IPNI INSIGHTS
INTERNATIONAL PLANT NUTRITION INSTITUTE

Northcentral Research Report

September 2008

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 Northcentral Region. This information and even more detail on each project can be found at the research database at our website: >**www.ipni.net/research**<.

Iowa

Variability in Soil Test Potassium and Crop Yield

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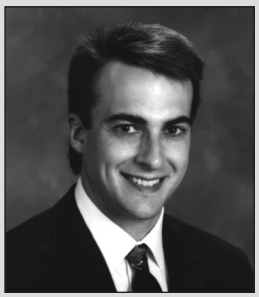
In 2007, this project evaluated the impact of rootworm resistance genetics on grain yield and nutrient uptake by corn. Nine conventional plot trials with corn were established at five Iowa

State University (ISU) research farms. The treatments included two corn hybrids (i.e., rootworm resistant and susceptible) and five K fertilizer treatments (0 to 180 lb K_2O/A). All sites had corn planted the two previous years, which showed evidence of rootworm infestation. Initial soil test K across sites ranged from values at the borderline between very low and low to optimum and high according to ISU soil test interpretations. No insecticide was applied. Plant samples taken for nutrient determination included ear leaves at silking, total above-ground plants near silking stage, and harvested grain. Rootworm damage evaluations were made as suggested by the ISU near silking stage.

Only grain yields and rootworm damage ratings are summarized at this time, and results should be considered preliminary because no detailed outlier or statistical analyses were conducted yet. Rootworm damage evaluations showed no damage for rootworm resistant corn at any site (0.1 or less in a 0 to 3 scale) while damage for susceptible corn ranged from 0.6 to 2.2 across sites. Across K rates, the rootworm resistant hybrid yielded significantly higher than the susceptible hybrid on three fields, which had medium to high rootworm infestation. The response to K fertilizer clearly differed between hybrids at one site, where the susceptible hybrid needed more K to achieve maximum yield. Similar but less defined trends were observed at two other sites. These results are in contrast with 2006 results, when at one site the rootworm resistant hybrid yielded higher, but also needed a higher K rate to achieve maximum yield. Plant analyses that are not completed at this time should provide information useful to better interpret these results. *IA-09F*



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Effect of Potassium Fertilization on Soybean Grain Yield and Disease Incidence

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This study was initiated in 2005 and has been assessing effects of long-term K fertilization on soybean grain yield and incidence of various leaf diseases at five Iowa locations. Asian Soybean Rust was not present in previous years or in 2007 at any site, although there was light to moderate incidence of Brown Leaf Spot and there were isolated effects on Cercospora Leaf Spot, Frogeye Leaf Spot, and Powdery Mildew. In 2007, as in the previous 2 years, there was a significant soybean grain yield response to K fertilization in low-testing soils and a small response in soils testing optimum (131 to 170 ppm K) according to Iowa State University recommendations. In 2005, there was an inconclusive K fertilization effect on soybean leaf disease incidence with a small effect only at one of five locations by slightly reducing incidence of Bacterial Blight and Brown

Spot. In 2006, however, there was a significant K effect at reducing diseases at two locations and smaller effects at two other locations, where mainly incidence of Brown Leaf Spot and sometimes Cercospora Leaf Spot, Frogeye Leaf Spot, and Powdery Mildew were reduced. Preliminary results for 2007 (no statistical analyses have been conducted yet) showed no significant K effects at any of the five locations, even though conditions in August were favorable to disease development. The study has been showing that adequate K fertilization does increase soybean yield in low-testing soils and often (but not always) results in reduced incidence of leaf/stem diseases. *IA-13F*

Evaluation of Corn Response to Sulfur Fertilization

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Project Cooperator: Brian Lang

Over 40 years of prior research in Iowa had rarely noted improved corn yields with sulfur (S) fertilization. Recently, S deficiency was documented through increased forage yields and plant S uptake from S fertilizers applied to northeast Iowa alfalfa fields. Deficiencies were especially strong in field areas with low organic matter, eroded, and side-slope landscape positions. Exploratory work in 2006 indicated significant corn yield increases to S application in specific field areas where early-season corn plant coloration indicated possible S deficiency. In 2007, small-plot trials were initiated to test S application rates at 20 producer field sites. Four S rates were replicated at each field site.

Corn yield increase to S application was significant at 17 of 20 sites, with an average yield increase of 18 bu/A when adequate S was applied. On coarse textured soils, the optimal S rate was 24 lb S/A and it was 14 lb S/A on finer textured soils. Leaf S concentration was low at all sites. These results indicate that S deficiency in corn is more widespread in northeast Iowa than was previously suspected and further research is needed to delineate the probability and geographic extent of S deficiency in Iowa corn and other cropping systems. In addition, tools need to be developed that can be used to detect S deficiencies and improve fertilization decisions. *IA-18*

Illinois

Effect of Nutrient Management and Fungicides on Soybeans in Southern Illinois

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Project Cooperator: C.D. Hart

Field study began in 2005 at two locations to determine the effects of K, chloride (Cl^-), boron (B), and manganese (Mn) nutrition on the response of soybean to disease (possibly including Asian soybean rust) with and without the application of fungicides. Soybean crop types included Roundup Ready® and conventional herbicide tolerant varieties. Pre-plant fertilizers included a comparison of potassium chloride (KCl) and potassium sulfate (K_2SO_4) at 75 lb K_2O/A plus a check with no K. Foliar treatments included an application of either 0.5 lb chelated Mn/A or Solubor® at 0.25 lb B/A, or both, in addition to KCl.

Foliar application of B and/or Mn caused some phytotoxicity problems in dry years and with multiple applications. The fungicide treatment reduced the incidence of frog-eye leaf spot for most of the site-years, and increased yields about 50% of the time. None of the fertilizer treatments studied significantly affected soybean grain yields in any year. The foliar application of B usually increased soybean leaf B and the application of Mn usually increased leaf Mn, but neither affected yields. The application of Cl^-, Mn, and B significantly reduced disease levels in only one case at Dixon Springs in 2007, but there was no effect on soybean yields. *IL-32F*

Minnesota

Turkey Manure Ash as a Phosphorus and Potassium Source for Field Crops and Its Effects on Soil Properties

Project Leader: Jeff Strock, University of Minnesota, Dept of Soil, Water and Climate, 23669 130th St, Lamberton, MN 56152. Telephone: 507-752-5064. E-mail: jstrock@soil.umn.edu

Field studies were conducted from 2005 to 2007. The objective of this study was to test turkey manure ash (TMA) effectiveness to supply plants with nutrients compared with that of commercial sources of fertilizer for corn, soybean, and alfalfa. In 2007, none of the plots received TMA or fertilizer due to an inadequate supply of TMA. Therefore, the 2007 year was interpreted as a drawdown year. For corn, soybean, and alfalfa yield, no significant differences were observed in 2007. For alfalfa, tissue nutrient concentrations, boron (B), and copper (Cu) concentrations were higher for the control. In addition, Cu concentrations were higher with TMA than with fertilizer. Phosphorus concentrations in alfalfa tissue were highest for the fertilizer treatments. The higher P concentration in the fertilizer treatments might have been due to the higher amount of P applied in the first year.

In addition to the field study conducted from 2005 to 2007, a greenhouse pot study was also conducted. This study was conducted using a low P (6 mg/kg) and high K (121 mg/kg) soil/sand mixture with a pH of 7.0 to evaluate corn growth response to soil amended with TMA. A control and five rates based on P and K contents in the TMA were compared with equivalent triple-superphosphate (TSP) and potassium chloride (KCl) fertilizer rates. Plant height and stalk thickness for the first 31 days were highest with fertilizer, while at harvest (52 days after planting) no significant differences were found. Due to faster initial plant development, corn dry biomass was greater with fertilizer treatments compared with TMA. Regardless of nutrient source, plant biomass increased as P rate increased. Potassium did

not limit plant growth. Plant tissue P concentration was higher with TMA than with fertilizer. Plant P and K uptake increased as the P application rate increased, but were not different between TMA and fertilizer. Tissue micronutrient concentrations including B, Cu, iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (Zn) were highest for the control. At equivalent rates of P application, soil P concentrations measured at harvest with the Bray P-1 extractant in TMA amended soil were higher than those in fertilizer amended soil. In contrast, soil P measured with the Olsen extractant in TMA amended soil was lower than that in fertilizer amended soil. The Olsen extractant provided a better estimate of plant available P in TMA amended soils than the Bray P-1 extractant.

A soil incubation study was conducted to learn how the availability of P in TMA behaves with time and also to determine if TMA had any liming potential. This study was also conducted using a low P soil (9 mg/kg) with pH 7.0. A control and two rates based on P content in the TMA were compared with equivalent TSP fertilizer rates. Soil samples were collected on a weekly basis from 0 to 64 days after treatment application. Soil pH was measured in a 1:1 soil water mixture, and soil P concentrations in the sampled soils were extracted using water, Bray P-1, Olsen P, and a resin extractable-P method. Concentration of water soluble P in TMA was found to be the same as in fertilizer. Bray P-1 and resin extractable-P over estimated plant available P. However the Bray P-1 and resin extractable-P tests indicated that calcium phosphate from TMA is solubilized slowly with time. The Olsen P was found to better estimate plant available P by comparison with fertilizer. Field studies should be conducted to learn if P release under field conditions is similar to that under laboratory conditions. *MN-25F*

South Dakota

A Decision Aid for Fertilizer Placement with Seed

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

"How much fertilizer can I place with the seed?" That is a common planting season question. A spreadsheet decision aid was developed to assist crop advisers in applying current knowledge and pertinent factors to answer this question. A survey of the literature was used to develop relationships between plant stands and fertilizer rates used with the seed. A laboratory study is being conducted to fill in literature gaps, especially with minor crops and fertilizers. *SD-15F* ■

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INSIGHTS

Northcentral Region
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Northern Great Plains Research Report

September 2008

The yield of crops in most areas of the Northern Great Plains (NGP) region is often determined by the weather, specifically whether sufficient precipitation and heat units are received. However, making sure there are sufficient levels of plant nutrients present is critical, because adequate moisture and temperatures cannot be utilized effectively if there is a nutrient deficiency. The research project summaries presented in this issue of *INSIGHTS* show that plant nutrient research is being done to help NGP farmers have the information needed to grow high yielding and good quality food crops.

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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Alberta

Assessment of Soil Quality on Tillage-Straw-Nitrogen (TSN) Plots at Ellerslie and Breton Utilizing Physical, Chemical, and Biological Properties

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The Tillage-Straw-Nitrogen (TSN) plots were originally set up at the Ellerslie and Breton research sites in 1979. These plots have been in consistent management under different experimental treatments for 28 years. The tillage treatments include tillage and no-tillage; the straw treatments include no straw (i.e., straw was removed and not returned to the plots) and straw (i.e., straw returned to the plots); N fertilizer was applied at rates of 0, 50, or 100 kg/ha. Much information has been gathered over the length of the research project about aboveground productivity and changes in some soil characteristics. This research initiative is designed to gather detailed chemical, physical, and biological information to assess the effect of long-term management practices on soil quality characteristics. Soil samples from experimental treatments were collected in the early fall of 2007 from both research sites and laboratory analyses are on-going. *AB-25*

Manitoba

Impact of Cropping Sequence and Phosphorus Fertilization on Cadmium and Zinc Accumulation in Soybean and Durum Wheat

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Project Cooperators: Mario Tenuta, Don Flaten, and Eugene Gowalko

Crop sequence and tillage system can influence nutrient availability and response of crops to fertilizer applications, through effects on nutrient cycling, microbial population, soil temperature, and root growth. Therefore, optimum P fertilizer management may change with management practices as well as with crop type sequence. This study is evaluating the effects of cropping sequence and tillage practices on yield and quality response of durum wheat and soybean to different forms and placements of P fertilizer.

Phosphorus fertilization has previously increased the biomass yield in durum wheat, but not in soybean. When averaged over the 3 years of the study, wheat on both the clay-loam and silty-clay soils produced the highest grain yield when grown after canola and the lowest yield when grown after barley. On the clay-loam soil, P fertilizer produced a significant increase in yield. Durum wheat yield tended to be higher when ammonium polyphosphate was side-banded rather than surface dribble-banded, but was similar with monoammonium phosphate (MAP), ammonium polyphosphate, MAP treated with Avail®, and polymer coated MAP when the fertilizers were side banded. Cadmium (Cd) content of the durum wheat seed was strongly affected by

preceding crop, being highest when grown after canola and lowest when grown after barley. Mycorrhizal colonization in durum wheat was not affected by P fertilization, but is highest when durum wheat has grown under reduced tillage following flax, and lowest when grown under conventional tillage following canola. It is possible that the increased mycorrhizal colonization due to the combination of reduced tillage after flax may encourage nutrient uptake and improve crop performance. There has also been an interaction between tillage system and preceding crop on biomass and grain yield. Generally, both soybean and durum wheat produced higher yields after flax than after canola under reduced tillage, but produced lower yields after flax than canola or barley under conventional tillage. Analysis of crop and soil samples is on-going from the 2007 crop year and will help clarify some of the factors causing the tillage system x previous crop sequence interaction. *MB-20F*

Saskatchewan

Effect of Potassium and Chloride Nutrition on the Seed Yield of Canaryseed

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Project Cooperators: Yantai Gan and Sukhdev Malhi

In 2007, this trial was conducted at five locations in Saskatchewan, near Melfort, Stewart Valley, Regina, and two locations south of Indian Head. Yields were low due to temperature and moisture stress during seed development in July and August.

At both of the sites near Indian Head, a strong yield response occurred when chloride (Cl^-) was applied and a moderate yield response to Cl^- occurred at the Regina site. The yield components most affected were seeds per square meter and seeds per head. Grain yield was not affected by Cl^- or K applications at Melfort or Stewart Valley. These preliminary results indicate that Canaryseed growers should assess soil Cl^- status through soil testing. The response to Cl^- occurred when the canaryseed was under moisture stress, and it will be interesting to see if this response occurs under higher yielding conditions. This research will be conducted for two more growing seasons. *SK-38*

North Dakota

Suppression of Disease with Agronomic Practices in Recently Released Spring Wheat and Winter Wheat Cultivars

Project Leader: Dr. David Franzen, North Dakota State University, Dept of Soil Sciences, 229 Walster Hall, Box 5758, Fargo, ND 58105-5758. Telephone: 701-231-8884. Fax: 701-231-6186. E-mail: david.franzen@ndsu.edu

Project Cooperators: Jeffrey Stein and Howard Woodard

This study was designed to examine whether a synergy exists between chloride (Cl^-) nutrition and fungicide application in winter and spring wheat. The study was conducted at two sites in North Dakota in 2007.

Heading applications of Cl^- were not effective in reducing scab in winter wheat. Soil application of Cl^- as calcium chloride ($CaCl_2$) reduced leaf diseases at one site. $CaCl_2$ seemed to increase yield at the spring wheat site. These studies will be repeated in 2008 to further investigate if $CaCl_2$ consistently demonstrates these effects. Future work will examine both Cl^- and copper (Cu) and the interaction with foliar and heading-applied fungicide on winter and spring wheat. *ND-13*

Agronomic Evaluation of New Sulfur Sources for Canola

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

Fertilizer sulfur (S) plays a major role in the production of canola. The balance between N and S is critical to flowering and seed formation in this crop. Research trials were carried out to evaluate a number of S sources on canola production at two different locations deficient in S near Langdon, North Dakota. Two fertilizer S products, which incorporate N, P, and S into a compound fertilizer granule, were compared to treatments that had only P as monoammonium phosphate (MAP), only S as ammonium sulfate (AS), and both P and S in a physical blend of MAP and AS.

There was a significant response to S at the site south of Langdon, but not at the site north of Langdon. At the S responsive site, the response to S fertilizer products that are compound fertilizers containing N, P, and S was similar to the response to a physical blend of MAP and AS. This research will continue in 2008. *ND-14* ■

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Southeast Research Report

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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'

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

The objectives of this research, initiated in 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

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

Project Cooperator: David Moorhead

Two fertilizer trials and an untreated control were established in 2004 near Bullard, Georgia, within a loblolly pine tree stand planted in 1978 and thinned in 2002-03. The objectives of the study were to: (1) quantify the magnitude and duration of wood volume response to various fertilizer combinations, (2) determine changes in product class distribution, (3) determine the cash flow and rate of return for each fertilizer combination compared to unfertilized control plots, and (4) discern when fertilizers are to be re-applied to maintain wood volume gain. Fertilizer treatments 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.

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

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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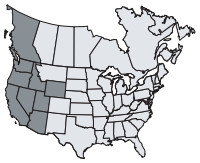
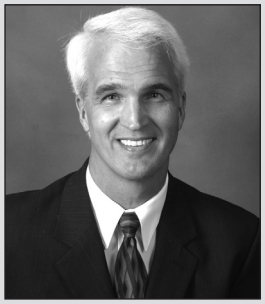


September 2008

Western Region Research Update

OUR TRANSITION from the well-known Potash & Phosphate Institute to the International Plant Nutrition Institute has gone extremely well and has provided new opportunities for education and research. With the increases in fertilizer prices and the keen interest in environmental impacts, our research efforts are more important than ever as we continue to identify opportunities for improved nutrient management.

This issue of *INSIGHTS* features the brief Interpretive Summaries related to research projects supported by IPNI in the Western North America 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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British Columbia

Slow-Release Nitrogen and Phosphorus as an Alternate Delivery Method for Diverse Soil Types in British Columbia Cranberry Production: Decreasing Nutrient Losses to Riparian Systems

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Project Cooperators: Mike Wallis and Murray Isman

While recent overall cranberry production in North America has been impressive, production efficiency varies substantially within and among regions. For example, the average yields in the main cranberry producing areas in 2003 were 10 t/A for Wisconsin, 8.5 t/A for both British Columbia and Oregon, 7.5 t/A for New Jersey, 6 t/A for Washington, and 5 t/A for Massachusetts. Some well-managed farms in each of these main cranberry growing regions have fields that have consistently reached 15 to 17 t/A and occasionally 20 to 25 t/A. With the potential for such high yields, the barriers to these high yields need investigation. With the exception of N, the response of cranberry to the addition of various essential elements is not easily observable in the short-term. The addition of N quickly promotes shoot elongation and leaf development. Other nutrients will influence growth in a more subtle fashion (e.g. improved photosynthesis) and the benefits to yield may require several years of enhanced root surface area and rooting depth and a gradual canopy adjustment with more flowering buds and shoots and less vegetative growth, or runnering.

Plants were grown the first year with equal applications of nutrients. Last year, plants were given either one complete application of temperature responsive controlled-release diammonium phosphate and urea-N (DAP and UN), or a one-third rate of soluble, granular DAP and UN with two additional one-third applications in June and July. One set of the elemental N:P rates applied was at a level recommended currently for new plantings (25 lb N/A and 25 lb P/A) while the second rate had an enhanced rate of P (25 lb N/A and 50 lb P/A) to promote rooting and to take into account the low availability of P in the acidic soils used for cranberry. The influence of soil type on cranberry root and plant growth, nutrient uptake and mineral nutrition, and the plant's balance between vegetative vigor and flower bud set were considered.

The findings of this experiment demonstrate how various commercial cranberry soils differ in their capacity to hold nutrients for efficient capture by the cranberry root system. As the soils of commercial cranberry farms are variable, fertilizer strategies must be devised that will allow efficient nutrient absorption and prevent the loss of nutrients through leaching into nearby aquatic ecosystems. Our past findings demonstrated that temperature responsive controlled-release DAP plus urea were more effective at preventing such losses in comparison to the standard soluble granular nutrients – even when the latter were applied more frequently and at small doses. The use of controlled release DAP plus urea allowed for enhanced floral bud set (114% increase) and vegetative growth (23% increase) in various soils for young cranberry plants grown in a pot model system. Our early indications comparing the use of a 1:1 and 1:2 N:P ratio indicated a possible minor benefit to

vegetative growth with a 1:2 ratio. However, further investigation is required to confirm this.

Four large farms (in close proximity to rivers) agreed to allow sampling of their reservoirs and to cooperate in this study. All farms had drainage systems in place. Two major reservoirs on each farm were also sampled in July and October (just before/at release of the harvest flood waters). It appears that movement of nitrate from the cranberry farms to their associated rivers is not a major concern. In the case of these and other nearby cranberry and blueberry farms, ammonium-N and urea-N are the primary forms of N fertilizer and may be contributing to the river ammonium concentrations via the ditch system. In the case of the cranberry farms that use extra river water for flooding the wet harvest operations, any soluble N should be managed carefully to avoid release to the nearby rivers. In the case of phosphate-P, the ditch system and the rivers sampled indicate a fairly low concentration of P.

The findings of this study indicated that with the current farming strategy, fertilizer N and P used by cranberry farms may potentially move via the ditch systems and contribute to the nutrient levels of the Fraser and Pitt Rivers associated with these farms. The actual impact on riparian systems was not investigated in this study specifically. Experiments with various fertilizers have shown that with controlled-release fertilizers, nutrient leaching was greatly slowed, while overall plant growth and development was improved. The benefits of these slow release fertilizers appeared more significant with soil types that were conducive to good root and plant growth. *BC-16F*

California

Evaluation of Improved Methods for Tissue Testing of Alfalfa

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Project Cooperator: Dan Putnam

Rising costs of fertilizer and the high value of hay make fertility management an especially critical issue for alfalfa producers. Many growers fertilize based on past practice with little idea of the actual nutrient status of the field, virtually guaranteeing improper application. The long-standing University of California (UC) recommendation has been to sample the standing crop at the 10% bloom stage, and fractionate the sample into three parts (tops, mid-stem, and mid-stem leaves). Because the grower must sample prior to harvest, and the special processing required, most growers currently do not tissue test alfalfa. In contrast, many growers routinely take cored samples of haystacks for forage quality analysis of Acid Detergent Fiber (ADF), Neutral Detergent Fiber (NDF), Crude Protein, and Dry Matter. Research was needed to determine whether these cored bale samples could be used to assess nutrient needs as well.

Trials were established in 2006 and 2007 to determine the effect of alfalfa fertilization rate on alfalfa yield and tissue P levels. Six different fertilizer rates were applied in 2006 in a trial in Butte Valley, California, including a zero fertilizer check, 30, 60, 90, 120, and 150 lb P_2O_5/A. Eight rates were used in 2007 to apply the same rates as in 2006, plus 180 and 210 lb P_2O_5/A at a site with higher yield potential in Scott Valley, California. The fields were sampled three to four times at various growth stages for the first and second cuttings. Whole tops and mid-stem samples were collected and analyzed. The intent was to monitor changes in P content with advancing alfalfa maturity. This allows us to assess the need for specific critical nutrient levels for different alfalfa maturities. Acid detergent fiber and NDF were analyzed to determine if these could be used to quantify alfalfa maturity and to adjust critical nutrient values. Yield was determined to help establish critical P concentrations at various growth stages for both whole plant and fractionated plant samples. Thirty-nine commercial alfalfa fields were sampled during the 2006 and 2007 growing seasons. Standing plant samples were collected from three locations in each field for in-field replication. One standing plant sample was used as a "whole plant" sample and another sample was fractionated according to the current UC recommendations for tissue analysis. Soil samples were collected from the same area that the standing plant samples were collected. After the fields were cut and baled, the bales were cored and sampled according to the protocol for forage quality analysis. If this alternative method for tissue sampling works well, the assumption is that growers will analyze other nutrients in addition to P. Therefore, the cored and standing crop samples from growers' fields were also analyzed for sulfur (S) and K.

Yield data has been collected over the 2 years and shows a significant yield increase with P fertilization. Tissue samples were collected and analyzed for available P, total P, available S, total S, K, ADF, and NDF. Soil samples were analyzed for pH and Olsen P. Data analysis has not yet been completed, but initial results look very promising and it appears at this point that bale samples could be used in lieu of the far more laborious mid-stem samples. Mid-stem P and cored-bale P were closely correlated. The results from grower fields showed considerable variation in the levels of all nutrients analyzed (P, K, and S). Averaged across all fields, the nutrient levels were adequate, however, individual fields varied from very deficient to high. This indicates that fertilizer practices for many growers could be improved significantly. The P rates applied in the fertilizer studies created very distinct plant tissue levels. The plant tissue levels for all fertilizer rates declined with advancing maturity, suggesting that the critical values used for plant tissue testing should be adjusted for plant maturity. *CA-26F*

Oregon

Fertigation of Fluid Nitrogen and Phosphate Fertilizers for Pears in the Pacific Northwest

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Project Cooperators: Clark Seavert and Jinhe Bai

The mid-Columbia region in Oregon produces 40% of the "winter" pears and 20% of the Bartlett "summer" pears in the U.S.A. Presently, N fertilizer is mostly broadcast-applied on the soil surface once (in March or April) per year at a rate of 80 to 100 lb N/A as a dry material followed by an intensive irrigation season. Nitrogen use efficiency is relatively low with this N management system because the tree root system cannot take up all the applied N fertilizer at such a high rate in a short time. Similarly, P fertilizer is currently broadcast-applied to the soil surface once per year (in March or April) at a rate of 100 to 125 lb P_2O_5/A as a dry material. Phosphorus use efficiency is relatively low with this P management system because P is highly immobile in the soil, and surface-applied P fertilizer does not positionally match up well with pear root system. Little research has been done to address the effects of split N and P fertigation on the growth, yield, quality, and storability of pears or other orchard trees in the Pacific Northwest. The objectives of this study were to: 1) evaluate the effects of fertigation of N and P fertilizers under drip irrigation and fertigation of N and P fertilizers under micro sprinkler as two integrated production systems on pear fruit yield, quality, and storability compared with the current pear production system, and 2) compare the costs of installing and maintaining fertigation plus drip irrigation system or fertigation plus micro sprinkler system with the costs of the current production system.

A field experiment initiated in 2005 was continued in 2007 on a mature green d'Anjou pear orchard near Parkdale, Oregon, with five treatments: 1) Broadcast application of N and P fertilizers to the soil surface under drip irrigation, 2) Band application of N and P (12 in. deep) under drip irrigation, 3) Broadcast application of N and P to the soil surface under drip irrigation along with soil disturbance caused by banding (no fertilizer was banded), 4) Fertigation of N and P under drip irrigation, and 5) Fertigation of N and P under micro sprinkler irrigation.

In the 2007 season, fertigation of N and P fertilizers under drip irrigation resulted in similar leaf N concentration as surface broadcasting of N and P fertilizers. The two N and P fertigation treatments had equal or significantly higher leaf P concentration than surface broadcasting. The results indicate that split fertigation could supply adequate mineral nutrition to fruit trees, even at a reduced application rate, relative to broadcast application. Our results show a tendency for P fertigation to have significantly increased leaf P concentration relative to broadcast application. Enhanced mobility of P in soil under fertigation may be responsible for improved tree P nutrition. The differences in fruit yield were statistically insignificant among the five treatments in 2007. Numerically, pear yield with broadcasting application of N and P fertilizers to the soil surface was 208 kg/tree. Fruit sugar, firmness, or titratable acidity was not statistically different among the five treatments. Fruit size or color did not differ among the five treatments. On average, the two fertigation treatments reduced both N and P fertilizer use by 20% compared with broadcast application of N and P fertilizer to the soil surface.

Visual evaluation of fruit surface scald was conducted after the fruits had been stored in a cold storage room for three months in 2007. The two split N and P fertigation treatments reduced the total of slightly scalded, moderately scalded, and severely scalded fruits by 9 to 14% (absolute value) compared with surface broadcasting. The increase in marketable fruit, which resulted from the reduction in slight, moderate, and severe scald incidence, could significantly enhance grower profitability. Our results show that reduction in fruit superficial scald during cold storage is another notable benefit with split fertigation. OR-15F

Washington

Spatial Variability in Soil Phosphorus

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Wheat growers in eastern Washington are in a below-maintenance P fertility program. In low (<12 in. annual) precipitation, winter wheat-fallow environments, few use P fertilizer due to low yield potential and need to minimize input costs. In high (>18-in. annual) precipitation annual cropping environments, most growers use P fertilizer, but at rates far below removal. At standard removal rates of approximately 0.5 lb P_2O_5/bu, more P is being removed than is added in most fertilizer programs. At the same time, many growers report stable or increasing soil test P concentrations. The majority of growers in eastern Washington place P in a band beneath the surface with N, or directly with the seed. Clearly, this placement method is leading to high P use efficiency. However, the sustainability of this P management program is questionable. This work is examining the apparent contradiction between below-maintenance P applications and the apparent increase in soil test P concentrations. Based on the results of earlier research, we conducted experiments to evaluate dryland winter wheat responses to fluid and dry P fertilizer in low and high rainfall zones of eastern Washington State. The intent was to compare wheat responses to dry and fluid P in common crop-tillage fallow and annual cropping systems.

Studies were conducted at two locations in the low rainfall zone of eastern Washington and in the high rainfall zone. Each study included four rates of fluid ammonium polyphosphate P (0, 10, 20, and 40 lb P_2O_5/A) placed in a deep band with N (32-0-0) and one rate of dry monoammonium phosphate (MAP, 20 lb P_2O_5/A). Phosphorus was

placed 2 weeks before seeding at the crop-fallow sites and at seeding with a one-pass, no-till drill at the annual cropping locations.

Positive grain yield responses to fluid P at summer fallow locations were obtained when soil test levels were near or above historical critical values. This suggests current soil test-based fertilizer recommendations may be outdated and critical levels do not accurately predict a response to P in these situations. Grain yield responses to dry P were lower than to fluid P at 3 of the 4 site-years. This is similar to results from Australian research, showing better responses to fluid P than to dry P. Interestingly, responses to fluid P rate were quadratic in 3 of the 4 site-years. At the highest rate of P, both anthesis whole-plant dry matter and final grain yields were reduced slightly over the intermediate rate. Moisture is a main limiting factor in the summer fallow cropping systems at these locations. Higher rates of P apparently stimulated excessive vegetative growth that depleted stored soil moisture and reduced late-season vegetative and grain yields. Responses to P were not obtained at annual cropping sites even though yields were high and soil test P levels were as low as in the summer fallow locations. We are unable to explain why there was no response to P at the annual cropped sites.

Early results of this study indicate a good potential for dryland wheat to respond to fluid P in the low rainfall, crop-fallow areas of eastern Washington. Intermediate rates of fluid P should be applied to optimize yields and prevent grain yield reductions in this moisture limited environment. While responses to applied P were not obtained in the high rainfall zone, given the high yields in these areas, regular P applications are still necessary. *WA-13F* ■

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