ABSTRACTS
RESEARCH
CONFERENCE
VOLUME 13

Arkansas Crop Protection Association

November 30 – December 1, 2009
Clarion Inn
Fayetteville, Arkansas

Monday, November 30, 2009
10:00 a.m. Business Meeting
12:00 noon Registration

MODERATOR:

* - Denotes M.S. Student ** - Denotes Ph.D. Student

Tuesday, December 1, 2009

MODERATOR:

11:15 a.m. **Alternative Methods of Rice Irrigation Using RiceTec Hybrid Rice.** Greg Simpson, RiceTec Development rep, Van McNeely, Brian Ottis Ph.D, Kurt Johns, D.J. Shipman, Mason Wallace, William Hutchens 22

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12:00 Noon **Palmer Amaranth Control with Dicamba and Glufosinate as Influenced by Weed Size and Herbicide Rate**. R.C. Doherty, K.L. Smith, J.A. Bullington and J.R. Meier; University of Arkansas, Division of Agriculture, Monticello, AR...24

12:15 p.m. **Authority MTZ® (sulfentrazone + metribuzin) Efficacy in Soybean Weed Control Programs.** Jeremy A. Bullington, Kenneth L. Smith, Ryan C. Doherty, and Jason R. Meier; University of Arkansas Division of Agriculture; Monticello, AR...25

12:30 p.m. Presentation of Awards – M. T. Barapour

01:00 p.m. **Adjourn**

Novaluron Exposure to Different Sexes Reduces Egg Viability, Effects of Topical Application and Horizontal Transfer to Eggs in Codling Moth (Lepidoptera: Tortricidae).

Soo-Hoon S. Kim*, John C. Wise[2], Ayhan Gökçe[2], and Mark E. Whalon[2,] Department of Entomology, University of Arkansas, Fayetteville, AR; (2) - Department of Entomology, Michigan State University, East Lansing, MI

The codling moth, Cydia pomonella (Linnaeus), is a primary pest of apple production throughout the United States. The effects of novaluron, a chitin synthesis inhibitor, was studied to determine if reduced egg viability was seen after exposure of this compound to different sexes. Effects of this compound through horizontal transfer were also compared with a topical application to codling moth eggs. Results from independent exposure of different sexes to novaluron were different than the control when all three exposure types, male only, female only, and both treated were combined ($p < 0.05$). The horizontal transfer experiment yielded no significant difference ($p = 0.7451$) while the topical application of novaluron onto eggs showed significance ($p = 0.011$). Although novaluron has no direct toxicity to adults, the results of this study demonstrate the sublethal activity of this compound reduces viability of the subsequent generation's eggs. Along with the standard ovicidal and larvicidal properties of novaluorn, the sublethal activity should also be considered when using the product in the field.

Using Days Suitable for Fieldwork Information in the Farm-Management Decision-Making Process.

Clay T. Lee* and Terry W. Griffin, Department of Agricultural Economics and Agribusiness, University of Arkansas, Fayetteville, AR.

Anyone who has planted, replanted, or attempted to harvest crops in Arkansas this year knows—the weather can be heaven sent or downright uncooperative. Weather risk is of particular concern to agricultural producers because weather conditions define the parameters of whole-farm planning, i.e. production constraints formed by climatic boundary conditions. Weather conditions dictate when to plant, what to plant, and machinery complement to perform the necessary field operations.

Several sources of risk influence production decisions and impact yields and profits in agricultural production. Weather risk is of concern to farm decision makers for timing of applications, machinery management decisions, and whole-farm planning. The expected number of days suitable for fieldwork during critical production times such as planting and harvest must be determined before many farm management decisions can be made. Conventional wisdom suggests that it is impossible to predict the seasonal weather conditions that determine how many days are suitable for field work in a given year. However, it is possible to use readily available USDA data from the National Agricultural Statistics Service to determine the probability of having a certain number of days suitable during a given segment of the growing season. This data has been analyzed and is presented to clearly illustrate the weekly expected number of days suitable for *good*, *average,* and *bad* years. Perhaps more importantly, this data is used to ascertain the probability and character of growing seasons that are anomalous. For instance, *good*

and *bad* years can be assigned a percentile, such as the 15th and 85th worst years out of 100, while the *average* year would be the median or 50th percentile. This knowledge provides producers with information necessary to plan for the dreaded *bad* year. Even with sufficient understanding of the yield potential by planting date, making farm management decisions such as machinery management and acreage allocation without information on the probabilities of suitable days for fieldwork may lead to unsuccessful farming operations.

N-STAR: Improving the Long-Term Sustainability of Arkansas Rice through Site-Specific Nitrogen Fertilizer Management.

Trenton L. Roberts**, Richard J. Norman, William J. Ross, Nathan A. Slaton, Charles E. Wilson, Jr., and Anthony M. Fulford, , Crop, Soil and Environmental Sciences Department, University of Arkansas.

Nitrogen (N) response trials were conducted in Arkansas to evaluate the Illinois Soil Nitrogen Test (ISNT) and Direct Steam Distillation (DSD) in measuring soil N availability and as a tool for N fertilizer recommendations. Field studies were conducted on many silt loam soils at experiment stations and producer fields across the state. Six N fertilizer rates ranging from 0 to 202 kg N/ha were applied in split applications in a randomized complete block design with four replications. Total N uptake and grain yield were used for correlation and calibration of each soil test. Percent relative grain yield and N fertilizer rate to achieve 95% relative grain yield was regressed against the mean ISNT and DSD values for the 0 kg N/ha rate plots at each location. Currently, 25 site-years have been used to develop soil-based N tests for rice with significant relationships between the two soil tests and percent relative grain yield and N rate to give 95% relative grain yield. Results show a strong correlation between percent relative grain yield and ISNT and DSD at the 0-45 cm depth. The coefficients of determination increased for percent relative grain yield and N rate to give 95% relative grain yield as depth increased until 45 cm, but then dropped significantly at the 0-60 cm depth. Coefficients of determination >0.80 for both methods at the 0-45 cm depth indicates the incorporation of either test for use in N fertilizer recommendations could improve N management for rice producers while lowering costs and environmental impacts. Recently, N-Soil Test for Rice (N-STAR) calibration curves have been developed which include N fertilizer recommendations to achieve 90, 95 and 100% relative grain yield. Field validation trials are currently in place to evaluate the predictive capabilities of the N-STAR calibration curves when compared to the traditional University of Arkansas Cooperative Extension Service recommendations. Soil samples were taken immediately after emergence and analyzed by DSD. Fertilizer rates were determined using the N-STAR calibration curves and standard rates for silt loam soils and rough rice yields were compared. Initial results are promising and suggest that N-STAR can be used for site-specific management and can accurately predict N fertilizer needs for rice grown on silt loam soils in Arkansas.

Biofuel Crops and Pest Management.

Tara N. Wood*, R.N. Wiedenmann, and T. Kring, Dept. of Entomology, University of Arkansas, Fayetteville, AR.

Among the many issues to consider in developing biofuels for Arkansas are factors that may affect management of pests—insects, nematodes and insect vectored pathogens—of both biofuel and other agronomic crops. Although the impacts of pest management issues related to biofuel crops may be difficult to predict, we can develop a framework to address questions and deliver results to growers and others interested in biofuels.

Key pest management issues include pests of biofuel crops, scale of production, monocultures vs. diverse plantings and landscape-level ecology.

Comparison of Runoff Qualities and Soil Qualities of Cover Cropping, Conservative Tillage, and Conventional Tillage Practices in Cotton Farming.

Daniel R. Sappington*, Teresa R. Brueggen, Tina G. Teague, and Jennifer L. Bouldin, Ecotoxicology Research Facility, Arkansas State University, State University AR.

Better Management Practices (BMP) have been tested and implemented all across the agricultural sector. Research has shown that BMP such as conservative tillage (NT) and cover cropping (CC) can reduce nutrient and pesticide runoff. This study compares chemical, physical, and toxicity parameters of runoff samples from NT, CC, and conventional tillage (T) treatments in cotton. Ten liter grab samples were collected from row-transecting channels following rain and irrigation events. Ongoing soil runoff data analysis show significant correlation between treatment types and total suspended solids (TSS) amounts ($p < 0.05$). In five rain events CC and NT show TSS runoff abatement when compared to T (Averages: 203.7, 364.4, and 734.2 mg/L respectively). In two irrigation events CC and NT show similar abatement in respect to T (Averages: 64.8, 118.6, and 176.1 respectively). Toxicological analysis of *Ceriodaphnia dubia*, *Pimephales promelas*, and *Chironomus dilutus* data are ongoing. Agricultural soil and water runoff often carry nutrients and pesticides into adjacent waterways. Implementing CC or NT BMP could reduce TSS runoff wherein reducing the runoff of these chemicals.

Non-Glyphosate Programs for Palmer Amaranth Control in Cotton.

S.K. Bangarwa**, J.K. Norsworthy, G.M. Griffith, J. DeVore, J. Still, G. T. Jones, and M. J. Wilson. Department of Crop, Soil, and Environmental Sciences, University of Arkansas, Fayetteville, AR.

Glyphosate has been the foundation of broad-spectrum weed control in glyphosate-resistant cotton production in Arkansas. However, the continuous use of glyphosate and lack of crop rotation resulted in a serious problem of glyphosate-resistant weeds in cotton. Palmer amaranth (*Amaranthus palmeri*) is a major problematic glyphosate-resistant weed in cotton because of its competitive growth habit and prolific seed production. Thus, an effective non-glyphosate weed management program is needed. A field experiment was conducted in 2009 to evaluate the cotton response and weed control efficacy of different non-glyphosate herbicide programs in cotton. The experiment was organized in a randomized complete block design with a 3-factor factorial treatment arrangement replicated four times. The treatment factors included: 1) three preplant (PP)/preemergence (PRE) herbicides - Reflex PP, Cotoran PRE, and Prowl PRE; 2) two postemergence (POST) herbicides – Dual Magnum at 1-leaf and 4-leaf cotton; 3) two post-directed (PD) herbicides (Suprend and none). Additionally, a non-treated control was included for comparison. Data were collected on cotton injury, Palmer amaranth control, and seed cotton yield. Cotton injury was minimal (≤2%) in all herbicide programs. Herbicide programs including Reflex PP controlled Palmer amaranth ≥75% throughout the season. However, herbicide programs including Cotoran PRE and Prowl PRE provided no more than 68 and 39% control of Palmer amaranth, respectively. Weed control was similar from Dual Magnum POST applied either at 1-leaf or 4-leaf cotton, regardless of PP/PRE treatment. However, the addition of Suprend PD improved Palmer amaranth control in herbicide programs containing Reflex PP. Seed-cotton yield data are yet to be analyzed and will be presented. This research shows the importance of effective early-season herbicide programs for season-long Palmer amaranth control. Using Reflex PP, effective Palmer amaranth control can be maintained throughout season with POST followed by PD herbicides. In contrast, use of a short-residual herbicide (Cotoran or Prowl) before or at planting will not provide season-long Palmer amaranth control even with the sequential application of POST and PD herbicides.

Update of the Redbanded Stink Bug (*Piezodorus guildinii* Westwood) in Arkansas Soybean.

Howard, J.E., D.S. Akin, G.M. Lorenz III, and C.D. Capps, Extension IMP Coordinator-Entomology; C.D. Capps, Graduate student-Entomology

Due to a recent increase in the value of soybeans, an increasing number of Arkansas producers are willing to protect their crop from insect pests. The redbanded stink bug (*Piezodorus guildinii*) is a relatively new pest to Arkansas soybean that has been found in southern areas of the state over the last few years. Reports from Louisiana suggest that this pest may be more difficult to control than our more traditional stink bugs. Previous reports also indicate that the redbanded stink bug may cause more damage than the more common stink bugs found in Arkansas, such as the southern green stink bug (*Nezara viridula*). The objectives of this preliminary research was to investigate the damage potential caused by the redbanded stink bug to soybeans, and determine if control of this pest is indeed more difficult to attain than other stink bug species found in Arkansas.

A cage study was conducted to investigate the damage potential of the redbanded stink bug compared to the southern green stink bug at the Rohwer Research station in Rohwer, AR. Treatments included no stink bug, redbanded, and southern green stink bug species. Two 3^{rd}-4^{th} instar nymphs of each species were placed in each of 10 single-plant cages for each treatment at early R5 and remained caged for 10 days. Plots were managed aggressively for insect pests prior to infestation and following completion of the study. Upon reaching physiological maturity, all seed were harvested from each plant by hand, then weighed and rated for visible injury. Data were analyzed using Fisher's Projected LSD (SAS Institute 2008). Both redbanded and southern green stink bug significantly reduced mean seed weight and visible injury compared to the untreated check. Furthermore, seeds exposed to the redbanded stink bug sustained significantly more injury than those exposed to the southern green stink bug.

Assays were conducted in the laboratory to compare susceptibility of redbanded and southern green stink bug to labeled insecticides. Treatments included acephate, methyl parathion, beta-cyfluthrin, and lambda-cyhalothrin + thiamethoxam (premix). Adults and 4^{th}-5^{th} instar nymphs were treated with one µL of solution applied directly to the ventral surface of the abdomen via Hamilton® micro-pipette and subsequently placed in a diet cup with green beans (Harris and Todd 1981). Mortality was assessed at 24, 48, and 72 hours after treatment, and were analyzed using LSmeans (SAS Institute 2008). Across most treatments, southern green stink bug sustained significantly higher mortality than the redbanded stink bug. There was no significant difference between the two species within the lambda-cyhalothrin + thiomethoxam treatment, perhaps due to higher mortality than other treatments (>90% for both species).

Field experiments were conducted with field populations of redbanded stink bug to determine effectiveness of foliar insecticides (Portland, AR). Insecticide treatments with a single active ingredient included acephate, methyl parathion, and bifenthrin. Various treatments containing multiple active ingredients were also evaluated. Sweep-net samples were collected 4 days after treatment and again at 7 days after treatment. Data were analyzed using Student-Newman Kewls (ARM 8.2 2008). Most treatments were effective at 4 days after treatment when compared to the untreated check. However, populations showed the tendency to rebound several days later. This corroborates observations reported in other mid-south states.

These data suggest that the redbanded stink bug may indeed be more damaging than our more common "green" stink bugs. More research is needed to verify this as well as how increased damage may translate to yield. Preliminary laboratory and field efficacy data indicate that while this pest may be more difficult to control than other stink bugs in Arkansas, acceptable initial control may not be unattainable. However, scouting intervals may need to be reduced (e.g., 7 days to 5 days) during the reproductive stages of soybean in order to monitor the reinfestation capabilities of this pest. More research to investigate control and damage is needed and will be conducted in 2010.

Characterizing Leaf N with Digital Images in Corn and the Association of "Greeness" with Yield.

Robert L. Rorie, Larry C. Purcell, Crop, Soil, and Environmental Science Department, Douglas E. Karcher, Horticulture Department Charles A. King and Morteza Mozaffari, Crop, Soil, and Environmental Science Department.

The environmental implications of nitrate pollution coupled with the growing usage and cost of N fertilizers have recently compelled agronomist to develop quick and accurate methods of determining plant N. Our objective was to use a digital camera and image analysis software as an estimation of chlorophyll content in corn (*Zea mays* L.) leaves. Along with this method of Digital Color Analysis (DCA), we also evaluated the relationship among SPAD, total leaf N, seed yield and the use of internal standards for camera calibration. DCA is possible because the amount of N available to a plant is directly related to the amount of chlorophyll it produces and thus, effects how green the tissue appears. Field experiments were conducted in Fayetteville, Marianna, Keiser, and Rohwer, Arkansas with N treatments ranging from 0 to 340 kg N/ha^{-1}. At tassleing, the uppermost collared leaf was sampled and subjected to DCA, SPAD and then analyzed for total N. Average Red, Green, Blue, (RGB) values were calculated and transformed to Hue, Saturation, and Brightness (HSB) parameters. These values were further processed into a Dark Green Color Index (DGCI), which combines the HSB values into one composite number. SPAD and DGCI agreed very closely for all locations with $r^2 \geq 0.90$ in many cases. There was a close relationship (r^2 typically ≥ 0.70) among SPAD, DGCI and % total leaf N. Within a location, yield increased linearly with increasing values of SPAD and DGCI. Determination of corn N needs by a digital image opens possibilities for producers to send photographs of corn leaves to researchers for analysis. Researchers may then quickly and with little cost determine DGCI and return recommendations for corrective action.

Soybean Production Systems and Deep Tillage Affect Palmer Amaranth Seed Burial and Emergence.

Justin D. DeVore*, J.K. Norsworthy, G.M. Griffith, M.J. Wilson, S.K. Bangarwa, G.T. Jones, E.K. McCallister, and D.B. Johnson, Department of Crop, Soil, and Environmental Sciences, University of Arkansas, Fayetteville, AR.

Glyphosate-resistant Palmer amaranth is fast becoming a major concern of Arkansas crop producers. With Arkansas soybean producers relying heavily on glyphosate-resistant soybean, an alternative solution to controlling resistant Palmer amaranth is needed. A field experiment was conducted at Marianna, AR, in which various soybean production systems were tested in combination with deep tillage and no tillage to determine the impact on Palmer amaranth emergence and soil seedbank numbers. This experiment was organized in a split plot design with a four by two factorial arrangement of treatments replicated four times. The four production systems were early-season soybean, full-season soybean following tillage, full-season soybean following rye, and soybean double-cropped with wheat. The second factor was deep tillage using a mouldboard plow or no tillage. A 1-m^2 area was marked in the center of each plot by GPS. Once marked, 250,000 glyphosate-resistant Palmer amaranth seed were placed within the m^2 and then the plot was disked twice. At this point, half of the plots were deep-tilled and half were not. During the growing season, five counts were taken to determine the number of Palmer amaranth that emerged within the m^2 as well as the rest of the plot. Soil cores were taken at 0 to 6 inches and 6 to 12 inches at the beginning and the end of the growing season. Emergence studies were then conducted in a greenhouse using the soil cores to estimate the number of Palmer amaranth seed in the soil seedbank. Significant results were seen in plots that received the deep tillage in combination with a rye cover crop with up to a 98% reduction in emergence. In conclusion, this research shows how deep tillage in combination with various soybean production systems could be an alternative method for use in controlling glyphosate-resistant Palmer amaranth.

Influence of Late-Season Herbicide Applications on Population Dynamics of Glyphosate-Resistant Palmer Amaranth Biotypes.

Prashant Jha, Jason K. Norsworthy, Michael J. Wilson, Evan McCallister, Justin DeVore, and Joshua Still, Department of Crop, Soil, and Environmental Sciences, University of Arkansas, Fayetteville, AR.

Experiments were conducted in 2008 and 2009 at the University of Arkansas in Fayetteville to determine the effectiveness of late-season herbicide applications for control and seed suppression of glyphosate-resistant Palmer amaranth. Glyphosate-resistant biotypes from Mississippi County (MC) and Lincoln County (LC) were evaluated. Seedlings of both biotypes were transplanted in the field and sprayed with glyphosate, dicamba, 2,4-D amine, glufosinate, and pyrithiobac when inflorescence began to appear. Experiments were conducted as a factorial arrangement of treatments (biotype by herbicide) with an untreated check and four replications. Percent control of treated plants was visually evaluated at 7, 14, and 28 days after treatment (DAT). Individual plant survival was recorded at 28 DAT, and seed production, viability, and growth were evaluated. Control of the MC biotype was superior to the LC biotype due to smaller size of the MC plants at the time of application. Among all herbicides, 2,4-D amine provided the greatest control of Palmer amaranth, an average of 66%. Control of both biotypes with pyrithiobac was unsatisfactory (<5%). Glufosinate and dicamba caused 64 and 31% mortality, respectively, of the MC biotype compared to <20% mortality of the LC biotype. Treated plants produced seeds, with a maximum of 3500 seeds/female plant of the LC biotype in glyphosate-treated plots in 2008. All herbicides in 2008 reduced seed viability of the LC biotype; however, viability of the MC progeny was reduced only when sprayed with glufosinate and pyrithiobac. A reduction in biomass production of progeny from herbicide-treated plants was evident in 2008. Data for seed production, viability, and germination, and biomass production of progeny for 2009 will be presented at the conference. In conclusion, late-season applications of 2,4-D, dicamba, or glufosinate can suppress seed production of glyphosate-resistant Palmer amaranth; however, the suppression will not be to the extent that can prevent replenishment of the soil seed bank and future spread of the resistant population.

Soybean Nitrogen Fixation and Nitrogen Allocation Response to Drought at Different Reproductive Stages.

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Soybean (*Glycine max* [L.] Merr.) N_2 fixation is a primary plant mechanism responsible for supplying N during seed development. Nitrogen fixation is recognized as a drought sensitive mechanism; however, N_2 fixation response to drought at different reproductive stages is not well documented. We evaluated soybean N_2 fixation and N allocation during the entire season using different genotypes and maturity groups (MG) in field conditions, and we estimated nitrogenase activity response to drought at different reproductive stages in growth chamber conditions. Isolines for maturity group (IV, V and VI), a drought tolerant genotype, and a non nodulated soybean were grown under well-watered conditions in the field. Sub-plots were periodically harvested from flowering until maturity. During sampling, plants were divided into leaves, stems, pods, and seeds for total N analysis. In a growth chamber, N_2 fixation response to drought at flowering (R2), seed-set (R5), and full-seed (R6) stages were measured using a non-destructive acetylene reduction assay (ARA) in Hendricks (MG 0). In field conditions, nitrogen fixation activity peaked during early seed development. Leaves were the main N source allocated to the seeds during late seed development, which coincided with a decrease in nitrogenase activity. In the growth chamber study, N_2 fixation completely recovered from drought at R2 and R5 after rewatering. Drought stressed plants at R6 stage did not recover N_2 fixation, which resulted in early senescence compared with plants stressed at R2 and R5. These results indicated that N_2 fixation can occur through late reproductive stages and that drought during full seed stage may cause irreparable damage to N_2 fixation, inducing early senescence and decreasing yield.

Residual Effects of Herbicides in Summer Crops to Spinach and Canola

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Cool-season crops such as spinach and canola are potential components of a summer-fall-spring crop rotation system. However, herbicides applied to summer crops could injure the succeeding crops. Thus, it is necessary to evaluate the tolerance of cool-season crops to the soil-active herbicides applied in the summer. The experiment was conducted at the University of Arkansas Vegetable Substation, Kibler, AR in 2007 and 2008. Experimental units were arranged in a strip-split-plot design with herbicide application time as the main strip plot, planting date of crops as subplot, and herbicide treatments as sub-subplot replicated three times. Eight herbicides were evaluated: imazethapyr (0.069 kg/ha), imazamox (0.034 kg/ha), halosulfuron (0.052 kg/ha), sulfentrazone (0.210 and 0.420 kg/ha), clomazone (0.420 kg/ha), fomesafen (0.210 and 0.420 kg/ha), flumioxazin (0.073 and 0.210 kg/ha), and rimsulfuron (0.034 and 0.069 kg/ha). The herbicides were applied at three timings, May 15, June 15, and July 15. Two plantings dates were set. In 2007, spinach was planted in September 27 and October 30. In 2008 the crops were planted on September 19 and October 13. The herbicides were applied in May 13, June 18 and July 18, 2008 using a CO_2 backpack sprayer and a handheld boom equipped with four flat flan nozzles, 50.8 cm apart at 140.29 L/ha sprayer output. Fertilizer was applied and crops were irrigated as needed. Crop injury and crop stand were recorded 4 weeks after planting. Crops were harvested 40 days after transplanting. Data were subjected to analysis of variance in JMP 7.0; significant means were separated using Fisher's protected $LSD_{0.05}$.

The time of herbicide application and the date of planting did not cause a significant effect on the crop stand of canola. Averaged over herbicide treatments and time of application, crop stand ranged from 30-32 m^2. All herbicides did not cause stand reduction relative to the control. The higher rate of fomesafen (0.420 kg /ha) and imazethapyr caused greater than 40% crop injury regardless of the time of application; planting canola 123 days after application of fomesafen (0.420 kg /ha) and imazethpyr (0.069 kg /ha) is not safe. Canola treated with low rate of fomesafen (0.210 kg /ha), clomazone, halosulfuron, imazamox, and both rates of flumioxazin, sulfentrazone and flumioxazin, had injury ratings comparable to the untreated plants, regardless of time of application. Imazethapyr and the high rate of fomesafen caused high reduction in yield regardless of application time and planting date; other herbicide treatments were comparable to the untreated check.

In both years, stand count was significantly affected by planting date and herbicide treatments. The herbicide treatments did not cause stand loss except both rates of fomesafen and sulfentrazone and imazethapyr. October planting gave a better stand count than that of the September planting. Imazethpyr (0.069 kg /ha), sulfentrazone (0.210 and 0.420 kg/ha), and fomesafen (0.210, 0.420 kg /ha) showed the highest residual effect on spinach, averaged over herbicide application time and crop planting time. Spinach was sensitive to imazethapyr, and both rates of fomesafen and sulfentrazone, which caused yield loss relative to the control. Spinach planted in September had higher yield than that planted in October.

Response of Rice, Soybean, and Wheat to Low Rates of Glufosinate.
B.M. Davis*, R.C. Scott, J.W. Dickson, and N.D. Pearrow, University of Arkansas Cooperative Extension Service, Lonoke, AR.

Field studies were conducted in 2007 and 2008 to evaluate and compare the effects of low rates of glufosinate and glyphosate on rice, soybean, and wheat.

In rice, canopy height reductions, reduction in flag leaf length, prolonged maturity and yield losses were caused by both herbicides when applied at various timings (3-to 4-leaf, ¼" inch panicle initiation (PI), and boot). Although both herbicides caused significant response in the parameters measured, visual symptoms varied greatly between the two herbicides. Glufosinate injury to rice was more rapid and visually intense than with glyphosate. Glufosinate symptoms, which consisted of rapid necrosis, were visible in 1 to 2 days, while glyphosate symptoms, stunting and chlorosis, became visible after 7 to 10 days or not at all depending on time of application. For example glyphosate 3 weeks after treatment (WAT) at the 1/2x rate applied at the boot application timing caused less than 10% injury, but resulted in 80% yield loss. Conversely, glufosinate at this timing caused 80% injury which resulted in similar yield losses of 80%. Glyphosate symptoms from PI and boot timings were typically only visible at heading and included malformed seedheads and short flag leaves. Harvested grain seed weights were reduced as much as 14% by either herbicide at PI and boot. Germination of harvested grain was not effected by any treatment.

Soybean response to low rates of glufosinate was visible with in 1 to 2 days and was detrimental to soybean yield. Symptoms from glufosinate consisted mainly of rapid necrosis of leaf tissue with little to no regrowth depending on rate and timing. Yield reductions ranged from 11 to 91% depending on rate and treatment timing. Soybean varieties responded similarly to glufosinate with some minor exceptions. Soybean varieties were less sensitive to glufosinate when applied at the R1 timing. Height reductions were the greatest at 4 WAT when glufosinate was applied at the V3 timing. Soybean maturity was only delay 2 to 5 d regardless of treatment. Glufosinate applied at the highest rate was the most detrimental to yield regardless of timing. Yield data closely followed injury data with V3 and R5 timing being more sensitive to glufosinate.

In wheat, canopy height reductions, reduction in flag leaf length, delayed maturity and yield losses were caused by both herbicides when applied at various timings. Although both herbicides caused significant response in the parameters measured, visual symptoms varied greatly between the two herbicides. Glufosinate injury to wheat was more rapid and consisted of necrosis which was visible in 1 to 2 days. Glyphosate symptoms consisted mainly of stunting and chlorosis became visible after 7 to 10 days or not at all depending on time of application. For example, glufosinate 3 WAT at the 1/10x rate applied at the boot application timing caused 20-40% injury and resulted in a 27% yield loss. Conversely, glyphosate at this timing caused less than 10% injury which resulted in higher yield losses of 50-60%. Glyphosate symptoms from PI and boot timings were very similar to rice and also were typically only visible at heading and included malformed seedheads and short flag leaves. Harvested grain seed weights were reduced as much as 8% by either herbicide at boot. Germination of harvested grain was not effected by any treatment.

Herbicide Programs for Management of Glyphosate- Resistant Johnsongrass in Liberty Link Soybeans.

D. Brent. Johnson*, J. K. Norsworthy, R. C. Scott, J.A. Still, M. J. Wilson, Department of Crop, Soil, and Environmental Sciences, University of Arkansas, Fayetteville, AR.

In the fall of 2008, Drs. Jason Norsworthy and Bob Scott confirmed a population of glyphosate-resistant johnsongrass a few miles north of West Memphis, Arkansas, in Crittenden County. With glyphosate no longer controling the johnsongrass the only option the producer was left with was the use of a graminicide. The continuous use of graminicides would, however, place high selection pressure on the ACCase chemistry and possibly lead to the development of multiple- resistance mechanisms within the same field. In the summer of 2009, two studies were conducted in the center of the resistant patch of johnsongrass. The focus of these studies was to determine if the adoption of a Liberty Link (glufosinate- resistant soybean) production system would provide adequate control of the johnsongrass and to develop program approaches to managing glyphosate-resistant johnsongrass in Liberty Link soybeans.

Treatments in the first experiment were Ignite at 22, 29, and 36 fl oz/A applied to 12-24 inch or 48-72 inch johnsongrass alone or following Valor (flumioxazin) applied preemergence (PRE) at 2 oz/A . Each Ignite rate was also applied to 48-72 inch johnsongrass following Valor PRE. In general, multiple applications of Ignite provided better control (75-96 %), than a single application following Valor (41.3-65 %).

In the second experiment, Ignite at 22 or 29 fl oz/A was applied with Select Max (clethodim) at 8, 12, or 16 fl oz/A to 12-24 inch johnsongrass and was followed by (fb) the same rate of Ignite when the johnsongrass was 48-72 inches tall. Ignite at 22 or 29 fl oz/A was applied alone or in a tank mixture with Select Max at the 12-24 inch growth stage fb the same rate of Ignite plus Select Max when the johnsongrass was 48-72 inches. Two applications of Select Max proved to be more beneficial providing 88-94 % control; however, if only one application was made, it was more beneficial to apply Select Max in the early season postemergence application (81-92 %) than in the late season application (62-68 %).

Presence of Weed Species in Liberty Link® and Roundup Ready Flex® Cotton Systems.

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With the evolution of glyphosate-resistant weed species worldwide, new technology such as the Liberty Link cotton system are being used along with different herbicide rotations to help manage glyphosate resistance and further sustainable agriculture. Incorporating a residual herbicide in a cotton weed control program applied either preemergence (PRE), postemergence (POST), or post-directed (PD), may broaden the weed spectrum and provide extended weed control. The objective of this research was to evaluate the effect of different herbicide programs on seed rain and the subsequent species shift in Liberty Link and Roundup Ready Flex cotton rotations. Soil cores (1,440) taken at 30.5, 61, 91, and 122 m from a 6 ha field at the Northeast Research and Extension Center in Keiser, AR, were used to determine that spotted and prostrate spurges were the dominant species present in April 2007. Large crabgrass, prickly sida, carpetweed, and Palmer amaranth were also present at low to moderate levels. In 2007, 2008, and 2009 seed traps were placed in the field in early August to catch seed rain through fall harvest. These traps were collected and counted to determine the benefit of adding a residual herbicide either preemergence, PD at LAYBY, or both, in comparison with a total postemergence program in Liberty Link or Roundup Ready Flex cotton systems. Visual observations during seed collection and counting in 2007 and 2008 indicate the dominant species may have shifted to Palmer amaranth, large crabgrass, barnyardgrass, and prickly sida. Other species, such as velvetleaf and the morningglory species were also more prevalent in 2008. Data from 2009 seed traps will be collected and counted, and the results presented at the meeting.

Ryegrass Resistance to ACCase and ALS Inhibitors

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Annual ryegrass (*Lolium multiflorum*) is the most troublesome weed in wheat. Twelve suspected biotypes of herbicide resistant ryegrass around Arkansas were collected in 2008 to determine their resistance to ACCase and ALS herbicides. The populations were treated with 1x, 2x and 4x rates of pyroxsulam, imazamox, mesosulfuron and diclofop at the two-leaf stage in greenhouse experiments. Visual injury was evaluated two and four weeks after treatment. Results revealed that all the 12 accessions were resistant to 1x rate of the four herbicides. Nine populations showed multiple resistance to 2x rate of pyroxsulam, mesosulfuron and diclofop. Resistance to both pyroxsulam and mesosulfuron at 4x rate were found in eight populations, four of which also exhibited resistance to imazamox. Ten ACCase-resistant accessions were resistant to at least one ALS herbicide at 4x rate. Two of these biotypes were resistant to both pyroxsulam and mesosulfuron but not to imazamox. The resistance to all four herbicides was found in seven populations at 2x rate but only in two accessions at 4x rate. This indicates that there are different patterns of cross-resistance to ALS inhibitors and there are cases of multiple resistance to ALS- and ACCase inhibitors. Ryegrass management with herbicides has become more complex. Weed management options have to be planned prior to the growing season.

Tolerance of Sweet Sorghum to Metolachlor and Mesotrione Herbicides in Non-Irrigated Conditions.

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Sweet sorghum (*Sorghum vulgare*) is grown on very small acres in Arkansas for molasses, but is being considered as an alternative biofuel crop that can fit into existing cropping systems in the Delta. A study was conducted to evaluate the tolerance of sweet sorghum to metolachlor and mesotrione under non-irrigated condition. The experimental units were arranged in a randomized complete block design with four replications, with the treatments being combinations of metolachlor and mesotrione at different rates. Sweet sorghum cv. 'Dale' was planted in plots with 4 rows, 20 ft long, 40 in apart. The experiment was conducted at the Main Agricultural Research and Experiment Station, Fayetteville, AR in 2007, 2008 and 2009. Mesotrione at 0, 0.094 and 0.375 lb ai/A and metolachlor at 0, 0.48, 0.96, 1.43 and 1.91 lb ai/A were applied preemergence, separately and as mixtures. A combination of metolachlor (1.91 lb/A) + mesotrione (0.375 lb/A) was included as a 'standard treatment' for comparison of weed control efficacy and crop tolerance.

In 2007, 13% injury was observed on sweet sorghum treated with metolachlor + mesotrione (1.43 lb ai/A + 0.094 lb ai/A), metolachlor + mesotrione (0.48 lb ai/A + 0.094 lb ai/A) and metolachlor alone (0.96 lb ai/A). Plots treated with metolachor alone (0.48 lb ai/A), metolachor + mesotrione (0.96 lb ai/A + 0.094 lb ai/A), mesotrione alone (0.375 lb ai/A) and metolachor + mesotrione (1.91 lb ai/A + 0.375 lb ai/A) had less crop stand than the non-treated plots. Average fresh biomass of 18.93 mt/acre as recorded where none of the herbicide caused any significant reduction in fresh biomass.

In 2008, mesotrione (0.094 lb ai/A) caused 14% crop injury; metolachlor (0.48 lb ai/A), 23%; and metolachlor + mesotrione (0.48 + 0. 094 lb a.i./A), 29% at 21 d after application. Mesotrione alone (0.094 lb ai/A) had the highest stand count, followed by metolachor + mesotrione (1.91 lb ai/A + 0.094 lb ai/A), metolachor (0.48 lb ai/A) and metolachor + mesotrione (0.48 + 0. 094 lb a.i./A) treatments. Sweet sorghum sprayed with metolachor + mesotrione (1.91 lb a.i./A + 0.094 lb ai/A) had the highest biomass yield (28.935 mt/acre) comparable to other treatments.

In 2009, of the 17 treatments, the combination of mesotrione and metolachor (0.094 + 0.48 lb ai/A), and metolachlor alone at 0.96 and 1.43 lb ai/A caused the least stand loss or early-season crop injury. Sweet sorghum in plots sprayed with metolachlor at 1.43 lb ai/A showed the highest biomass of 34.45 mt/acre.

Therefore we conclude that a combination of mesotrione and metolachlor at (0.094 lb ai/A + 0.48 lb ai/A) is safe for sweet sorghum. Higher rates of metolachlor can be used alone without biomass yield loss.

Palmer Amaranth (Amaranthus palmeri) Control in Soybean.

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Palmer amaranth is a problematic weed in today's agriculture, especially with glyphosate resistance. The objective was to provide information on control of glyphosate- susceptible Palmer amaranth in soybean. Field experiments were conducted at Pine Tree, AR, in 2007 through 2009 on a natural Palmer amaranth infestation. The experimental design was an RCB replicated four times. Armour 53K3RR soybean were planted from late May to early June on 30-inch rows. S-metolachlor (Dual Magnum), fomesafen (Reflex), S-metolachlor+metribuzin (Boundery), S-metolachlor+fomesafen (Prefix), pendimethalin (Prowl H_20), flumioxazin (Valor), glyphosate (Roundup WeatherMax), 2,4-DB (Butyrac), and lactofen (Cobra) were evaluated alone and in conjunction with one another. In another study, glufosinate (Ignite 280) was applied weekly for 8 weeks. Visual evaluations of Palmer amaranth control were taken at 1, 3, 5, and 8 weeks after emergence (WAE).

In 2007 and 2008 rainfall was lacking for the first 4 weeks after preemergence (PRE) applications; however, in 2009 the PRE's were rainfall activated. Only Valor and Valor+Prowl H_20 provided approximately 40 and 60% control, respectively, for 6 weeks without activation. The other PRE's required Flexstar (0.24 lb ai/A) at 2- to 3-inch Palmer amaranth to provide acceptable control (73 to 90%) by 5 WAE. With adequate activation, all PRE's gave 83 to 100% control for 3 weeks after application (WAA) without a follow-up postemergence (POST) application of Flexstar and Prefix provided 80% for 7 WAA. Cobra (0.1 to 0.2 lb/ai/A) and Flexstar (0.29 lb/A) applied at 8-inch Palmer amaranth controlled approximately 85% while the addition of Butyrac 200 (0.1 or 0.2 lb ai/A) at 3 days after application (DAA) improved control approximately 10%. Ignite 280 at 0.4 lb ai/A gave 90 to 100% control when applied within 3 WAE or by 4- to 6-inch Palmer amaranth.

Palmer amaranth can be controlled season-long with conventional PRE and POST herbicides applied in combination. Ignite is an excellent option when applied by 3 WAE.

Fruit Injury and Developing Action Thresholds in Dual Gene Cotton

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Fruit abscission rate of Bollgard II and Widestrike cotton varieties was based on white flower injury at 0, 10, 25, 50, and 75% infestation of white flowers within respective plots. Abscission rates from 0 to 25% infestation levels did not significantly differ; however, 50 and 75% infestation levels showed a significant increase in fruit abscission rate. Action thresholds currently revolve around 10% infestation and therefore result in unnecessary foliar applications.

Effect of Roundup-Ready Technology on Weed Population Dynamics in Soybean.
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Field studies were conducted from 2007 through 2009 at Pine Tree, to evaluate the effects of late-season glyphosate applications on the density and seed production (SP) of common Delta weeds in Roundup Ready soybean. The plot area contained a natural infestation of Palmer amaranth (*Amaranthus palmeri*), pitted (*Ipomoea lacunosa*) and entireleaf morningglory (*Ipomoea hederacea var. integriuscula*), prickly sida (*Sida spinosa*), broadleaf signalgrass (*Urochloa platyphylla*), and barnyardgrass (*Echinochloa crus-galli*). The experiment was designed as a randomized complete block with eight treatments and four replications. Plots were 30 ft wide by 30 ft long with 10-ft alleys between plots and 20-ft alleys between replications. Treatments were: 1) Roundup WeatherMax (RWM) applied at V3 stage of soybean; 2) RWM applied at V3 followed by (fb) RWM at weed flowering (WF) stage; 3) RWM applied at V3 fb RWM at WF fb RWM at 10 days sequential (DSeq) after WF stage; 4) RWM applied at V3 fb RWM at WF fb RWM at 30 DSeq; 5) RWM applied at V3 fb at V6; 6) RWM applied at V3 fb V6 fb WF; 7) RWM applied at V3 fb V6 fb WF fb 10 DSeq; and 8) RWM applied at V3 fb V6 fb WF fb 30 DSeq. Roundup WeatherMax rates were 0.84 kg ae/ha (1X) at V3 and V6 stages of soybean growth and 0.42 kg/ha (1/2X) at weed flowering (except treatment 2) and sequential applications. Plot integrity was maintained throughout the study and Armor 53KRR was planted each year. Each year WF application was triggered by barnyardgrass (2007) or Palmer amaranth (2008 and 2009).

RWM applied only once at the V3 stage of soybean provided only 30, 39 and 17% (averaged over years) of pitted morningglory, prickly sida, and barnyardgrass, respectively, and resulted in significantly lower soybean yield than other treatments. The weed population, dry weight, and seed production was highest with RWM at soybean V3 as compared to the other treatments at the end of season. Treatments 2, 5, and 6 (with no sequential application) did not provide 100% control of all weed species present. Therefore, weed seed was produced in these plots. Pitted morningglory, prickly sida, and barnyardgrass control at the end of season was 67, 90, and 81%; 76, 85, and 45%; and 85, 95, and 86% from the application of treatments 2, 5, and 6, respectively. Only those treatments (3, 4, 7, or 8) with the sequential applications provided 90 to 100% control (averaged over years) of all weed species with no weed seed production and reduced weed soil seedbank. At the end of study, the weed density increased from 25 to 366 plants/m^2 and 30 to 82 g/m^2 of SP, from 7 to 53 plants/m^2 and 8 to 44 g/m^2 of SP, from 9 to 135 plants/m^2 and 11 to 53 g/m^2 SP, and from 11 to 61 plants/m^2 and 8 to 50 g/m^2 SP in the plots that received treatments 1, 2, 5, and 6, respectively. Soybean yield was reduced 40% (2007) and 79% (2008) from treatment 1 as compared to treatment 3 which further indicates an increasing population dynamics.

In conclusion, treatments 3, 4, 7, or 8 were the best in terms of weed control and stopping weed seed production (reducing soil seedbank) and resulted in the highest soybean yield. Thus, to reduce weed seed density (reduce soil seedbank) or to stop weed seed production, three applications of RWM (0.84 kg/ha) at V3 fb RWM (0.42 kg/ha) at WF fb RWM (0.42 kg/ha) at 10 to 30 DSeq is required.

Effect of Imazosulfuron Rate and Timing on Weed Control in Rice.

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Imazosulfuron is a new herbicide that will be brought to market by Valent in 2011. The purpose of this study was to examine control of several weed species by imazosulfuron. Research was conducted in the summer of 2009 at Stuttgart, AR. Rice was planted and Weed species were overseeded and incorporated into the soil. The test species were hemp sesbania (*Sesbania herbacea*), yellow nutsedge (*Cyperus esculentus*), Palmer amaranth (*Amaranthus palmeri*), prickly sida (*Sida spinosa*), pitted morningglory (*Ipomoea lacunosa*), broadleaf signalgrass (*Urochloa platyphylla*), and barnyardgrass (*Echinochloa crus-galli*). Three rates of imazosulfuron were applied preemergence (PRE), early postemergence (EPOST), preflood (PREFLD), and 7 to 10 days postflood (POSTFLD). PRE application rates were 0.2, 0.3, and 0.4 lb ai/A. All POST application rates were 0.15, 0.2, and 0.3 lb ai/A with 2.5% v/v Dyne-A-Pak. Ratings were made on PRE and EPOST treatments at 21, 28, 35, 41, 49, 68, and 82 days after application. Ratings were made on PREFLD treatments at 8, 27, and 41 days after application. POSTFLD treatments were rated at 12 and 26 days after application. Imazosulfuron controlled hemp sesbania at least 95% when applied EPOST and PREFLD at 0.3 lb ai/A. Yellow nutsedge was controlled 95% with all PRE treatments. Imazosulfuron only suppressed Palmer amananth, prickly sida, and pitted morningglory. There was little to no grass activity by imazosulfuron. Because of the absence of grass control with imazosulfuron, this herbicide will need to be tank-mixed with an additional herbicide or applied after a PRE herbicide that effectively controls grass weeds.

Distribution and Control of Herbicide Resistant Ryegrass in Arkansas.

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In the spring of 2009, a survey of Italian ryegrass (*Lolium multiflorum* L.) populations in Arkansas was conducted. County agents and others from across Arkansas harvested ryegrass panicles from 40 sq ft areas and sent them to Lonoke. These samples were labeled with GPS coordinates and as much field history as possible. A total of 300 samples from 21 counties in Arkansas have been obtained from various sources. These samples will be screened for resistance in the greenhouse with Roundup PowerMAX at 22oz/A, Hoelon at 2.67pt/A, Axial XL at 16.4oz/A, and Osprey at 4.75oz/A + MSO at 1%v/v. Twenty-five of the samples received survived a glyphosate spring burn-down. These samples will be treated in the greenhouse with Roundup PowerMAX at 22 and 44oz/A at the 3- to 4-leaf and 3- to 4-tiller timings in addition to the previous set of treatments. Commercial Italian ryegrass samples will also be subjected to these treatments to determine herbicide resistance levels in commercially available sources.

A field study was conducted to determine the most effective spring burn-down options for Italian ryegrass. The study was conducted in the spring of 2009 in Pulaski County near Bredlow Corner. The study consisted of 16 treatments arranged in a randomized complete block design with four replications. Applications were made using a pressurized CO_2 backpack sprayer with a four-nozzle boom delivering a spray volume of 10 gallons per acre. A natural population of diclofop-resistant Italian ryegrass was treated at boot stage (24 inches tall) with several herbicides labeled for spring burn-down. Weed control was evaluated 12, 26, and 48 days after application.

Italian ryegrass control of 90% or greater 48 days after application was achieved with Roundup PowerMAX at 88oz/A, Roundup PowerMAX at 22oz/A + Select MAX 16oz/A, Roundup PowerMAX at 44oz/A + Select MAX 8oz/A, and Roundup PowerMAX at 44oz/A + Select MAX at 16oz/A. Select MAX alone at 8 and 16oz/A controlled Italian ryegrass 74% and 81%, respectively 48 days after treatment. Ignite at 40 oz/A controlled Italian ryegrass only 20% at 48 days after treatment. Tank mixes of Ignite and Select MAX did not improve ryegrass control over Select MAX applied alone.

Both the resistance survey and efficacy studies in this project are ongoing. In addition to the spring burn-down trial, fall burn-down and residual treatments will also be evaluated. A few more ryegrass samples from counties that did not participate in the initial survey may be added next spring.

The Effect of After-Ripening Time on Dormancy Release in Red Rice Seeds from Arkansas

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Loss of seed dormancy during after-ripening of weedy rice (*Oryza sativa*), collected from Arkansas, was investigated. Freshly harvested, mature seeds, from rice fields in Cross, Desha, Drew, Lawrence, Lee, Lincoln, Lonoke, Monroe, Prairie and Randolph counties were used. Seeds were after-ripened at average room temperature of 28 C. Dormancy was tested at intervals of 0, 4, 8, and 12 weeks after harvest by germinating seeds at 30 °C in the dark. The experiment was conducted in Split-plot design with three replications. Twenty five seeds from each plant sample were placed in Petri dishes lined with filter paper, and moistened with 5 ml of deionized water. At daily evaluations, seeds were considered germinated when radicle emergence was noted. Germination was recorded over a 15 day period.

Variations in dormancy were observed among accessions at different after-ripening periods. All accessions showed high dormancy immediately after harvest, but dormancy was released in the majority of accessions after longer durations of after-ripening. Weedy (red) rice produces seeds that persist under unfavorable conditions. This experiment suggests different abilities of red rice populations to persist due to different seed dormancy traits. The distribution of these high-dormancy populations are shown on the map. For such populations, longer rotations out of rice culture are required to deplete the soil seed bank. On the other hand, seeds which are otherwise non-dormant can go into secondary dormancy if unfavorable conditions occur such as, deep seed burial during land preparation or low temperature in the winter. Such deeply buried seeds or those that transitioned into deep secondary dormancy may persist long in the soil seed bank.

Evaluation of Herbicide Programs for Controlling ALS-Resistant Barnyardgrass in Rice.

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Barnyardgrass is the most problematic weed in Arkansas rice production, causing yield reduction, lodging, and poor grain quality. It infests most of the Arkansas rice acreage and has resistant biotypes to Stam (propanil), Facet (quinclorac), and Command (clomazone). Clearfield rice has led to extensive use of the Newpath (imazethapyr) herbicide in rice and with the use of other acetolactate synthase (ALS)-inhibiting (ALS) herbicides such as Grasp (penoxsulam) and Regiment (bispyribac), the evolution of resistant barnyardgrass was inevitable. In early 2009, an ALS-resistant barnyardgrass biotype was documented. Thus, an effective herbicide program is needed for control of the ALS-resistant biotype. A field study was conducted in Lonoke, AR, on a Stuttgart silt loam to determine herbicide programs that would provide effective control of the susceptible and resistant biotypes. The experiment was organized as a factorial arrangement of treatments on a randomized complete block design with four replications. Newpath at 4 oz/A (product) was applied alone and in combination with Command at 0.8 pt/A, Facet at 0.67 lb/A, Prowl H2O (pendimethalin) at 2.1 pt/A, Bolero (thiobencarb) at 4 pt/A, and Ricestar HT (fenoxaprop) at 24 oz/A at multiple timings [PRE (preemergence), DPRE (delayed preemergence), EPOST (early postemergence), and PREFLD (preflood)]. Multiple applications of Newpath alone and tank mixed with Ricestar HT were ineffective in controlling the resistant biotype, but did control the susceptible biotype. Programs that contained Command, Facet, Prowl H2O, and Bolero PRE or DPRE followed by split applications of Newpath EPOST and PREFLD alone or tank mixed with Ricestar HT controlled at least 90% of both biotypes.

Herbicide Combinations with Permit for Hemp Sesbania Control in Rice.

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Permit herbicide is halosulfuron, which can be used for broadleaf and sedge control in a rice production system. Halosulfuron is not intended to be used as a stand-alone herbicide in rice; therefore, there is a need to determine optimal herbicide combinations with halosulfuron to minimize antagonism and maximize weed control. Three field experiments were conducted at Stuttgart, AR, to optimize herbicide combinations with Permit for hemp sesbania control in rice. Herbicides used in these experiments included: Stam (propanil), Aim (carfentrazone), and Vida (pyraflufen-ethyl) alone and in combination with Permit (halosulfuron). Plot layout was a five by five factorial design with different rates of each herbicide alone and in combination with halosulfuron. Stam was applied at rates of 0, 1, 2, 3, and 4 qt/A, and Aim and Vida at rates of 0, 0.5, 1, and 2 fl oz/A. In each experiment, Permit was applied at rates of 0, 0.33, 0.67, 1, and 1.33 oz wt/A. All treatments were applied to 12- to 15- inch hemp sesbania and rated for control 7, 14, and 28 days after treatment. The optimal rates of

Stam and Permit for hemp sesbania control were 3 qt/acre Stam and 1 oz wt/acre Permit, which gave 95 to 100% control with 5% or less rice injury. The optimal rates of Aim and Permit were found to be 0.5 oz/acre Aim and 1.33 oz/acre Permit, which gave 95 to 100% control with 5 to 10% rice injury. The optimal rates of Vida and Permit were 2 oz/acre Vida and 1.33 oz/acre Permit, which gave 95 to 100% control with 10 to 20% early stage rice injury. Stam alone controlled approximately 85% hemp sesbania, Aim alone controlled 30 to 40%, Vida alone controlled 20 to 30%, and Permit alone controlled 70 to 80%.

Ignite Weed Control Programs in Soybean.

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Glufosinate (Ignite 280) controls many annual weeds, but dependence on glufosinate alone for season-long weed control may have limitations. A study was conducted in 2009 to evaluate broadleaf and grass weed control in a Liberty Link herbicide program at Pine Tree and Keiser, AR, on a Calloway silt loam and Sharkey clay, respectfully. The objective was to determine the differences in efficacy of various preemergence (PRE) herbicides used prior to postemergence (POST) application of Ignite 280 in a Liberty Link soybean program. The treatments were arranged in a randomized complete block (RCB) with four replications. Parameters evaluated were soybean yield plus visual control ratings of Palmer amaranth (*Amaranthus palmer*i), pitted morningglory (*Ipomoea lacunosa*), entireleaf morngingglory (*Ipomoea hederacea var. integriuscula*), prickly sida (*Sida spinosa*), hemp sesbania (*Sesbania exalta*), broadleaf signalgrass (*Urochloa platyphylla*), and barnyardgrass (*Echinochloa crus-galli*) taken at 3 and 10 weeks after emergence (WAE). Treatments evaluated were PRE herbicides: flumioxazin (Valor), Valor + metribuzin (Sencor), flumioxazin + chlorimuron (Valor XLT), sulfentrazone + chloransulam (Authority First), sulfentrazone + metribuzin (Authority MTZ), S-metolachlor + fomesafen (Prefix), and S-metolachlor (Dual Magnum). All PRE-applied herbicides were applied at labeled rates adjusted for soil texture. All PRE applications were then followed by (fb) Ignite 280 at 0.4 or 0.65 lb ai/A at 22 days after emergence (DAE) or 0.4 lb/A at 22 fb 44 DAE. Data were analyzed in ANOVA with alpha equal to 0.05.

At 3 WAE, only Dual Magnum failed to control all broadleaf weeds at least 90%. Prefix and Authority MTZ controled pitted morningglory and hemp sesbania < 90%. Dual Magnum and Prefix were the only PRE treatments that controlled at least 90% of the barnyardgrass. Valor XLT, Authority First, Prefix, and Dual Magnum provided weed control of broadleaf signalgrass greater than 90%. At 10 WAE, Valor fb Ignite at 0.4 and 0.65 lb/A, and Valor XLT fb Ignite at 0.4 lb/A had significantly less barnyardgrass control (77, 85, and 62%, respectfully) than the other treatments. Single applications of Ignite (0.4 lb/A) at 22 DAE only provided season-long control of pitted morningglory while at 0.65 lb/A prickly sida and hemp sesbania were controlled season-long. However, a split application of 0.4 lb/A at 22 fb 44 DAE was effective for all species (greater than 90%).

Thus, Ignite in combination with a PRE herbicide can be an effective treatment for season-long weed control in Liberty Link soybean.

Utilizing Observed Data for Farm Management Decision Making: Yield Potential by Planting Dates Based on Rice Verification Program.

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The Rice Research Verification Program (RRVP) was created in 1983 and represents a public demonstration of the implementation of research-based recommendations in actual field-scale farming environments. The goals of the RRVP are to: 1) educate producers on the benefits of utilizing University of Arkansas recommendations to improve yields and/or net returns, 2) to conduct on-farm field trials to verify research based recommendations, 3) to aid researchers in identifying areas of production that require further study, 4) to improve or refine existing recommendations which contribute to more profitable production, 5) to incorporate data from RRVP into Extension educational programs at the county and state level. The RRVP has been conducted on 297 commercial rice fields in 33 rice-producing counties in Arkansas. Until recently, data from the RRVP have only been subjected to analyses based upon the current year results. This study uses the entire dataset in a panel-context with cross-sectional and time-series attributes to evaluate long-term trends for use in a whole-farm decision making model. Observed data from 1983 to 2009 were analyzed to estimate the yield potential by planting date and to determine whether Arkansas farmers are planting earlier over time. The shape of the function form was evaluated by goodness of fit metrics and estimation results signify the expected yield potential based on planting dates measured as 'weeks of year'. Estimation results can serve as useful information in the farm management decision process. The data from the RRVP along with yield potential by planting date for other crops can be modeled and used to determine optimal machinery sizing that maximizes profits given specific resource availability such as land, labor, and days suitable for field work. The yield potential based on planting dates can also be used to determine optimal crop acreage allocation to maximize profitability based upon machinery and acreage availability.

Insecticide Combinations to Improve Tarnished Plant Bug Control in Arkansas Cotton, 2009.

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Tarnished plant bugs (*Lygus Lineolaris*) are perennial pests of cotton in Arkansas. Levels of damage vary from year to year based on the magnitude of populations in Arkansas. Growers and consultants rely on foliar insecticides for control of this pest. The purpose of these trials was to evaluate combinations of foliar insecticides for control of plant bugs. Combination applications significantly reduced plant bug numbers compared to single product applications and the untreated check when evaluated 7-21 days after application. With the results of this study, better recommendations can be made to achieve longer lasting control of the tarnished plant bug.

Controlling Rice Insects with Insecticide Seed Treatments

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Two of the major pests of rice are the grape colaspis, (Colaspis brunnea) also known as the "lespedeza worm," and rice water weevil (Lissorhoptrus oryzophilusl). With the loss of Icon in recent years there are no current insecticides that provide acceptable control of these pests. However, new seed treatments are currently being investigated that may provide some level of control for these pests. These products include: rynaxapyr (Dermacor X-100), thiamethoxam (Cruiser), and clothianidin (NipsIt Inside). Results of studies conducted in Arkansas the past three years will be discussed.

Corn Earworm, *Heliocoverpa zea,* Adult Moth Trapping Program and Pyrethroid Resistance Monitoring 2008-2009

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Heliocoverpa zea is considered by many to be the most costly crop pest in North America. In Arkansas, H.zea is a major pest of corn (corn earworm), cotton (cotton bollworm), grain sorghum (sorghum head worm), soybean (soybean pod worm) and tomato (tomato fruit worm). Pyrethroid insecticides are relied upon to control this pest in all of these crops. Because of the widespread dependence on this class of chemistry and field observations of reported pyrethroid applications with less than desirable results, Arkansas has joined with several other states in monitoring for pyrethroid resistance. If resistance becomes an issue, growers will be forced to other classes of insecticides which will probably increase farmers cost of control for this pest and may not be as efficacious. Recent monitoring indicates pyrethroid resistance may be a developing problem. Results in Arkansas and other states will be discussed.

Combining Seemingly Incompatible Data: A Bio-economic Analysis of Cotton Insecticide Termination Timing Studies.

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Combining individual experimental studies have been of interest to researchers since Fisher, Tippett, and Pearson discussed the idea nearly 100 years ago. Fisher explored the ideas of combing p-values across agricultural studies in an attempt to 'obtain a single test of the significance of the aggregate' (Fisher, 1932, p 99). Over the past 30 years, statistical techniques referred to as 'meta-analysis' have been developed and are currently being applied to agricultural studies. Meta-analysis can be thought of as a quantitative synthesis of existing results or more specifically as a statistical approach to summarizing quantitative empirical results of previous studies. Meta-analysis techniques have been used to determine if underlying, undiscovered findings from prior results can be isolated.

Over the last two decades, agricultural scientists have evaluated the physiological cutout and last economically sound application of insecticides for cotton production.

The body of available primary studies was evaluated against predetermined criteria regarding the availability of mean treatment effect sizes, measure of the precision of the estimate, and supporting moderator variables. Eleven studies met the criteria, reporting 57 field experiments conducted between 1993 and 2007. Meta-analysis and response surface analyses were sequentially employed to estimate the agronomic optima and yield potential functional form, respectively, to provide insights relative to improving production system recommendations by avoiding input applications that do not provide benefits greater than their respective costs. The agronomic optimal termination timing was estimated using meta-analysis methodology by evaluating the relationship between cotton lint yield and heat unit accumulation after nodes above white flower. Response surface analyses evaluated all mean treatment effects reported by the primary studies to estimate the shape of the yield penalty functional form from too early termination. Combining the results from the meta-regression and response surface analysis, an economic marginal analysis was conducted.

Use of Paraquat Alone and with PSII-Inhibiting Herbicides for Controlling Corn Prior to Replant

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The use of glyphosate-resistant corn in the United States has created a lack of options in a situation where a failed corn stand must be eliminated prior to replant. In 2009, studies were initiated at Keiser and Marianna, AR to evaluate several herbicide options for controlling failed herbicide-resistant corn crops without affecting a subsequent corn, soybean, or cotton crop. Paraquat and PSII-inhibiting herbicides were evaluated to determine the most effective use rates for the combinations of these herbicides. The experiment was a randomized complete block design with four replications. Paraquat was applied alone at 0.156, 0.313, 0.47, and 0.625 lb ai/A and in tank mixture with three PSII inhibitors labeled in corn, soybean, and cotton (atrazine at 1lb ai/A, diuron at 0.5 lb ai/A, and metribuzin at 0.14 lb ai/A), which were also applied alone at those rates. All treatments were applied at the V4 corn stage at Marianna and V2 corn stage at Keiser. At 7 days after application, none of the treatments were statistically different except for the PSII inhibitors alone which provided no more than 35% control of corn. Paraquat plus any of the PSII inhibitors provided control ranging from 91 to 100% at 7 days after application. Adequate control was maintained season-long by all combination treatments except paraquat at 0.156 lb/A plus atrazine. Control with paraquat alone was 75 to 92% at 7 days after application (not significantly different from mixtures), but many plants survived and began to re-grow by 14 days after application, especially at Marianna. By 34 days after application at Marianna, corn control from paraquat alone at all rates had decreased to between 24 and 73% due to regrowth. At Keiser, paraquat alone maintained adequate control season-long except for the 0.156 lb/A rate. The good corn control obtained and maintained by the synergistic effect of adding a PSII inhibitor to paraquat suggests that there are several good options for controlling glyphosate-resistant corn prior to replanting corn, soybean, or cotton.

Alternative Methods of Rice Irrigation Using RiceTec Hybrid Rice.

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RiceTec Hybrid rice has higher water use efficiency than recommended self pollinated cultivars.

In 2005 RiceTec began simple field experiments comparing hybrids and varieties in furrow irrigation. In 2006 RiceTec began experiments comparing water use among irrigation methods such as furrow irrigation, intermittent flood irrigation, and standard flood irrigation. Measuring and comparing water use in side by side tests and comparing hybrids and varieties side by side at different levels of water use. In 2008 RiceTec began field studies under sprinkler irrigation methods. Center pivot sprinkler systems offer the advantage of uniform application rate and timing as well as reduced irrigation labor cost.

Multiyear comparisons between RiceTec hybrid rice and popular cultivars show improved water use efficiency for RiceTec hybrid rice compared to self pollinated cultivars. Field studies using unconventional rice irrigation methods can bring rice irrigation water use down by 40%. Variable costs can be lower than flood irrigated rice production.

Timing of Irrigation and Tarnished Plant Bugs - One Thing Leads to Another in Late-Season Decision Making in Cotton.

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Insect control termination recommendations in Arkansas are based upon long standing and on-going COTMAN research conducted by University of Arkansas Division of Agriculture scientists. Work continues to address the questions: When is a cotton crop safe from new infestations of insect pests? When is scouting no longer necessary? Using the COTMAN™ crop monitoring system, producers and their crop advisors can answer with confidence. For each field or management zone, decision makers must first determine the flowering date of the last effective boll population, that last cohort of flowers that produce bolls that contribute to economic yield. This is called cutout. If a field reaches physiological cutout (average number of nodes above white flower=5 (NAWF=5)) in late July or early August in Arkansas, then heat units (DD60s) are accumulated from the NAWF=5 date. Otherwise, DD60s are accumulated from a seasonal cutout date based on historical weather for that production region. Typically a boll needs 850 DD60s to mature with acceptable size and quality. The weather restricted, seasonal cutout date is the calendar date on which there is a 50% probability that the crop will have the benefit of late season temperatures sufficient to develop a mature boll. Seasonal cutout dates range across the state from 8 August in northernmost parts of Arkansas out to 21 August in the most southern areas. When that last effective boll population has accumulated 350 DD60s (heat units) the crop has been shown to be safe from new infestations of the most significant boll feeding insect pests in Midsouth history: boll weevil, tobacco budworm and bollworm. The protection endpoint also has been validated for tarnished plant bug. In 2008, it was recommended in Arkansas that the endpoint should be cutout + 250 DD60s.

What about special cases? Crop advisors have questioned the appropriateness of extending the season for protection should the crop initiate new terminal growth after cutout. This late-season decision making dilemma typically occurs after a period of water deficit stress is followed by rains or late initiation of irrigation. Uncertainty in late season decision making can arise if NAWF values hover or dip below 5 earlier than “expected”. Irrigation timing decisions that result in crop delay ultimately translate into availability of highly attractive squares in late season just in time for highest population densities of bugs. If there is time for late season crop recovery (time dependent compensation), should money be spent on providing protection from tarnished plant bugs for this new “top crop” or should the NAWF=5+250 DD60s guide be followed?

The aim of this Cotton Incorporated Arkansas State Support Committee sponsored study was to determine if the COTMAN guides should be revised to take into account possible late season re-growth following stress. Late season termination timing for plant bug control was evaluated in field trials in 2008 and 2009 in Lee County and in Mississippi County. The experiment was designed as a 5* 5 factorial with irrigation timing (5 factors) and tarnished plant bug control timing (5 factors), arranged in a split plot with irrigation as main plots. Irrigation scenarios involved initiation and termination timing. Early start of irrigation meant furrow irrigation was initiated during the first 2 weeks of squaring. Late start irrigation meant irrigation was delayed until first flowers. Early quit irrigation meant timing for the final irrigation occurred just after physiological cutout. Late quit irrigation meant that irrigation was continued after physiological cutout. Irrigation timing treatments were 1) early start + early quit, 2) early start + late quit, 3) late start + early quit, 4) late start + late quit, and 5) no irrigation. Plant bug control included combinations of protection and plant bug injury pre-flower and post cutout. Pre-flower injury in Mississippi Country trials was induced by manually infesting plots with bug with late season compensation monitored. Field population densities of plant bugs were low through early and mid-season in both years, but around the time of cutout, pest pressure surged, creating ideal conditions for validating the COTMAN insect control decision guide.

Yields in 2008 and 2009 were significantly higher with an early irrigation start compared to delayed or no irrigation. Providing extra weeks of irrigation did not compensate for the early water deficit stress. The COTMAN insect control termination endpoint of NAWF=5+250 DD60 was sufficient for plant bug control termination under all irrigation regimes. Avoiding the risk of late season pest pressure by setting an early crop has long been a goal of integrated pest management (IPM) in Arkansas cotton. Proper irrigation timing is critical to efficient crop management in our once-over machine harvested Midsouth production system. To achieve early and high yields irrigation initiation should be timed to avoid pre-flower stress.

Hemp Sesbania (*Sesbania exaltata*) Control in Clearfield® Rice.

Meier, J.R., K.L. Smith, R.C. Doherty, and J.A. Bullington, University of Arkansas Division of Agriculture

Hemp sesbania is one of the most common broadleaf weeds found in Arkansas rice fields. The use of imazethapyr in a Clearfield® rice herbicide program provides insufficient control of hemp sesbania and another herbicide is needed to improve control.

There are many herbicides labeled for use in rice that are effective for control of hemp sesbania depending upon weed size and application timing. Six trials were conducted in 2009 at Rohwer, AR, to evaluate hemp sesbania control with imazethapyr, imazethapyr plus quinclorac, quinclorac, halosulfuron, orthosulfamuron, penoxsulam, triclopyr, carfentrazone, pyraflufen, and saflufenacil at various timings in Clearfield® rice. Early- and mid-post applications of halosulfuron, orthosulfamuron, carfentrazone, and pyraflufen provided excellent short-term control of hemp sesbania, but did not last until permanent flood and a later application was needed. Late-post applications of halosulfuron and orthosulfamuron provided insufficient control due to larger weed size, but early-post applications of quinclorac or quinclorac plus imazethapyr followed by late-post applications of halosulfuron or orthosulfamuron were more effective. Carfentrazone, pyraflufen, and saflufenacil provided sufficient control alone but lacked residual activity, and were more effective when applied with quinclorac mid- to late-post. Preflood and postflood applications of penoxsulam alone or in combination with triclopyr or halosulfuron also provided excellent control of hemp sesbania.

Palmer Amaranth Control with Dicamba and Glufosinate as Influenced by Weed Size and Herbicide Rate.

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One trial was established in Rohwer, AR, on the Southeast Research and Extension Center in a Hebert silt loam soil in 2009 to evaluate Palmer amaranth control. The trial was arranged in a randomized complete block design with four replications. Parameters evaluated were visual ratings of Palmer amaranth control, based on weed size at application. The objective was to provide data that would support the use of dicamba and glufosinate-resistant crops to gain optimum control of glyphosate-resistant Palmer amaranth. Two rates of each herbicide were applied at four timings. Dicamba was applied at 0.25 and 0.5 lb ae/A and glufosinate was applied at 0.53 and 0.73 lb ai/A. The application timings were 3-6, 6-9, 9-12, and 24-28 inch Palmer amaranth. At 40 DAT (day after treatment) dicamba applied at 0.25 and 0.5 lb ae/A to 3 inch Palmer amaranth and dicamba at 0.5 lb ae/A applied to 6 inch Palmer amaranth provided 99 to 100% control. Dicamba applied at 0.25 and 0.5 lb ae/A to 9 and 12 inch Palmer amaranth provided less than 85% control, but did suppress seed production. Dicamba applied at 0.25 and 0.5 lb ae/A to 24-28 inch Palmer amaranth provided less than 40% control and did not suppress seed production. Glufosinate applied at 0.53 and 0.73 lb ai/A provided 100% control of 3 and 6 inch Palmer amaranth. Glufosinate applied at 0.53 and 0.73 lb ai/A provided greater than 90% control of 9, 12, 24, and 28 inch Palmer amaranth. All glufosinate treatments suppressed Palmer amaranth seed production. Dicamba and glufosinate can be used to control and suppress seed production of glyphosate –resistant Palmer amaranth.

Authority MTZ® (sulfentrazone + metribuzin) Efficacy in Soybean and Corn Weed Control Programs.

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Glyphosate resistant weeds are a growing problem in Arkansas. Many producers are considering reverting to the use of conventional preemergence herbicides followed by Glufosinate. Metribuzin and sulfentrazone have shown to provide effective weed control in corn and soybean production. Two studies were conducted at the University of Arkansas Southeast Research Branch Station; near Rohwer, Arkansas on a Hebert Silt Loam soil; one in corn and one in soybean. An additional soybean study was set up at the Lon Mann Cotton Branch Research, near Marianna, Arkansas on Memphis Silt Loam soil. Corn and soybeans were planted on thirty-eight inch rows and all trials were established in a randomized complete block design with four replications. Parameters evaluated included Amaranthus palmeri and Echinochloa crus-galli control, crop phytotoxicity, and yield.

The corn study consisted of 12 treatments evaluating Authority MTZ, Authority MTZ + Dual Magnum, and Authority MTZ + AAtrex applied PRE followed by various POST programs consisting of Ignite 280, AAtrex, and/or Callisto. All treatments showed greater than 87% control of Palmer amaranth and barnyardgrass at the 14 days after PRE timing. Control of barnyardgrass dropped to 70%, before the POST application in all treatments except those containing Dual Magnum, which provided greater than 90%. Fourteen days after the POST applications, control of both species were greater than 92 % in all treatments containing Ignite 280. Late season evaluations also showed good control. Yield was not affected by Authority MTZ application.

The soybean studies consisted of 6 treatments each evaluating Authority MTZ and Authority MTZ + Poast Plus applied PRE, followed by Ignite 280 applied POST. Fourteen days after the PRE application, control of barnyardgrass was greater than 82% and control of Palmer amaranth was 100%. The addition of Poast Plus to the PRE application did increase barnyardgrass control to greater than 94% control. Twenty-one days after POST application, control of both species was greater than 90% in all treatments containing Ignite 280. Late season evaluations also showed greater than 92% control of both species. Treatment with Authority MTZ did not affect yield.

In conclusion, Authority MTZ + Dual Magnum applied PRE followed by Ignite 280 applied POST provided a good, season-long weed control program in corn. Authority MTZ applied PRE followed by Ignite 280 applied POST provided a good, season-long weed control program in soybean.