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Southeast Research Report

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

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

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Arkansas

Soybean Response to Boron Fertilization

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

Boron (B) deficiency is a common problem for soybean grown on alkaline, silt, and sandy loam soils in Northeast Arkansas. Field studies have been conducted since 2002 evaluating soybean response to B application timing and rate. In 2007, a trial was conducted in Woodruff County, in a field that exhibited B deficiency symptoms in the previous year's soybean crop. The test soil had 2% organic matter, 7.2 pH, and 0.5 ppm Mehlich-3 B. Soybean (DK5066) was no-till drill seeded on April 21. Boron was soil applied as a granular material at emergence (May 1) at 1 and 2 lb B/A and as foliar applications at V4 (May 31) and R2 (June 28) at rates of 0.37 and 0.75 lb B/A. Trifoliate leaf samples were collected on June 28 before B was applied and analyzed for B concentration. Yield was measured at maturity.

Boron deficiency was noted in an unfertilized border area on May 31, but no symptoms or growth differences appeared within the test area. Within the test area, tissue B concentration of soybean receiving no B ranged from 9 to 32 ppm (indicating considerable variation within the research site). At the R2 stage, soybean receiving no B had a mean tissue B concentration of 25 ppm, which is above the 20 ppm critical level. Leaf B concentration was increased more by the soil applied B (53 and 59 ppm for 1 and 2 lb B/A, respectively) than by the foliar-applied treatments (39 and 46 ppm). Within the test area, B deficiency symptoms were not observed and soybean yield was not affected significantly by B fertilization. Soybean plants affected by B deficiency in the unfertilized border never recovered from B deficiency and failed to set seed by harvest. The test site was apparently near, but not within the B-deficient part of the field deficient in B. *AR-23F*

Florida

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

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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 chloride (Cl^-), through either potassium chloride (KCl) or calcium chloride ($CaCl_2$), plus foliar application of boron (B) at 0.25 lb/A and manganese (Mn) at 0.5 lb/A for the control of soybean rust. Soybean variety Asgrow 6702RR 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 36-in. row spacing. The experimental design was a randomized complete block design with four replications. The application of B and Mn was on September 26 using a platform sprayer

powered by CO_2 fitted with Turbo TeeJet 11002 nozzles and sprayed with 15 gallons of water per acre. Soybean plants were rated for soybean rust on October 10. The middle two rows of each plot were harvested on October 30 and yield was adjusted to 13% moisture.

White fly infestation was severe throughout late summer and fall and could not be controlled. The infestation significantly impacted yield and likely contributed to the lack of differences among treatments for soybean rust severity, yield, test weight, or seed weight. *FL-23F*

Response of Tomato to Ammonium Sulfate Nitrate

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Project Cooperators: Humberto Moratinos and Jack Rechcigl

Two field studies were conducted to determine the effect of sulfur (S) fertilization on tomato yield and foliar S concentration. The soil had very low S content (<30 ppm) and 1.5% organic matter. Fertilizer source treatments were: a) ammonium nitrate (AN; 34% N) at a rate of 300 lb N/A; b) AN + potassium sulfate (PS; 23% S and 55% K) at rates of 300 and 343 lb N and S/A, respectively; c) ammonium sulfate nitrate (ASN; 26% N and 14% S) at rates of 300 and 343 lb N and S/A, respectively; and d) a non-treated control. Potassium chloride (KCl) was used to balance total K amounts in each treatment to ensure that this nutrient was under non-limiting conditions.

Plots treated with only AN had the lowest foliar S concentration, ranging between 0.55 and 0.53%, which was not different from the non-treated control. However, plots treated with S-containing fertilizers had foliar S concentrations averaging 0.74%, which was approximately 40% higher than the concentration in control plots. There were no significant marketable yield differences in plots treated with either AN + PS or ASN, with average marketable yields ranging between 27.5 and 28.2 t/A in the S-treated plots. In contrast, average yield in the AN-treated plots was 18.7 t/A, which was 44 and 42% less than the yields in the AN + PS and ASN-treated plots, respectively. These results suggest that soil analysis should be performed in tomato fields before planting to determine appropriate S application rates. *FL-24F*

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

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The objectives of this research, initiated in April 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. Faunal (abundance and diversity) and geochemical (stable isotope, elemental, and molecular) 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 input of terrestrial organic matter and sediment. The extent of the pre-anthropogenic low-oxygen events is similar to that observed in recent times. These results suggest that MR discharge volume and delivery of continentally-derived materials to the Louisiana shelf are important processes to consider when evaluating the causes and consequences of the recent development and expansion of hypoxic conditions.

Climate variability has been shown to influence atmospheric circulation patterns, the transport of evaporated moisture from the Gulf of Mexico to the North American (NA) continent (as precipitation), and the volume of MR discharge. Associating the timing and recurrence frequency of MR discharge and pre-anthropogenic low-oxygen events on the Louisiana shelf with natural climatic conditions was limited by the sediment discontinuities (time missing) due to widespread sediment erosion associated with historical storm (hurricane) events. In order to assess the role of natural climate variability in controlling MR discharge, we have analyzed a sediment core from the continental slope (Pigmy Basin), where storm events have not disturbed the sediment record. Initial results from the 1,400-year Pigmy Basin record show a direct linkage between Gulf of Mexico evaporative processes and MR discharge. Although high MR discharge events are observed within time periods of strongly varying climatic conditions, including the Little Ice Age, the Medieval Warm Period, and the anthropogenic time-windows, elemental analyses of the Pigmy Basin sediment exhibit significant differences and systematic changes. These results suggest that the delivery of suspended sediment from the six sub-basins comprising the MR drainage basin changed abruptly. Delineation between the contributions of these six sub-basins to MR terrestrial input can provide insights into how changing climate conditions control where and when precipitation on the NA continent occurs. *FL-26F*

Georgia

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

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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 NP, NPK, and NPK plus sulfur (S) and copper (Cu) in one trial and NP, NPCu, NPKCu, and NPKSCu in the other 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. More will be known after the 4-year measurements in December 2008 where fertilizer gains (diameter and volume) typically tend to peak. *GA-26F*

Louisiana

Soybean Rust Control with Nutrition and Fungicides

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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 manganese (Mn) and boron (B). Two rates of KCl (60 and 120 lb K_2O/A; 27 and 53 lb Cl^-/A) and $CaCl_2$ (47 and 95 lb Ca/A; 27 and 53 lb Cl^-/A) were tested both as preplant applications and sidedress applications at the time of first flower. Treatments were then split, with half receiving foliar applications of Mn and B just prior to the R1 stage, and the other half receiving no supplemental micronutrients. Urea was applied at R1 in response to a suggestion that a supplemental application of N would reverse the yield loss associated with ASR. Disease ratings were made at early R6 stage.

The non-amended control exhibited severe disease development. However, the most severe disease was observed in the urea treatment. It is possible that soil N status affects ASR development, and N fertilization in a previous crop may need to be taken into consideration with regard to ASR development. Micronutrient applications were variable in their response, and no conclusions could be drawn with regard to their effects. The most effective treatment was the preplant application of $CaCl_2$ followed by micronutrient application at R1, which resulted in only traces of disease. Low rates of preplant application of KCl with or without micronutrient applications were also effective. However, it is apparent that the response was not related to K, but rather to Cl^-. Sidedress applications did not affect disease severity compared to the preplant applications. The nutritional response does not control ASR for the duration of the season. Rather, it delays disease onset by several weeks and reduces the rate of disease increase. Nevertheless, this response may be sufficient to reduce the number of fungicide applications or eliminate the need for fungicides altogether if ASR arrives late in the season or environmental conditions are not favorable for severe disease development. *LA-22F*

Missouri

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

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The objective of this study was to compare ammonium sulfate (AS), ammonium nitrate (AN), and urea as N sources for tall fescue production. This report summarizes data from 5 site-years. Fertilizer sources were applied at 75 lb N/A in mid-March and mid-August in separate experiments at each location. Following the spring application, forage was harvested in late May, late July, and mid-October to measure season-long pasture production. Following the late-summer application, plots were harvested in early December to simulate growing "stockpiled" forage for winter grazing.

Only the initial harvest responded to spring-applied N. Between 60 and 80% of the annual dry matter was harvested at the initial sampling date in May and few treatment differences were measured in the two subsequent harvests. The spring N application increased yields by an average of 2,354 lb/A over the unfertilized control, with yields from AS and AN seldom being different. Yields from urea were lower than AS and AN in 2 out of 5 site years when weather conditions favored surface volatilization. For late-summer applied N, urea, AN, and AS resulted in comparable yields in 2 of 3 site-years. In the third site-year, forage fertilized with urea yielded 35% less than that fertilized with AN. Five days elapsed before any precipitation fell at the site and for 14 days, only 0.20 in. of rain fell. This is a classic example of the risk associated with using urea as the N source for late-summer applications to pasture. Fertilizing tall fescue with urea worked as well as AN about 75% of the time. However, the losses in forage yield the other 25% of the time would negate any savings in fertilizer costs from using urea. Ammonium sulfate was a consistently good product, with yields equal to or in a few cases, better than those from urea or AN. *MO-30F*

Effects of Foliar-Applied Potassium Fertilizer Sources on Chloride Uptake for Soybean Rust Resistance

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Research has established a link between the incidence of disease and the disease-suppressing effects of plant nutrients, specifically K, chloride (Cl^-), manganese (Mn), boron (B), and P. The objectives of this study were to: 1) determine soybean yield response, disease incidence, and K and Cl^- tissue concentrations from application of potassium chloride (KCl) alone or in combination with several fungicides, and 2) examine the effects of application timing of KCl or the fungicides on crop response and disease incidence. Studies were conducted at Novelty and Portageville, Missouri. Factors evaluated were preplant KCl applied according to soil test-based recommendations and foliar KCl at a rate of 27 lb/A applied with or without fungicides (pyraclostrobin or azoxystrobin) at V4 or R4 growth stages. Diseases evaluated included Frogeye leaf spot and Septoria brown spot, though incidence never exceeded 10%. Asian soybean rust was not present.

At the Novelty location, preplant KCl significantly reduced incidence of Frogeye and Septoria and increased grain yield by 5.1 bu/A. Foliar application had much less effect on disease suppression and only increased yield by 1.6 bu/A. At the Portageville location, preplant KCl increased yield by over 5 bu/A, but there was no yield response to fungicides or foliar KCl. Effects of treatments on disease incidence were variable and inconsistent at Portageville. Preplant KCl increased leaf tissue K by 0.1 and 0.9% at Portageville and Novelty, respectively. No interactions between fungicide treatment and KCl on leaf tissue K concentration were observed. Preplant KCl increased Cl^- concentration in the leaves of soybean when compared to the non-treated check at Portageville, but had no effect at Novelty. Foliar-applied KCl at the R4 growth stage increased leaf Cl^- concentrations by 2,770 to 3,740 ppm compared to the non-treated check and by 1,500 to 3,370 ppm compared to preplant KCl at both locations. *MO-32F*

Crop Sensors for Variable-Rate N Application to Cotton in the Mid-Southern U.S.A.

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Cotton lint yield can be very responsive to N fertilizer. However, misapplication of N can result in excess vegetative growth, which can delay maturity and increase the need for growth regulator, defoliant, and insecticide, and reduce N use efficiency. The objective of this study was to calibrate canopy reflectance sensors to predict the amount of N fertilizer needed by a cotton crop. Six N rate experiments were carried out over a 2-year period on widely varying soil types. Three sensor types (Greenseeker®, Crop Circle®, and Cropscan®) were used at three growth stages (early square, mid square, and first bloom) and three heights above the canopy (10, 20, and 40 in.).

The most profitable N rates for these six experiments were 0, 45, 60, 80, 175, and 200 lb N/A. Applying these rates would have increased profitability by US$43/A relative to a typical producer rate of 100 lb N/A on every field. All three sensors were able to give fairly good predictions of the most profitable N rate at mid square and first bloom, but not at early square. The visible/near-infrared ratio from a height of 20 in. predicted the best N rate with $r^2 > 0.5$ for all three sensors. Our results support the feasibility of applicator-mounted sensors to control variable-rate N applications to cotton. *MO-33*

Mississippi

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

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Improvements in yield potential and changes in cotton production practices such as elimination or minimization of tillage may alter availability of nutrients such as K, magnesium (Mg), and sulfur (S). The objectives of this study were to determine individual response functions of cotton leaf K, Mg, and S levels and lint yield to varying residual levels of K, Mg, and S...and to compare combined K, Mg, and S residual response to individual nutrient responses. The project was established in 2004 and treatments were applied 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 rates of 0-0-0, 36-9-18, 72-18-36, and 108-27-54 as potassium magnesium sulfate or K-Mag® ($K_2SO_4 \cdot 2MgSO_4$) with 50% of the K derived from KCl. No fertilizer treatments were applied in 2007, thus reported responses are due to residual effects of the historical fertilization. Total N applied to all treatments was 100 lb N/A.

Lint yield increased from 909 to 1,211 lb/A with an increase in historical fertilization of 0 to 108 lb K_2O/A. Response to residual Mg was inconsistent, but treatments with Mg yielded an average of 1,040 lb lint/A compared to 975 lb/A for the no Mg check. Response to residual availability of S was not evident. Yield response to historical rates of K-Mag® was similar to the response to KCl, suggesting the primary residual response was to K. Response to residual soil K availability highlights the need to include these benefits in economic analyses to obtain a more accurate overall response to fertilization. Leaf K and S responded to historical fertilization treatments with increases in tissue concentration, while Mg did not. Extractable soil K and Mg increased with increasing historical fertilization rates confirming residual soil build-up of these nutrients. *MS-13F*

Tennessee

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

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

Three inter-related studies were conducted in long-term fertility plots at Jackson, Tennessee: (1) variety response to K rates of 60 and 120 lb K_2O/A; (2) variety response to 80 and 160 lb N/A at different K levels; and (3) response to extremes of K fertility (0 to 180 lb K_2O/A). Two cultivars with contrasting growth habits, FM 960BR and DP 555BG/RR, were planted with no tillage in replicated 4-row plots. In experiment 1, dry matter partitioning was determined at early bloom and cutout. All plots were spindle-picked at 128 and 141 days after planting.

Despite supplemental irrigation, all three experiments were affected by prolonged heat and drought conditions that may have negated nutrient responses. In experiment 1, total lint yield for FM960 did not respond to K rate, but yield of DP555 decreased slightly in response to the higher K rate. The higher K rate delayed maturity of both cultivars. Both K fertility and cultivar had significant effects on dry matter partitioning, as the higher K rate decreased partitioning to reproductive parts, particularly in DP555. This result is consistent with 2006, when DP555 partitioned a lower proportion of dry weight to reproductive organs at the 120 lb K rate. In experiment 2, N rate did not significantly affect yield or earliness, but there were significant N-by-cultivar interactions for yield. Lint yield of DP555 increased with increasing N rate at the 30 lb K rate, while there was no yield response to N for FM960. In experiment 3, yields and earliness of DP555 were not significantly affected by K rate, although the zero K rate tended to decrease yield relative to the higher rates. In all experiments, micronaire tended to fall into the low discount range at the 160 lb N rate, especially with higher rates of K. *TN-19F* ■

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