 source compared to AMS.
AR-32F

Florida

Evaluation of Chloride and Other Nutrients for the Control of Soybean Rust in North Florida

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Project Cooperator: Jim Marois and Tristan Mueller

Soybean variety NK S57-A4 was planted at the North Florida Research and Education Center in Quincy on August 23, 2006, in 4-row plots. Plots were 20 ft. long with 36 in. row spacing. The experimental design was a randomized complete block with four replications. The objective of this experiment was to determine the efficacy of chloride (Cl^-) applied in-furrow at planting as potassium chloride (KCl) or calcium chloride ($CaCl_2$). Micronutrient application included boron (B) at 0.25 lb/A and manganese (Mn) at 0.5 lb/A as a foliar application for the control of soybean rust. The KCl was applied with a Gandy spreader and the $CaCl_2$ was applied in-furrow with 33 gallons per acre (gpa) of water. Foliar application was on October 4 at R2 growth stage with a platform sprayer using 15 gpa of water. Soybean plants were rated for soybean rust on

October 11 and 20 and on November 2, 9, and 17. The rating from these dates was used to calculate rust severity. The middle two rows of each plot were harvested on December 11 and the yield was adjusted to 13% moisture content.

Soybean rust was first observed on October 9 at the R3 growth stage. Thus, Mn and B were applied just before soybean rust was observed. There was no effect on soybean rust severity or yield for the treatments with $CaCl_2$ and KCl when compared to the untreated control. The effect of Mn and B was much more significant in almost all of the treatments. Foliar application of Mn and B had significantly lower soybean rust severity and higher yields. Treatments with Mn, B, and KCl had the highest seed weights, while $CaCl_2$ had the lowest seed weight. No phytotoxicity was observed for any treatments. *FL-23F*

Louisiana

Effect of Potassium, Manganese, and Boron on Asian Soybean Rust and Other Diseases in Soybean

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Project Cooperator: Jim Wang

Asian soybean rust (ASR) was first discovered in North America in Louisiana in November 2004 and was confirmed in eight other states within a few weeks of the initial discovery. This disease has been documented to cause in excess of 80% yield losses in Brazil and elsewhere. The only weapon available to U.S. producers at this time is fungicides, which have not been evaluated under our environmental and agronomic conditions. Other control or disease mitigation options are desperately needed. The objective of this project is to determine if there is an effect of potassium chloride (KCl), along with manganese (Mn) and boron (B), on ASR and other diseases in soybean. In addition, treatments will be included to assess the role of Cl^- without K because Cl^- is known to affect disease development in other host:pathogen systems. If there are positive responses to these treatments, subsequent experiments will investigate application rates in more detail and their interactions with fungicides. It may be possible to reduce fungicide rates and frequencies of application if one or more of these nutritional regimes reduce the rate or severity of disease development. Potassium chloride will be applied at a low (60 lb K/A) or high (112 lb K/A) rate to the soil surface and then lightly incorporated just before planting at the Louisiana State University research station near Baton Rouge. Manganese and B will be applied at 0.5 and 0.25 lb/A, respectively, via foliar application at the V4 and V10 growth stages. There will be four replications per treatment with plot dimensions of 4 rows by 40 ft. The center two rows of each plot will be harvested with a plot combine, and yields will be calculated on a per acre basis. Calcium chloride ($CaCl_2$) will also be evaluated at a low (86 lb Cl^-/A) and high (172 lb Cl^-/A) rate, with and without the foliar Mn and B. Low (30 lb Cl^-/A) and high (90 lb Cl^-/A) rates of ammonium chloride (NH_4Cl) will also be included to evaluate the effects of ammonium-N nutrition during vegetative growth. Leaf samples will be collected for complete nutrient analyses, and disease evaluations for ASR, frogeye leaf spot, and Cercospora leaf blight will be made periodically during the season so that rates of infection can be calculated. One evaluation at the end of the season will be made for pod and stem diseases, and grain quality also will be assessed.

Unfortunately, after three attempts to establish the study in 2006, it was abandoned for the year because of repeated failure to establish a soybean stand because of very severe drought. The test is being conducted again in 2007. The principal investigators of this project are working in collaboration with scientists at the University of Florida in coordinating similar tests where the soybean rust potential is high each year. *LA-22F*

Missouri

Use of Pre-Plant or Foliar-Applied Potassium Chloride with Fungicides to Improve Soybean Response and Disease Resistance

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An increased occurrence of K deficiency in soybeans and the potential widespread on-set of Asian soybean rust (ASR, *Phakopsora pachyrhiza*) in soybeans have stimulated interest in new management practices that may improve K nutrition and lower incidence of disease. In 2004, ASR was reported in nine states including Louisiana, other Gulf Coast and southeastern states, and Missouri. Combining K, chloride (Cl^-), and other nutrients either as a pre-plant or foliar application with a fungicide may improve disease management. The objectives of this study were to: 1) determine soybean yield response, disease incidence and K and Cl^- tissue concentrations from application of KCl alone or in combination with several fungicides, 2) examine the effects of application timing of KCl or the fungicides on crop response and disease incidence, and 3) evaluate the cost-effectiveness of applying KCl with fungicides for soybean production. The first of 2 site-year field trials was established at the Greenley and Delta Centers on soils with medium to low soil test K. Roundup-Ready® soybeans were no-till planted at

180,000 seeds/A in 15 in. rows. Treatments consisted of a non-treated control, a recommended pre-plant rate of KCl based on soil test (one-year buildup rate), or a foliar application of 16 lb K_2O/A (as KCl) in a factorial arrangement combined with and without fungicide applications of 6 oz/A of pyraclostrobin (Headline®), 6.4 oz/A of azoxystrobin (Quadris®), or 6.4 oz/A Quadris® + 2.6 oz/A of Warrior® (i.e., lambda-cyhalothrin insecticide) applied either at V4 or R4 growth stages. Foliar injury was rated 3, 7, and 28 days after foliar application. Treatments were evaluated for the incidence of septoria brown spot (*Septoria glycines*), frogeye leaf spot (*Cercospora sojina*), sudden death syndrome (*Fusarium solani*), and ASR.

Soybean injury was minimal except when fungicides were tank mixed with KCl at Portageville. Leaf necrosis was the primary symptom and plants recovered by 10 days after treatment. Asian soybean rust was not present at either location in 2006. The incidence of septoria brown spot, frogeye leaf spot, or sudden death syndrome was less than 10% in 2006. Interactions between application timing and fungicide treatment were common. This research indicates that KCl fertility reduced the incidence of septoria brown spot and frogeye leaf spot at Novelty, but no differences were observed at Portageville. Preplant KCl increased yield when compared to the non-treated control and foliar applied KCl at Novelty and Portageville, which could be related to the combined effects of disease tolerance and fertility. Fungicide treatments applied at the R4 stage of development increased grain yield at Novelty, but had no effect on grain yields at Portageville in 2006. The cost-effectiveness of the treatments will be determined following research in 2007. *MO-32F*

Mississippi

Rice Response to Phosphorus and Potassium

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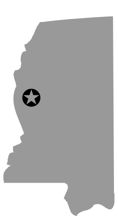

In 2006, two studies were conducted that investigated P rates and application timing in Mississippi. Study 1 was conducted in the cut (leveled) area of a newly land-formed field near Hollandale. Forestdale silt loam was the predominant soil type and it had a pH of 5.9 and a Lancaster extractable P concentration of 15 lb/A. Study 2 was conducted on a field near Drew, that was leveled in the fall of 2001 and produced its third rice crop with soybean planted every other year. Dundee silt loam is the predominant soil type and it had a pH of 5.8 and a Lancaster P concentration of 22 lb/A. Substantial vegetative responses to P fertilizer were observed at both locations. However, the yield response was greater in Study 1. Study 1 consisted of three application timings (Fall, Spring 1-leaf and Spring 5-leaf growth stage), three P rates (25, 50, and 100 lb P_2O_5/A), and a non-treated control.

The treatment producing the greatest yield response (14%), compared to the non-treated, was 50 lb P_2O_5/A applied at the 1-leaf growth stage. Yield response to P was not as great at Study 2. When 50 lb P_2O_5/A was applied at 5-leaf growth stage, grain yields were increased by only 4%. This research is on-going with the goal of correlating and calibrating our current soil test method for determining optimum P fertilizer rates for high yielding rice varieties and hybrids grown on different soil types with varying pH. In 2006, two studies investigated K rates and application timing in Mississippi. Study 1 was conducted near Drew on a Dundee silt loam with a Lancaster K concentration of 184 lb K/A and a CEC of 14 $cmol_c$/kg. Study 2 was also conducted on a Dundee silt loam near Merigold, and had a Lancaster K concentration of 228 lb K/A and a CEC of 15 $cmol_c$/kg. Four K rates (i.e., 30, 60, 90, and 120 lb K_2O/A) were applied at two timings (1-leaf and 5-leaf stage) and compared to a non-treated control. No yield response was obtained in Study 1. However, in Study 2, a 5% yield response was obtained with an application of 60 lb K_2O/A at the 5-leaf growth stage. *MS-10F*

Evaluation of Fungicides in Combination with Urea Ammonium Nitrate or Urea Solution at Various Rates and Application Timings for the Control of Soybean Diseases and Increased Yield

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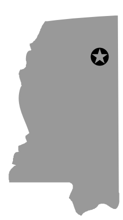
Project Cooperators: Normie Beuhring, Billy Moore, Dan Poston, Ben Spinks, Brian Ward, and Mitt Wardlaw



Research was conducted at Pontotoc and Verona, Mississippi, in 2006 to evaluate foliar fungicides for the control of soybean diseases and determine the effects on soybean yields. Maturity Group IV soybeans were planted in a field following corn near Pontotoc (P 94M80 RR) and in a field following soybean near Verona (DPL 5634). Plots were sprayed using a CO_2 tractor-mounted sprayer at 15 to 20 gal. of spray volume/A (gpa) traveling at a speed of 3.2 mph at 32 PSI, and using 8002 VS spray tips. Treatments were replicated four times at each location in a randomized complete block design. At Pontotoc, there were 10 treatments with combinations of different fungicides, two of which included urea ammonium nitrate (UAN) solution, Headline SBR® plus UAN 32%; 7.8 oz/A + 4.2 gpa, applied at R3 or R5 growth stage. At Verona, the treatments were: Headline plus Penetrator® plus Borosol® (5 oz+8 oz+0.25 lb/A), Headline SBR + urea

(7.8 oz+12 lb urea/A) at R3-R4, Headline SBR + urea (7.8 oz+12 lb urea/A) at R5, and an untreated control.

Due to extremely dry and hot conditions, disease development did not take place until late in the season at Pontotoc. The dry growing season also produced yields that fell well below average (<13 bu/A), prevented accurate disease ratings, and resulted in no differences in yield at Pontotoc. At Verona, ratings were taken for injury, late season Cercospora, greening effect, and Septoria brown spot. There were no statistical differences among treatments for greening effect or Septoria brown spot at Verona. However, there were slight differences in late season Cercospora control. Each treatment was slightly better than the check (i.e., 3.3 to 4.0 vs. 5.5 rating, with nine being a severe infection). Headline plus urea at R3-R4 resulted in a foliar spray injury rating of 0.8 on a scale of 0 to 9, with 9 being severe injury. No foliage injury was observed with the other treatments at Verona, and there were no differences in soybean yield. *MS-14F*

The Evaluation of Sulfur Fertilizer Sources in Rice

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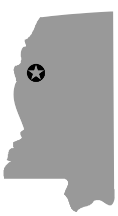

Rice sulfur (S) uptake is approximately 23 lb S/A for a 9,000 lb/A grain yield. Sulfur deficiency symptoms can sometimes be detected during the vegetative growth stage of rice when soils have recently been leveled and/or the clay pan has been compromised, or symptoms may be detected during the reproductive stage as biomass production is rapid and the panicle is forming. A field near Tunica, Mississippi, with a recent history of late-season S deficiency was selected for a field trial to evaluate S fertilizer sources including: Simplot, 13-33-0-15; Mosaic, 13-33-0-15; and ammonium sulfate (AMS), 21-0-0-24 at three S rates of 0, 15, and 30 lb/A. Triple superphosphate and urea were applied to the control, AMS, and to the lower application rates of the 13-33-0-15 treatments so that N and P_2O_5 rates were equal across all treatments. All S treatments including the control were applied when rice had two to three leaves. Urea was applied at the rate of 120 lb N/A at first tiller and the field was flooded within 3 days after application.

Though S deficiency symptoms were observed in the 2005 rice crop, deficiencies were not apparent in the 2006 crop. Mineralization of S from organic matter may have provided sufficient S to overcome the deficiency. No differences were obtained between S sources, though AMS provided numerically higher yields compared to all other sources.

Another field study was conducted on a Sharkey clay soil (i.e., very-fine, smectitic, thermic chromic Epiaquert) at the Delta Research and Extension Center, near Stoneville, Mississippi, using the Cocodrie semi-dwarf cultivar. The study involved a factorial combination of treatments replicated four times in a randomized complete block design. Factor A consisted of six early season N sources including: AMS, DAP, urea, Mosaic 13-33-0-15, Simplot 13-33-0-15, and none. Factor B consisted of preflood N rates of 90, 120 and 150 lb N/A as urea. The early season N sources were broadcast at 20 lb N/A on three-leaf rice on May 31. The fertilizer was incorporated with approximately 0.5 in. of precipitation which fell on June 2. On June 8, preflood N rates of 90, 120, and 150 lb/A were broadcast-applied and a permanent flood was established on June 10.

Early season N source did not affect early season plant growth in 2006. Preflood N rates affected total N uptake, biomass, and yield. When averaged across early season N sources, biomass, total N uptake, and rice grain yield were greatest when 150 lb N/A was applied. Early season N sources have been shown to affect early season growth in recent studies in Arkansas, Mississippi, and Missouri. The Simplot 13-33-0-15 source appears capable of providing early season N to stimulate vegetative growth when applied under conditions that support uptake and utilization by seedling rice. This product should be further evaluated in this situation because it would eliminate distributor blending of AMS and DAP which is a very common source used in rice in the midsouthern U.S. *MS-15F*

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Southeast Region
August 2007