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Oral Presentations

Management Strategies for Tarnished Plant Bug (*Lygus lineolaris)* in Mid-South Cotton S. Graham, A. Catchot, J. Gore, D. Cook, D. Dodds, and F. Musser.

The tarnished plant bug, *Lygus lineolaris* [Palisot de Beauvios], is the most important pest of cotton in the Mid-South. While early season feeding can delay plant maturity and cause deformed plants, most economic damage is caused by feeding from first square (flower bud) to early bloom. During this time, it is a direct pest feeding on squares, flowers, and fruit. Numerous insecticide applications are needed to control this pest annually. Recent research has shown that multiple agronomic management practices such as planting date, leaf pubescence, and nitrogen rate can impact tarnished plant bug management. The objective of this research was to combine multiple best management practices to determine if we can reduce the reliance on chemical insecticides to manage this pest.

Value of Neonicotinoid Insecticide Seed Treatments in Mid-South Soybean (Glycine max L.) Production Systems. J. North, J. Gore, A. Catchot, S. Stewart, G. Lorenz, F. Musser, D. Cook, D. Kerns, and D. Dodds.

Neonicotinoid insecticides are under public scrutiny for their potential link to the decline of honey bee, *Apis mellifera* L., and other pollinator populations worldwide. Neonicotinoid insecticide seed treatments are the only seed treatment commonly used in soybean, *Glycine max* L., production in the Mid-South. A meta-analysis was performed on 170 neonicotinoid insecticide seed treatment trials from Arkansas, Louisiana, Mississippi, and Tennessee to evaluate the value of neonicotinoid seed treatments in soybean production systems across the Mid-South region of the United States. The meta-analysis compared neonicotinoid insecticide seed treatments with a fungicide to seed only treated with a fungicide. Data analyzed by state demonstrated soybean seed yields were significantly higher when neonicotinoid seed treatments were applied compared to only fungicide treatments. Soybean seed treated with neonicotinoid insecticides yielded 112.0 kg ha^{-1} (1.7 bushels $acre^{-1}$), 203.0 kg ha^{-1} (3.0 bushels $acre^{-1}$), 165.0 kg ha^{-1} (2.5 bushels $acre^{-1}$), and 70.0 kg ha^{-1} (1.0 bushels $acre^{-1}$), higher than fungicide only treatments for Arkansas, Louisiana, Mississippi, and Tennessee, respectively. Across the Mid-South region, neonicotinoid seed treatments yielded 132.0 kg ha^{-1} (2.0 bushels $acre^{-1}$) compared to fungicide treatments alone. Net returns from neonicotinoid treated soybean seed was $1,203 per ha^{-1} compared to $1,172 per ha^{-1} for fungicide only treated seed across the Mid-South.

Threshold Evaluation of Corn Earworm and Fall Armyworm in Mississippi Grain Sorghum. C. Dobbins, J. Gore, A. Catchot, D. Cook, F. Musser, and J. Moor.

An economic injury level is the point where the smallest number of insects will cause damage equal to the cost of control. Economic injury levels are dependent upon crop value, plant population, insect control costs, and amount of damage caused by a single pest. An economic threshold is the pest density when action is necessary to prevent an increasing population from reaching an economic injury level. During the summers of 2013 and 2014, trials were conducted on both corn earworm and fall armyworm larvae to determine yield reductions caused by each species. Grain sorghum was planted in early May ensuring no natural populations were present. Border rows were sampled weekly for larval presence, but none were present through the duration of the trials. Larvae were placed on individual grain sorghum panicles at eight levels of infestation including: 0, 0.167, 0.25, 0.5, 1, 2, 4, and 6 larvae per panicle. Sleeve cages were placed over infested panicles to reduce migration from plant to plant and predation by birds and other insect predators. Both infested and uninfested panicles were harvested by hand and

damage ratings were collected from infested panicles by visually examining the panicle, looking for the presence of frass and partially devoured grain kernels. Panicle weights were measured and the grain was removed from panicle branches. Grain was weighed to determine the amount of grain consumed at each level of infestation. The amount of grain consumed by one individual larva was determined with regression analysis. Results conclude that one corn earworm larva consumes 2.23 grams of grain and one fall armyworm larva consumes 2.24 grams of grain. These data result in a 3.5% yield loss caused by one corn earworm larva per head and a 3.9% yield loss caused by one fall armyworm larva per head. These results suggest that the current economic threshold is appropriate for these species.

Interaction Weed Management and Thrips Management on Peanut Development and Yield. J. Moor, J. Gore, D. Cook, A. Catchot, F. Musser, and C. Dobbins.

The area planted to peanut has been increasing in Mississippi over the past several years due to lower commodity prices in other crops. Peanuts have become a viable option in a producer's crop rotation on both irrigated and non-irrigated lighter textured soils. Insect pest management is complex, and numerous species typically feed on peanut. In general, at-planting insecticides are recommended to manage soil insects and thrips. Historical research has shown that foliar control of thrips provides little benefit in peanut. However, some pre-emergence herbicides can cause significant injury under certain environmental conditions, and it is not clear how thrips impact seedling peanuts following herbicide injury. The objective of this study was to evaluate the interactions between applications of Orthene and commonly used pre-emergence and post-emergence herbicides. Treatments were arranged as a split-split-plot within a randomized complete block design with 4 replications. The main-plot factor was flood irrigation at 2 levels, flooded and not flooded. The irrigation factor was included to maximize herbicide injury. The sub-plot factor was herbicide application at 2 levels. They included a pre-emergence application of flumioxazin (Valor®, Valent Co.) or no flumioxazin. The sub-sub-plot factor was thrips management at 4 levels. They included 1, 2, or 3 applications of acephate (Orthene 90S, Valent Co.) and an untreated control. Thrips densities were determined at various intervals after emergence to quantify level of control. Additionally, 5 plants were removed from each plot at 23 days after planting and weighed to determine biomass. Percent canopy closure was measured at 64 and 75 days after planting. At the end of the season, plots were harvested and yields were determined. Applications of flumioxazin and acephate each impacted plant weights and percent canopy closure. In general, these impacts were greater where peanuts were flood irrigated.

Impacts of Neonicotinoid Resistance on tobacco thrips, Frankliniella fusca, in the Mid-South. C. Darnell.

This paper will address reduced insecticidal efficacy of imidacloprid, thiamethoxam, and clothianidin against tobacco thrips, *Frankliniella fusca* (Hinds), in the Mid-Southern Region. Over the past several years tobacco thrips, have become an increasing problem throughout the cotton cropping systems in the South. Thrips can cause a delay in maturity and cause a reduction in yield if not controlled. If infestations are severe, thrips can cause a loss of apical dominance or even kill plants. Currently, seed treatments are the primary means of controlling tobacco thrips in cotton. It is critical to understand the potential levels of resistance currently established in populations throughout the southern region of the U.S.

Dose-response bioassays with the three commonly used neonicotinoid insecticides were performed on field-collected adult female tobacco thrips during May and June, 2014 and 2015. Populations were collected from agricultural regions in Mississippi from wild hosts as well as from insecticide-treated crops. 2014 results showed resistance was largely limited to thiamethoxam and clothianidin in the Delta region. However, 2015 suggests resistance is rapidly increasing to all three neonicotinoids throughout the state. Over the past several years farmers have seen a decrease in tobacco thrips control from thiamethoxam . During the 2015 growing season similar control problems with imidacloprid were observed. Further research is planned to confirm findings and to explore the mechanisms that are responsible for resistance to these insecticides.

Populations of foraging honey bees in Midsouth crops. A. Whalen, A. Catchot, J. Gore, S. Stewart, G. Lorenz, D. Cook, F. Musser, J. Harris, and N. Krishnan.

In recent years there has been a global decline in populations of both native and managed pollinators. Pesticides are suggested to contributing in these declines. A study was conducted to see when and at what densities honey bees forage agronomic crops in the Midsouth. Fields of corn, cotton, and soybean were visually sampled for foraging honey bees across Arkansas, Mississippi, and Tennessee. Honey bees were observed at three time intervals and at four distances into each field. Significantly more honey bees were observed in soybean during the middle of the day than in any other crop and time interval combination. To limit interactions between pesticides and foraging honey bees in soybean, pesticides should be applied in the evening rather than at night. This allows for the most time for the residual activity of pesticides to diminish before foraging honey bee numbers increase in the middle of the next day.

Primary Pest Black Fly Species (Diptera: Simuliidae) Occurring in Mississippi. T. M. Nations and J. Goddard.

Black flies are second to mosquitoes as being a notorious blood-feeding pest. In many parts of the world, black flies are a serious problem and transmit various diseases such as onchocerciasis (human) and leucocytozoonosis (animal). Black fly outbreaks were common in Mississippi during the first half of the 20th century, but ended for unknown reasons. There has been a resurgence of black fly problems in Mississippi since 2009. This study was initiated as part of a broader project on black flies in Mississippi. To survey the primary pest species, we chose 10 sites around the state near rivers and creeks known to have black fly breeding and sampled each site with an aerial net once every two weeks from February 1st to July 31st, 2015. A total of 102 black flies was collected during the study. At least, one specimen was hand-netted at each site. Seasonally, we found that black flies were active from March – July, with a peak in May. The two main pest species collected were *Simulium meridionale* and *Simulium jenningsi complex.* The geographic distribution and seasonality of Mississippi pest black fly species will be presented and discussed.

Effects of Compounding Defoliation on Midsouth Soybeans. B.C. Thrash, A.L. Catchot, J. Gore, F. Musser, D. Cook, T. Irby and J. Krutz.

Injury from defoliating insects is responsible for more yield loss to Mississippi soybean producers than any other feeding guild of insects. Insects causing defoliation include bean leaf beetles, soybean loopers, velvetbean caterpillars, green cloverworms, armyworms, grape colaspis, flea beetles, and grasshoppers. In 2013 defoliating insects cost Mississippi producers losses of $42,358,460. Previous research has shown that excessive foliage loss that occurs during the R3-R5 growth stages can have devastating effects on yield. In order to refine the current treatment recommendations and help apply them to situations commonly encountered by producers, tests were conducted during the 2015 growing season in the hills and delta region of Mississippi. Soybeans were defoliated at various levels and growth stages throughout the growing season. Leaf area index, heights and yields recorded periodically. Leaf area index values directly affected soybean yields.

Evaluation of Human Attachment by Larval *Amblyomma maculatum* (Acari: Ixodidae). J.S. Portugal III and J. Goddard.

The tick, *Amblyomma maculatum* Koch (Gulf Coast tick), has recently been shown to be an important disease vector of both medical and veterinary concern. Although much is known about the behavior and ecology of adults, little is known of the immatures. Larval feeding on humans has never been demonstrated (and thus, there are no collection records from humans). In this experiment, approximately 10 larval *A. maculatum*, *Amblyomma americanum* (L.) (a positive control), and *Dermacentor variabilis* (Say) (a negative control), were applied to both forearms of 10 human volunteers (five male, five female). Ticks were placed in plastic caps and secured to skin with medical-grade adhesive tape, and volunteers remained sedentary during the

experiment. After 15 min, caps were removed, and attachment was determined using fine-tipped forceps. Any *Amblyomma maculatum* that were attached were then removed and subsequently examined microscopically to verify identification. A total of 34 ticks attached to the subjects, including 11 *A. maculatum* (5.5%), 23 *A. americanum* (11.5%), and no *D. variabilis*. *Amblyomma maculatum* attached to six volunteers, and no apparent association between gender and attachment rate was noted. No skin lesions developed in the human volunteers bit by *A. maculatum*. This is the first report of larval *A. maculatum* attaching to humans, and is significant in that *Rickettsia parkeri*, a human pathogen vectored by this species, has recently been reported to be transmitted transovarially. If *A. maculatum* are infected as larvae, they could potentially transmit *R. parkeri* to people.

An Examination of the Translocation Abilities of the Diamides in MS Soybean Production. A. Adams, J. Gore, A. Catchot, F. Musser, D. Cook, and T. Irby.

In the past five years, flubendiamide and chlorantraniliprole have become valuable management tools for lepidopteran pests in MS soybean production. These insecticides provide excellent residual control of lepidopteran insect pests and have been widely used since their introduction into the agricultural community. To determine if these insecticides are translocated to other parts of the plant, a series of experiments were conducted in the summers of 2013, 2014, and 2015 at Mississippi State University in Mississippi State, MS. Flubendiamide and chlorantraniliprole were applied to soybean at the V4 and R3 growth stages to determine if they moved to new tissues as the plants developed. Ten upper most newly emerged trifoliates that were not exposed at the time of application and ten leaves from the treated portion of the canopy were removed from each plot to determine the systemic and residual efficacy of these insecticides. Leaves were removed at various intervals after application until 32, 31, and 28 days after treatment in 2013, 2014, and 2015, respectively. At R5.5, ten soybean pods were removed from each plot to determine if the insecticides moved to the seed and to the seed hull. Corn earworm, *Helicoverpa zea* (Boddie), larvae were placed on leaf material, seed, and seed hulls to test for presence of the insecticide. Mortality was evaluated three days after exposure. Larvae were deemed dead if they were unable to right themselves after being flipped onto their dorsal side. At 25 days after treatment, flubendiamide resulted in 90% mortality and chlorantraniliprole resulted in 98% mortality compared to 8%mortality in the untreated control on leaves that were exposed at the time of application. At 25 days after treatment, for leaves that were not present at the time of application, flubendiamide and the untreated control resulted in 10% mortality compared to 90% mortality for chlorantraniliprole. Neither insecticide was detected in the seed or seed hulls in this study. These results suggest that chlorantraniliprole systemically moves to new vegetative structures but not to the reproductive structures of the plant and that the movement of flubendiamide was not observed in these studies.

Influence of Tobacco Thrips (*Frankliniella fusca*) and Reniform Nematodes (*Rotylenchulus reniformis*) on Cotton. W. Crow, A. Catchot, J. Gore, D. Dodds, T. Allen, and D. Cook.

Tobacco thrips, *Frankliniella fusca* (Hinds), and reniform nematode, *Rotylenchulus reniformis* Linford & Oliveira, are important pests of cotton production systems not only because of seedling susceptibility to early season damage, but also the potential of delayed maturity and stunted growth which can result in lower yields. Field studies were conducted in 2015 in Hamilton, MS to evaluate the influence of tillage, seed treatment, and nematicide for the control of tobacco thrips and reniform nematodes. A randomized complete block design with a split-split plot arrangement was used. Treatments consisted of two levels of tillage, (conservational and conventional tillage); six levels of seed treatments or in-furrow applications, (imidacloprid plus thiodicarb, imidacloprid, thiamethoxam plus abamectin, thiamethoxam, aceptate plus terbufos, and an untreated control); and two levels of nematicide, (no nematicide and 1, 3- dichloropropene). Analysis of variance was conducted using the GLIMMIX procedure of SAS 9.4 and p-values that where less than 0.05 were considered significant. There was no significant three way interaction between nematicide treatment, tillage system, and seed treatment on nematode control, thrips control, or damage due to thrips. There was an interaction between seed treatment and tillage on the amount of thrips

damage sustained where conventionally tilled treatments had an overall increase in thrips damage as compared to conservationally tilled treatments, and acephate plus terbufos provided the greatest control against thrips damage compared to other seed treatments. Furthermore, there was a main effect of seed treatment on thrips populations in which acephate plus terbufos provided the greatest population control. Conversely, there were no effects of tillage method, seed treatment, nematicide application, or interactions thereof on nematode population control. There was no interaction between nematicide application and tillage system, or seed treatment, nor was there a main effect of nematicide application on thrips control, damage due to thrips, or nematode population.

Effect of different management strategies on soybean in Mississippi. N. Bateman, A. Catchot, J. Gore, D. Cook, F. Musser, and T. Irby.

The early soybean production system consists of planting group 3 and 4 soybean in March and April to avoid late season drought stress, insect pressure, and disease problems. In recent years we have seen a significant drop in cotton acres and increased grain acres in Mississippi. To manage harvest growers in Mississippi have trended away from the early soybean production system, and have planted more maturity group 5 soybean from mid-April through July to help manage harvest. With these planting dates being delayed later and later, it leaves soybean more vulnerable to late season insect pest such as stink bugs, soybean loopers, and corn earworms.

In 2013 and 2014, seven planting dates of soybean were planted in both the hills and delta regions of Mississippi to quantify the seasonal occurrence of caterpillar pests. Only soybean planted after May 30 reached threshold for caterpillar pests in both years of the study. Because only the later planting dates reached economic threshold, in 2015 three later planting dates of soybean were used. Treatments consisted of automatic diamide applications (Prevathon) to simulate Bt soybeans compared to threshold treatments. This paper will address the potential value of Bt soybeans to Mississippi producers and identify seasonal periods of greatest risk from insect pests in soybeans.

Poster Presentations

Management of the headworm complex in grain sorghum. C. Dobbins, J. Gore, A. Catchot, D. Cook, F. Musser, J. Moor.

The area planted to grain sorghum, *Sorghum bicolor* L. Moench, has increased in recent years due to rising commodity prices that are competitive with other grain crops. Even though commodity prices are increasing, insect control costs are also on an upward trend. For many years, the pyrethroid class of chemistry was applied several times during the growing season providing effective control of sorghum midge, *Contarinia sorghicola* Coquillett, corn earworm, *Helicoverpa zea* Boddie, fall armyworm, *Spodoptera frugiperda* J.E. Smith, and sorghum webworm, *Nola sorghiella* Riley. Pyrethroid control failures on lepidopteran pests was first noticed in the early 2000's leaving producers with fewer tools to manage lepidopteran insects. In the mid 2000's, the diamide class of chemistry was introduced. This new class of insecticide provides an effective control measure with three to four week residual activity. In order to reduce production costs, companies are now pushing for tank mixtures or pre-mixed products that control sorghum midge and also provide lepidopteran control during the entire reproductive stage of the growing season. Efficacy trials were conducted at two locations across Mississippi at two different planting timings. Plots were sprayed with an automatic midge application at 25% bloom, to determine the effectiveness of diamide insecticides on the headworm complex when applied at that time. Treatments included Karate, Besiege, Prevathon, Belt, Baythroid, and an untreated control. Test plots were sampled with a beat-bucket several times and larval numbers were recorded. Results suggest that the diamide insecticides are the most effective products in controlling headworms. Besiege is the better of the products because of its dual action both on sorghum midge and

headworms. Pyrethroid' s suppress larval numbers when insect populations are low but overall efficacy is quite a bit lower than the diamide class of chemistry.

Varietal Response to Thrips, *Frankliniella fusca*, Feeding in Cotton. C. Darnell.

Host plant resistance to thrips, feeding on seedling cotton has potential to reduce reliance on chemical controls. Several species of thrips feed on seedling cotton; however, tobacco thrips, *Frankliniella fusca*, are the most abundant in Mississippi. Thrips feed on cotton with their rasping suck mouth parts by extracting plant juices from young crop cotyledons which can cause yield loss if left uncontrolled.

Thirty varieties of cotton are planted on 95% of acreage in the United States. In this field study eighteen of these varieties where planted in replicated one row plots. Seed without any pesticides were planted to show the innate resistance of the varieties to thrips pressure. Plant damage ratings, stand counts, and thrips counts where taken several times throughout the study. The four varieties that had the best damage ratings overall were PHY 222, FM 2011, ST 4747, and PHY 312.

Evaluating At-Planting Insecticides in Peanuts. J. Moor, J. Gore, D. Cook, A. Catchot, F. Musser, and C. Dobbins

At-planting insecticide applications are recommended for peanuts grown in Mississippi to manage early season pests such as thrips and soil insects like wireworms and white grubs. Experiments were conducted at the Delta Research and Extension Center in Stoneville, MS from 2012 to 2014. All experiments were conducted as a randomized complete block design with four replications. Plots were 4 rows by 12.2-m in length. Insect densities and yields were evaluated among treatments for all experiments. Although thrips control with Cruiser is decreasing due to resistance, peanuts treated with Cruiser have continued to maintain good yield. This is likely the result of controlling other insect pests in the field. Applications of Thimet, Velum Total, and Admire Pro have continued to provide good control of thrips, and they generally result in greater yields than the untreated control. In another experiment where high populations of lesser cornstalk borer occurred, an in-furrow application of chlorantraniliprole (Coragen, DuPont Corp.) provided significant yield protection compared to foliar sprays with other insecticides. These experiments demonstrate the importance of early season insect control in peanuts. As a result, at-planting insecticides are recommended in Mississippi to minimize injury from various insect pests and to maximize yields.

The Influence of Dioecism in Palmer amaranth on Densities of Tarnished Plant Bugs in the MS Delta. D. Denton, D. M. Dodds, C. A. Samples, M. T. Plumblee, L. X. Franca, A. L. Catchot, T. Irby, J. A. Bond, and D. B. Reynolds.

The tarnished plant bug [*Lygus lineolaris* (Palisot de Beauvois)] is the primary insect pest of cotton (*Gossypium hirsutum L.*) in Mississippi, as well as most of the mid-southern growing region of the U.S. In 2012, 99% of the cotton acres planted in the Delta region of Mississippi were infested with tarnished plant bugs (Williams 2013).

Palmer amaranth (*Amaranthus palmeri*), is a fast growing, broadleaf weed that is very problematic in agriculture throughout the Mid-South and Southeastern U.S. Within the genus *Amaranthus*, Palmer amaranth is one of 10 dioecious species that are native only to Native America (Steckel 2007). Although Palmer amaranth has invasive tendencies and a history of expansion, its presence as a major agronomic weed pest is somewhat recent (Ward et al. 2013). In 2009, Palmer amaranth was ranked as the most troublesome weed in cotton in the southern United States (Webster and Nichols 2012). With the proliferation of glyphosate-resistant Palmer amaranth in Mississippi, along with the increasing yield loss and cost to control tarnished plant

bugs, this experiment was conducted to determine whether or not dioecism had an effect on densities of tarnished plant bugs.

An experiment was conducted in 2015 in the MS delta to determine the Influence of Dioecism in Palmer amaranth on densities of tarnished plant bugs. The experiment was initiated in fields with mature Palmer amaranth plants. The locations in the delta consisted of Sidon, Stoneville, Dundee, and Lula, Mississippi. Each of 5 observers randomly sampled 100 male & 100 female Palmer amaranth plants at every location. Tarnished plant bug counts were conducted by visually observing each Palmer amaranth plant. Data were subjected to analysis of variance and means were separated using Fisher's Protected LSD at p = 0.05.

Although male Palmer amaranth plants had significantly greater tarnished plant bug counts, all Palmer amaranth should be destroyed, regardless of sex, to prevent buildup of tarnished plant bug populations that could later become a problem. Non-crop areas such as ditch banks or areas where gin trash is dispersed where Palmer amaranth thrives should be of concern due to the potential threat of high populations of tarnished plant bugs.

Impact of the new Diamide chemistry (Chlorantraniliprole, Prevathon™) on Dectes Stem Borer (*Dectes texanus texanus*, LeConte) infestations in Mississippi Soybeans. N. R. Bateman, A. L. Catchot, J. Gore, D. Cook, G. Lorenz, F. Musser, and T. Irby.

The dectes stem borer (*Dectes texanus texanus*, LeConte) has been reported as a pest in Mid-South soybeans, but is not considered a major pest due to it not causing significant yield loss. This pest mainly lays eggs in the petioles of soybean plants, but will also lay eggs in the secondary stems and the main stem. When the larvae hatch, they feed down the petiole to the main stem where they feed on the pith, and either tunnel up or down the main stem, until the fourth instar when the larvae goes to the base of the plant where it girdles the base of the stem to make an overwintering site.

Traditionally dectes stem borer populations were held at reasonably low number through tillage at the end of the growing season, but with an increased number of acres in no-till or limited till systems, the overwintering sites for dectes stem borer are more prevalent. This has led to higher than normal infestations of dectes stem borers in soybeans. Soybean variety has not shown any impact on larval infestations and currently there are no foliar control options for dectes stem borer larvae.

Eleven locations of soybean were planted throughout Mississippi. These locations had two treatments, an automatic Prevathon treatment from R1 to R6 every two weeks, and a grower check. 100 plants were sampled from each plot. These plants were cut at the soil surface and then split to check for dectes stem borer tunneling on the main stem. Also twenty damaged plants were taken from each plot and the main stem tunneling length was measured in inches. Plots receiving prevathon treatments had a lower percentage of plants infested with dectes stem borers at all locations. Prevathon treated plots had significantly fewer dectes stem borers compared to untreated plots across all locations. There was no statistical difference in tunnel length between the prevathon treated plots and the grower check plots, however, prevathon treated plots averaged 0.8 inches less main stem tunneling than the grower check. When comparing infested plants in the treated and untreated plots, total length of main stem tunneling was negligible.

Toxicity threshold of chitosan to subterranean termites. O. Raji, T. Telmadarrehei, J. Tang and D. Jeremic.

Chitosan is a hydrophilic and biodegradable polysaccharide with antimicrobial properties. It has low toxicity to non-target organisms and is considered an environmentally friendly preservative. In

this study, the efficacy of chitosan polymer (> 50 kDa) as a wood preservative was evaluated against subterranean termites (Isoptera: *Rhinotermitidae: Reticulitermes flavipes*). The treatability and leachability of chitosan from wood was also estimated. Air dried southern yellow pine wood samples were cut to dimensions recommended by the American Wood Protection Association E1 standard. The wood samples were vacuum treated with chitosan solutions ranging from 1-5% (in 25% acetic acid). The treated wood samples, including solvent-treated controls, were exposed to *R.flavipes* termites for two weeks. Visual ratings and mass difference were used to assess the degree of termite damage to the wood blocks, while percent mortality was recorded for the effect of chitosan on the termites. Finally, the mass of chitosan per gram of dried wood before and after leaching was used to determine the leachability of each treatment concentration. Approximately 100% mortality was observed in the termite population exposed to wood treated with 4% and 5% chitosan, whereas 98% mortality was observed in the 3% chitosan-treated samples. Alternatively, only 10% mortality was shown in wood treated with 1% and 2% chitosan. Percent mass loss of treated wood samples decreased with higher chitosan concentration. More than 50% of chitosan retained by the 3 to 5% treated samples was leached, while 27% of chitosan was lost from the 2% treated samples, and leaching removed all chitosan from the 1% treated samples. The results of this study indicate that solutions with chitosan concentrations greater than 3% are adequate for wood protection against *R.flavipes* for short-term, but not for long-term protection.

Field Observations of Questing and Dispersal by Nymphal *Amblyomma maculatum* Koch (Acari: Ixodidae). J.S. Portugal III, J. Goddard.

Almost nothing is known about the questing and dispersal behavior of immature Gulf Coast ticks (*Amblyomma maculatum* Koch), a vector of both medical and veterinary concern. This experiment examined host-seeking (questing) and dispersal of marked nymphal *A. maculatum* released in field plots in rural Oktibbeha County, MS. A total of 500 (250 per replication) *A. maculatum* nymphs were painted and released in five plots (50 ticks each). Observations were then made five times, approximately every three days, searching the plots from the release points outwards to 50 cm. Mean overall vertical questing height of ticks in Replication 1 in March (5.13 cm) was significantly higher than that of Replication 2 in April (2.57 cm) for a combined mean questing height of 3.58 cm. Ticks dispersed at a mean rate of 1.71 cm/day (Replication 1) and 0.98 cm/day (Replication 2), for an overall mean dispersal rate of 1.27 cm/day. When observation days where tick movement was impacted by adverse weather conditions were excluded, means between the replications were much closer. Only 38/500 (7.6%) of the marked ticks were subsequently seen questing in this study, possibly mirroring low questing rates of nymphal *A. maculatum* in nature. Additionally, two ticks were found in dense vegetation at the base of a plant. These data show that nymphs of this species disperse slowly, quest low to the ground, and can hide in very dense vegetation.

Testing a portable nanopore sequencer for usefulness in the fields of agricultural and medical entomology. J. G. King.

Massively parallel sequencing technologies promise to allow the development of detection technologies that will require little prior knowledge of the identities of the organisms or etiological agents present in a sample. One problem with developing these technologies is the size and costs of current instruments. A possible answer to this problem are nanopore-based sequencers which are already highly portable and promise to become more affordable in the near future. Here, we will test a portable nanopore-based sequencer (Oxford, MinION) for its ability to detect diverse plant pathogens from within total nucleic acid preparations of infected plant tissues. Studies testing for efficacy in discerning the contents of insect traps and possible applications in medical entomology will also be discussed.

Mosquitoes Collected in a Rural Area of Central Mississippi and Implications for WNV Transmission. W. C. Varnado and J. Goddard.

To determine abundance and seasonality of potential WNV mosquito vectors in a forested area of central Mississippi, mosquitoes were collected weekly from a wildlife management area located approximately 10 miles from a local urban area with numerous human WNV cases. We were particularly interested in the presence or absence of *Culex quinquefasciatus* Say, the primary vector of WNV in Mississippi, although other *Culex* species were assayed. Two CDC light traps baited with CO_2 were set once a week in the Pearl River Wildlife Management Area (PRWMA) which consists of 6,925 acres primarily composed of bottomland hardwood forest with wetland areas. The collection area is adjacent to the 1,500 acre waterfowl refuge which is located at the southwestern end of the management area. Weekly collections were made January 2005 through December 2006. Traps were placed midafternoon and picked up the following morning. A total of 199,222 mosquitoes were collected during the two-year study. No *Cx. quinquefasciatus* were collected throughout the entire study, although other health department surveys have indicated they are abundant just a few miles away. As for other potential WNV vectors, 1,325 (0.6%) *Cx. nigripalpus* Theobald, 1,804 (0.9%) *Cx. restuans* Theobald, and 6,076 (3.1%) *Cx. salinarius* Coquillett were collected in the PRWMA over the two-year period. These data suggest that *Cx. quinquefasciatus* is not usually found in remote forested environments, but is more associated with human habitation.

A New gland in Lepidoptera Larvae —the Basistipal Fimbriate Pocket of *Cactoblastis cactorum* (Pyralidae). G. Baker, S. Hight and R. Brown.

Unique structures with an apparent glandular function have been found on the ventral surfaces of the larval heads of the cactus moths, *Cactoblastis cactorum* (Berg) and *Melitara prodenialis* Walker. In *C. cactorum* the two invaginated pockets on the basistipal region contain 66-75 fimbria that are wide basally base and tapered apically. In cross-section the fimbria are hollow and are filled with an electron-opaque material. The fimbria arise from the apex of a projecting sac within each pocket. The sac includes a reservoir filled with an electron-opaque material and is lined at the bottom with a single layer of large cells. The cellular structures include extensive rough endoplasmic reticula, numerous mitochondria, and large nucleus and are indicative of a secretory function.

Results from the Regional Identification Center of the USDA-APHIS (Raleigh hub) for the 2015 Wood Boring Beetle Surveys, Including new State and County Records. J. Seltzer, T. Schiefer, and R. Brown

Enzymatic changes of honey bees under imidacloprid insecticide exposure. J. Yao, Y.C. Zhu, J. Adamczyk and R. Luttrell.

Honey bees are facing many increasing environmental pressures such as the decreasing of natural and semi-natural flower-rich habitat, pathogen and parasites infections, and accidental pesticides exposure. Accidental pesticide exposure may deteriorate honey bee immune defense and impair detoxification enzyme activities, which in turn facilitate parasites and pathogens infections. Thus, the development of biochemical and molecular approaches becomes necessary for understanding the pesticide toxicology and for monitoring honey bee colony health. In this study, we used imidacloprid (Advise 2FL), a widely used insecticide, to examine how insecticide applications affects honey bee immune and defense systems. In our first experiment, newly emerged bees (1-2 days old) were treated with insecticide-contaminated food sources (sugar and water) to simulate in-hive insecticide exposure. In another experiment, 3-week old bees (foraging

bees based on bee hive labor differentiation) were treated with Advise by using spraying method to simulate field exposure. The median lethal concentrations (LC50) for feeding and spraying treatments of Advise were 55.5 mg/L, and 197.4 mg/L, respectively. Samples were collected at 6-, 12-, 24- and 48-h after feeding or spraying. The activities of detoxification enzymes (glutathione S-transferase and esterase) and immune-related phenoloxidase were tested at each time. Results showed that phenoloxidase activity was significantly down-regulated by 1.3-1.5 folds at 6- and 12-h after spray treatment of Advise. The activity recovered to the level of untreated bees at 24-h after spraying application. However, the activities of detoxification enzymes, e.g. glutathione S-transferase and esterase, had no significant influence by feeding and spraying exposure to Advise, suggesting these two enzymes are not directly associated with imicacloprid detoxification in honey bees. We will continue to examine cytochrome P450s, another group of detoxification enzymes, by quantifying their gene expressions.

Powdered Food (*Artemia franciscana* eggs) Increases Oviposition in the Pink-Spotted Ladybird *Coleomegilla maculata.* E. W. Riddick, Z. Wu

The limited availability of alternative foods to replace natural prey hinders cost-effective mass production of predatory ladybird beetles for augmentative biological control. Using natural prey (e.g., aphids) to rear ladybirds is not cost-effective, because it often requires culturing live plants as food for prey. We have been evaluating brine shrimp, *Artemia franciscana*, eggs, i.e., decapsulated cysts, as an alternative food. Brine shrimp eggs are 50% less expensive than the industry standard alternative, *Ephestia kuehniella* Zeller (Mediterranean flour moth) eggs. In a previous study, we found that whole *A. franciscana* eggs were suitable as a food source that supported *Coleomegilla maculata* DeGeer (Coleoptera: Coccinellidae) development, but not reproduction. In this study, we compared the effects of using whole versus powdered *A. franciscana* eggs, with or without a dietary supplement, on development and reproduction of *C. maculata*. We tested the hypotheses that (1) powdered eggs are more suitable than whole eggs, and (2) palmitic acid, a common fatty acid in prey, i.e. aphids, is an effective dietary supplement. The results revealed that development time, pre-imaginal survival, sex ratio, and body weight of adults did not differ significantly amongst individuals fed whole versus powdered eggs, with or without 5% palmitic acid. However, total oviposition per female fed powdered eggs was two-fold greater than those fed whole eggs. Total oviposition per female fed powdered eggs with 5% palmitic acid was four-fold greater than those fed whole eggs. A functional relationship was found between pre-oviposition time and total eggs laid by females fed powdered eggs with 5% palmitic acid; pre-oviposition time decreased as oviposition increased. Food treatments had no significant differential effect on egg hatch rate. In conclusion, a simple change in *A. franciscana* egg texture and particle size (i.e., blending whole eggs into a dust-like powder) increases oviposition in *C. maculata*. Supplementing powdered eggs with 5% palmitic acid might accelerate egg maturation (oogenesis) in some females. Powdered *A. franciscana* eggs with 5% palmitic acid appears suitable as a food source to mass-produce *C. maculata* on a large scale for augmentative biological control.

Reproductive Rates of *Nezara viridula* (L.) (Heteroptera: Pentatomidae) Reared on Two Artificial Diets Developed for Lygus spp. M. Portilla, G. Snodgrass, D. Street, R. Luttrell.

The reproductive rates of *Nezara viridula* (L.) (Heteroptera: Pentatomidae) were studied on two artificial diets developed for rearing *Lygus* spp., a fresh (FYD) and a dry (DYD) yolk chicken egg based-diets as an alternative food source for rearing. *Nezara viridula* successfully matured from egg to adult on both diets. The mean developmental time for eggs and first instar nymphs was not statistically different between diets; however, stages of second instar nymphs to adult had

significantly shorter developmental times when reared on FYD. Reproductive activity of *N. viridula* started after adults were 10-d old on both diets. The fraction mating was similar for both diets from the first day of reproductive activity until adults were 23-d old. No significant differences were found between insects on the two diet during the first 23-d. After that mating of stink bugs on FYD was consistently greater than those fed DYD. The first egg masses were present two day after the first copulation occurred in *N viridula* reared on FYD (female 13-d old), and ten days after the first copulation occurred in *N. viridula* reared on DYD (female 20-d old). Thereafter, total eggs/day/total population for both groups was dependent on the frequency of mating. Larger egg masses were observed for insects reared on FYD. Longevity of female and male *N. viridula* was significantly higher for insects reared on FYD. Longevity of females and males were found to be the same on both diets with no significant differences between diet or sex. Although reproduction of stink bugs on the FYD diet was higher than that of the DYD group, fertility and hatching rates were significantly higher for insects fed DYD. All demographic measurement for insects reared on FYD were significant higher than those for insects fed DYD, except for generation time which was shortened almost a week. A higher gross fecundity of 395.8 ± 28.7 eggs/female was obtained for females reared on FYD. Those reared on DYD produced 140.3 ± 51 eggs/female. The biological and demographic parameters obtained in this investigation confirmed that the *Lygus* diet FYD has the potential to mass rear *N. viridula*.

Evaluation of *Beauveria bassiana* strains as Potential Agents for Control of *Megacopta cribraria* (Heteroptera: Plataspidae). M. Portilla, W. A. Jones, O. Perera, N. Seiter, J. Greene, R. Luttrell.

Megacopta cribraria (F.) (Hemiptera: Plataspidae) is an agricultural pest native to Asia. It was discovered in 2009 in the US feeding on kudzu, *Pueraria montana* (Lour) Merr. (Fabaceae). The virulence of three strains of *Beauveria bassiana* (Balsamo) Vuillemin (Sordariomycetes: Hypocrales); including the Mississippi Delta native strain NI8 ARSEF8889 (NI8) isolated from *Lygus lineolaris* (Palisot de Beauvois), the commercial strain GHA or BotaniGard®, and strain KUDSC-001 ARSEF13136 isolated from *M. cribraria* (KUDSC) were bioassayed on kudzu bug adults at two different times post field collection of the insects. Younger adults (8 days after collection) were treated with NI8 and GHA strains and older adult (50 days after collection) were treated with NI8, GHA and KUDSD. Higher concentrations (nx10^6, nx10^7) of NI8 and GHA strains caused kudzu bug mortality 2-d after treatment in younger adults and similar concentrations of NI8, GHA, and KUDSC caused mortality 1-d after treatment in older adults. Lower concentrations (nx10^4, nx10^5) were not significantly different among strains. High variability in lethal dose and sporulation responses were observed among adult age groups. Dose-ratios for mortality and sporulation were significantly higher for younger adults than those ratios found for older adults. Isolate GHA was less virulent than NI8 against young adults, but LD_{50} values of the three isolates did not differ in assays against older adults. LS_{50} values of the KUDSC strain were significantly lower than NI8 and GHA values in older adults. Data presented showed the potential for management of kudzu bugs with the entomopathogenic fungus *B. bassiana*.

Ant Faunal Surveys: A Variety of Collecting Methods is Crucial for Success. J. A. MacGown.

Ants (Hymenoptera: Formicidae) comprise a huge percentage of the terrestrial animal biomass. They occupy numerous ecological niches and habitats throughout the world, and with over 14,000 species worldwide, they are diverse in appearance and habits. Although a few opportunistic species have broad nesting requirements, others are sensitive to anthropomorphic disturbance. As such, the presence or absence of certain species and diversity of species in totality in a given habitat can provide valuable information on habitat quality. In addition to their use as bio-indicators, ants range from being a necessary component of natural ecosystems to

serious economic pests. Despite the amount of research that has been done with ants, new species are routinely being described, and in general, we know little about the biology and geographic range of most species. With increased global trade, the movement of species from region to region has become commonplace. For these reasons and others, faunistic surveys are critical. In addition to necessary taxonomic skills to identify species, a wide variety of collecting methods should be employed to adequately sample ants from the various microhabitats within a habitat or region. Traditionally, most collections of ants are made diurnally by methods such as visual searching, sifting leaf litter, splitting apart rotting wood, usage of pitfall traps, and beating vegetation. Usage of non-traditional ant collecting methods such as Malaise traps, barrier traps, aerial pitfall traps, and blacklight traps can be useful for collections of alate males and females to chart distribution, flight periods, and spread.

Composition and Mosquitocidal Activity of the Essential Oil of *Monarda fistulosa* (Beebalm). C. Ardizzone, A. Rogers, Y. Shaikh, K. Jeffers, J. Hightower, M. Cochran, W. Dees, J. Woolman, O. Christian.

Mosquito-borne diseases remain a major concern in the southern United States. Louisiana is ranked fourth behind Arizona, California, and Colorado for the number of West Nile virus cases reported in 2014. New and more innovative solutions are needed to control or eradicate mosquitoes that vector these disease pathogens. As a part of our ongoing conservation efforts, we examined the mosquitocidal activity of the essential oil of several plant species native to southwest Louisiana. *Monarda fistulosa* L. is a member of the Lamiaceae (mint) family which is known for producing a wide range of volatile insecticidal compounds. In preliminary Petri dish assays, female *Aedes aegypti* (L.) mosquitoes were exposed to the crushed seeds and buds of *M. fistulosa*. Mosquitoes exposed to the macerated seeds and buds exhibited 100% mortality 24 h post exposure. We obtained the essential oils from the seeds and deseeded buds of *M. fistulosa* by hydrodistillation using a Clevenger apparatus. The GC-MS analysis of the buds identified carvacrol, durene, thymol, terpinene-4-ol, and caryophyllene oxide as the major components of the buds. The oil derived from the buds displayed moderate mosquitocidal activity. This study describes the quantification and evaluation of the essential oil derived from the buds of *M. fistulosa* for mosquitocidal activity using a Petri dish contact assay.

Mosquitocidal Activity of *Solidago gigantea* (Giant Goldenrod): Essential Oil Yields Results. C. Ardizzone, N. DeVito, T. Estrada, J. Hightower, M. Cochran, W. Dees, J. Woolman, O. Christian.

Mosquito-borne diseases like chikungunya, dengue fever, and yellow fever remain a significant threat to public health. Aedes aegypti (L.) and Aedes albopictus (Skuse) are the primary vectors for the pathogens that cause these diseases. New and more efficacious strategies to combat these mosquitoes at various stages in their life cycle are critical to controlling the spread of these disease pathogens. Studies are underway in our laboratory that may lead to innovative personal protective measures against these mosquito pests. In preliminary mosquitocidal investigations using freshly ground plant parts of *Solidago gigantea* Ait., we detected no mortality in Petri dish assays using female mosquitoes. Usually, tests that show no evidence of mosquito mortality preclude us from conducting further studies due to the many plant species under investigation. However, due to the abundance of plant material, we decided to investigate the essential oil from *S. gigantea*. Investigations of the essential oil of *S. gigantea* displayed concentration-dependent toxicity toward *Ae. aegypti* mosquitoes in Petri dish contact assays. The essential oil of *S. gigantea* was obtained by hydrodistillation using a Clevenger apparatus. This study describes the evaluation of the essential oil derived from *S. gigantea* for mosquitocidal activity and demonstrates the need for further studies of plant oils and extracts from freshly cut plant parts initially determined to be ineffective against mosquitoes.

Effect of Botanical Components from Native and Exotic Plant Species on Mosquitoes. W. Dees, C. Ardizzone, J. Theriot, K. Leonards, A. Fusilier, O. Christian, C. Richmond, J. Hightower, A. Richard, J. Dupre, M. Cochran, J. Byrne, T. Estrada, A. Daugereaux, S. Mopper, J. Woolman.

We are investigating the effect of plant components and plant derivatives on the behavior and development of medically important arthropods (e.g., mosquitoes, fire ants and nuisance flies). Information obtained from these investigations may lead to innovative area-wide pest management methodologies as well as novel personal protective measures against biting/stinging arthropods. Current studies focus on the effects of botanical components on mosquito mortality. We evaluated the effects of freshly-cut plant parts, including essential oils, from eight plant families on female *Aedes aegypti* L. mosquitoes. Plant families included: Apiaceae, Apocynaceae, Asteraceae, Euphorbiaceae, Lamiaceae, Lythraceae, Malvaceae, and Verbenaceae. We used standard plastic Petri dishes to hold mosquitoes and cut plant parts. Glass Petri dishes were used to test essential oils in contact assays. We recorded percent mortality at 24 and 48 h. Mosquitoes exposed to fresh-cut flowers/petals, buds, leaves, stems, and seeds from Apiaceae, Asteraceae and Lamiaceae exhibited over 50% mortality when compared with the controls. Genera of interest include: *Chrysanthemum*, *Eryngium*, *Eupatorium*, *Rudbeckia*, *Monarda*, *Solidago*, and *Pycnanthemum*. Mosquitoes exposed to different parts of a chrysanthemum plant (flowers, buds, leaves, stems and seeds) exhibited 100% mortality in 24 h. Mosquitoes exposed to cut buds of *Pycnanthemum muticum*, *P. tenuifolium*, and *Monarda fistulosa* as well as crushed seeds of *M. fistulosa* exhibited 100% mortality in 24 h. Mosquitoes exposed to essential oils of *M. fistulosa* and *Eryngium yuccifolium* buds and *S. gigantea* seeds exhibited 100% mortality in 24 h.

Assessing Vector-Borne Disease Risks. W. Dees, D. Foley, D. Pecor, D. Burkett, L. Rueda, R. Wilkerson, C. Ardizzone.

With world-wide efforts by governments, institutions and scientists to monitor and forecast emerging disease risks, there is a need for an easily accessible spatial data repository enabling users to dynamically view the factors influencing these risks. VectorMap (www.vectormap.org), an online repository for medically important arthropod and vector-borne disease biosurveillance data, houses data management tools for uploading and managing surveillance information and spatial data critical for assessing emerging disease risks. VectorMap is a web-based resource for reviewing and depositing collection records of mosquitoes, sand flies, ticks, fleas, mites, animal hosts, and disease pathogens from around the world. This resource contains distribution models of many components associated with vector-borne diseases, including ecological niche and disease risk models related to vector ecology. Users have access to a plethora of information including 450-plus ecological niche models for vector species world-wide, climate data, slide presentations on current vector-borne disease topics, and other resources, including links to the Armed Forces Pest Management Board, Centers for Disease Control and Prevention, World Health Organization, and Walter Reed Biosystematics Unit (WRBU). The VectorMap Team at WRBU provides tools and support for publishing accurate and precise location data, vector identification and associated environmental data, and pathogen testing results, and contributes to global knowledge of vector-borne disease threats by collaborating with individual researchers and institutions around the world. For questions regarding VectorMap or if you wish to have your surveillance data (georeferenced/non- georeferenced data) posted to VectorMap, please email the VectorMap Team at mosquitomap@si.edu. VectorMap's data curation role aims to preserve knowledge that can be used to inform entomologists, medical/health scientists, vector control specialists, preventive medicine practitioners, and health planners about disease vector distributions and vector-borne disease risks.

Crape Myrtle Bark Scale (Hemiptera, Eriococcidae), A Serious New Threat to Mississippi Crape Myrtles, Layton, M. B. and K. Calcote

Crape myrtle bark scale (CMBS), *Eriococcus lagerstroemiae* Kuwana, (Hemiptera, Eriococcidae) was first detected in the US on crape myrtles in Texas in 2004. In March of 2015 CMBS was detected in Ocean Springs, MS and by the end of September infestations were confirmed in four additional locations: Olive Branch, New Albany, Madison, and Oxford. In all five cases it appeared that initial infestation occurred as a result of transport and planting of infested plants from out of state sources and that plants had been installed from one to several years before infestation was detected. Although female scales are wingless, CMBS readily spreads to nearby crape myrtles, with wind, birds, flying insects, and landscape maintenance personnel and other humans being the most likely modes of short-range transport. Infestations appear to be spreading in four of the five infested areas.

Although incipient CMBS infestations are difficult to detect, heavy infestations are quite obvious and easy to diagnose. CMBS produces large amounts of honeydew and heavily infested trees, as well as mulch or plants located under such trees, will be black with sooty mold. Closer examination of such trees will usually reveal branches and twigs that are encrusted with white felt-covered scales. Individual adult female scales are approximately 1/10 inch long and will bleed pink if punctured. Avoiding transport and planting of infested plants is the best means of avoiding this pest. Soil-applied systemic insecticides such as dinotefuran, imidacloprid or thiamethoxam are the most effective treatments for CMBS, but these treatments usually do not provide 100% control. Additional, supplemental treatment options are also available.

Development of a Physiological Age Grading System for the Southern Green Stinkbug. B. Elliot.

Nezara viridula (L.), also known as the Southern green stink bug (SGSB), has increasingly become an agricultural pest of some concern. While much research has been accomplished on this species, only minimal information is available on the morphology of the female's reproductive system especially in relation to morphological changes in relation to number of eggs oviposited. The ability to assess reproductive health and past and present reproductive status based on ovarian morphology (i.e., physiological age-grading) can be an important tool for evaluating field populations and laboratory colonies intended for various experimental trials. Toward the goal of developing a physiological age-grading system for SGSB, females of various chronological ages were randomly selected from laboratory colonies and dissected to assess ovarian morphology. While this research is still in the beginning stages, specific morphological differences in ovarian structure were noted that were apparently related to chronological age and presumably to the number of eggs oviposited. These included differentiation of the ovarioles, deposition of yolk in the most proximal follicle, quantity and appearance of follicular relics, expansion of the lateral oviducts, and number of developing follicles per ovariole. While more research is needed, the continuum of ovarian development can potentially be divided into three nulliparous (i.e., "no eggs") and four parous stages (i.e., "with eggs") based on specific combinations of characteristics as described previously. The current state of knowledge, research status and future directions will be presented.