FARMER FRIENDLY SUMMARY

COTTON INSECT PEST MANAGEMENT
Agreement 10-649TN
Scott Stewart, The University of Tennessee

Funding is used to partially support general extension activities such as scout training, moth trapping, resistance monitoring, insecticide testing and on-farm evaluations of various insect control technologies and treatment thresholds. Funding is also used to help support regional projects, several of which are also minimally supported by core grants from Cotton Incorporated. Pheromone moth trapping for bollworm, tobacco budworm, and beet armyworm are improving the decision making of crop managers. In 2010, moth catches for each county were reported weekly in the Tennessee IPM newsletter. This information is posted on the internet at www.utcrops.com and was distributed to agents, producers, consultants and other agricultural professionals via the *IPM Newsletter*. Only bollworm (i.e., corn earworm) moths were caught in substantial numbers during 2010. As predicted by moth traps, substantial bollworm pressure was observed in several counties of southwest Tennessee. The extensive use of WideStrike and Bollgard II technologies limited the amount of bollworm injury observed in cotton. Data from an annual boll damage survey confirmed a relatively low incidence of boll damage in West Tennessee. Nevertheless, caterpillar induced boll damage in WideStrike cotton was the highest on record in our survey since 2005. Assays using bollworm moths indicated low to moderate resistance to pyrethroid insecticides that would probably not result in noticeable field control failures unless larval populations were unusually high. Analyses show that 80 to 100% of bollworm moths caught during late July and early August are originating from grass hosts, likely corn. The boll damage survey recorded about average levels of injury from hemipteran pests.

As part of several multi-state projects, several experiments were done in Tennessee including the evaluation of 1) in-season use of Temik for insect management in cotton and efficacy of selected insecticides for control of the tarnished plant bug, 2) automatic insecticide applications following preventative insecticides for thrips, and 3) cotton yield loss caused by two-spotted spider mite and efficacy of selected miticides. Comprehensive reports for these efforts have been submitted by the appropriate project leaders. However, abbreviated reports for these projects are included within. We successfully identified the best pesticides for control of spider mites and plant bugs. For the third year, data indicated that side-dressing Temik significantly reduced plant bug infestations and improved cotton yields, although results are variable. Across 13 locations, at-planting insecticides for thrips control statistically improved yield at four locations in 2010, similar to 2009. Supplemental foliar insecticides in addition to at-planting treatments did not statistically improve yields.

About 20 additional experiments related to insect pest management in cotton were successfully completed in 2010. These evaluations included many insecticide efficacy trials for thrips, spider mites, plant bugs, stink bugs and bollworm. The data generated from these above experiments are used to validate and modify extension insect control recommendations in Tennessee. The results of most experiments have been individually summarized and published on the www.utcrops.com website.

ANNUAL REPORT

COTTON INSECT PEST MANAGEMENT
Agreement 10-649TN
Scott Stewart, The University of Tennessee

Funding for this project was used to partially support general extension activities such as scout training, moth trapping, insect damage surveys, resistance monitoring, and insecticide testing and on-farm evaluations of various insect control technologies and treatment thresholds. In addition, funds were also used to help support several regional projects as described herein.

1) Moth Trapping. Despite the use of Bt-transgenic cotton on over 95% of the acreage in Tennessee, bollworm and tobacco budworm still compose an important pest complex. Bollworms may cause significant economic damage to Bt cotton fields, and the bollworm/budworm can be even more damaging to non-Bt cotton. More importantly, the threat of tobacco budworm infestations results in high adoption of Bt cotton. Resistance to pyrethroid insecticides in tobacco budworm populations makes distinguishing between budworm and bollworm infestations very critical in non-Bt cotton. Using a pyrethroid insecticide on a "worm" infestation which contains a significant percentage of tobacco budworms often results in serious economic losses.

Area-wide monitoring remains a valuable tool in predicting the occurrence and size of pest populations. Pheromone trapping programs for bollworm, tobacco budworm, and beet armyworm provide insight into the timing and intensity of moth flights. For example, unusually high trap catches for a particular species can alert consultants and producers to the potential for impending outbreaks. When performed on a regional level and over a number of years, moth trapping can indicate historical and geographical patterns in the distribution of pest populations. Moth monitoring improves the decision making process, helping crop managers in the selection of insecticides and to indicate the need for intensified sampling efforts. This ultimately helps to minimize control costs and/or yield losses incurred by producers. Traps can also be used to collect moths used in assays for resistance to pyrethroid insecticides.

Pheromone moth traps for corn earworm (CEW or bollworm), tobacco budworm (TBW), and beet armyworm (BAW) were run on a weekly basis from early May through August. Traps were located in cotton growing areas of each county and were usually placed on the borders of cotton fields. All pheromone lures were obtained from Great Lakes IPM (Vestaburg, MI) and were changed at two week intervals. At least one, and usually two, sets of bollworm and tobacco budworm traps were run in each of the following 12 counties in West Tennessee: Carroll, Crockett, Dyer, Fayette, Gibson, Hardeman, Haywood, Shelby, Tipton, Lake, Lauderdale, and Madison. One beet armyworm trap was located in each of the above counties.

Outcomes: Moth catches for each trap were reported weekly in the Tennessee IPM Newsletter. The newsletter is distributed to agents, cotton producers, consultants and other agricultural professionals and is also posted on the internet at www.utcrops.com.

Tobacco budworm moth catches were low and similar to previous years (Figs. 1, 4). Most tobacco budworm moths were caught in Tipton and Shelby Counties. It is not surprising that few if any fields of cotton were treated for tobacco budworm considering the low acreage of non-Bt cotton and the low populations of tobacco budworm. The highest single-trap capture was recorded in west Fayette County where 36 moths were caught the week preceding August 18.

Catches of corn earworm (i.e., bollworm) moths in pheromone traps were much higher than tobacco budworm (Fig. 1). Statewide average moth catches peaked at the highest level observed since 2004 (Fig. 5). The bollworm is Tennessee's most significant caterpillar pest in cotton because this species is able to cause economic injury to Bt cotton which composes the vast majority of the acreage. Peak trap catches during 2010 were earlier than typical, probably due to higher than normal temperatures (Fig. 5). Some areas experience sustained bollworm pressure beginning in mid July and continuing until mid August. By far, the most corn earworm moths were caught in Shelby, Tipton and Lauderdale Counties (Fig. 3). The highest single trap catches in these counties ranged from 143-362 moths per week. Very few beet armyworm moths were caught in 2010 with no week averaging more than 1 moth per trap across West Tennessee (Fig. 1).

Trapping did not necessarily reflect all local variations in pest densities observed in cotton fields, in part because trap density was not high and because other factors influence oviposition and survival of these pests in cotton. However, the pheromone trapping program did an excellent job of predicting the relatively high populations of corn earworm populations observed in some areas, including populations found in soybean.

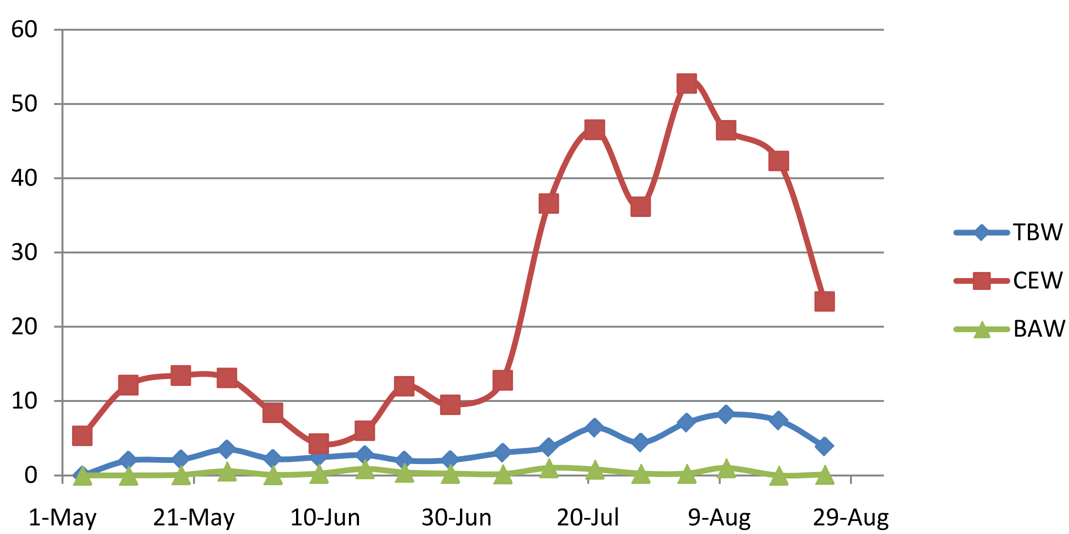

Figure 1. Average number of tobacco budworm (TBW), corn earworm (CEW), and beet armyworm (BAW) moths caught per trap in pheromone traps across West Tennessee (2010).

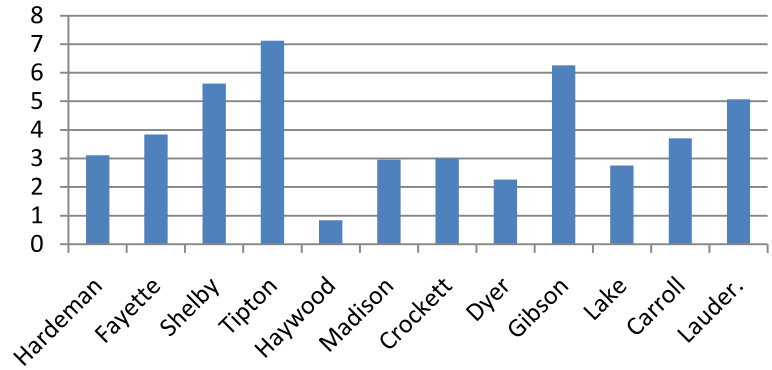

Figure 2. Seasonal average number of tobacco budworm moths caught per trap per week in each county during 2010.

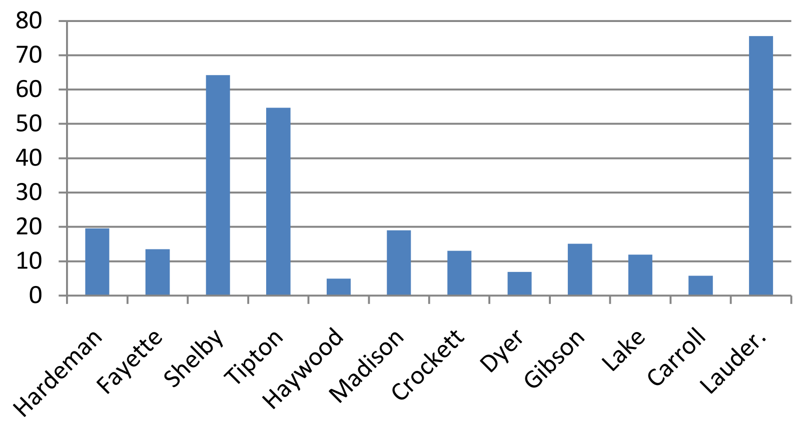

Figure 3. Seasonal average number of corn earworm moths caught per trap per week in each county during 2010.

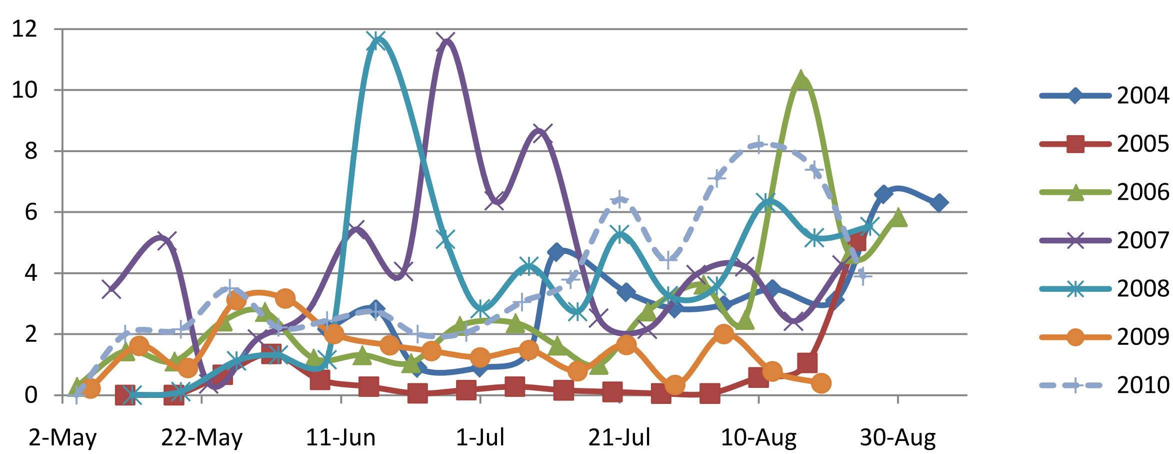

Figure 4. Statewide average catches of tobacco budworm moths during 2004-2010.

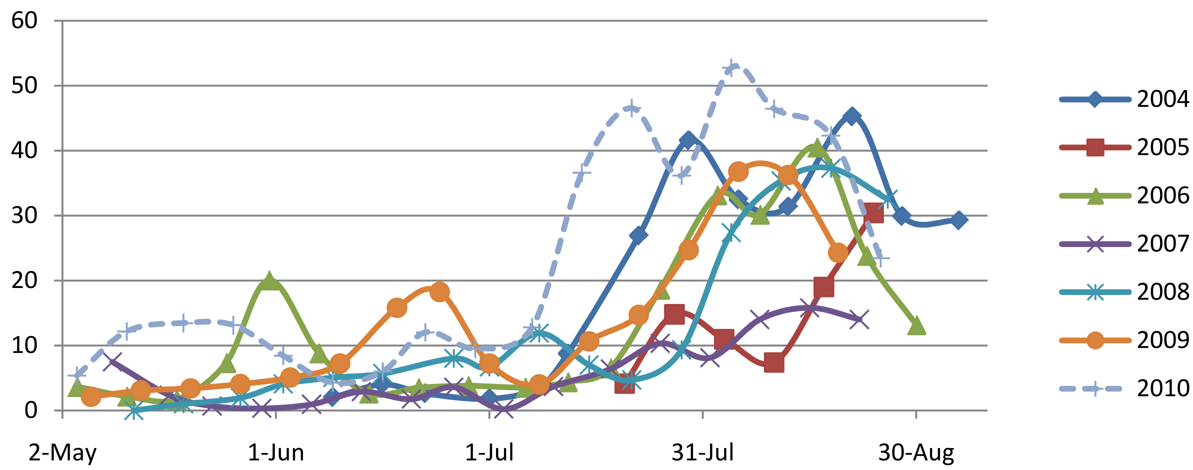

Figure 5. Average statewide catches of corn earworm moths during 2004-2010.

2) Boll Damage Survey in WideStrike and Bollgard II Cotton. A survey has been conducted in late season annually beginning in 2002. Since 2005, we have been doing this survey for selected varieties in the UT County Standardized Variety Trial. These data are used to identify major insect pests, changes in pest trends, and to estimate relative pest pressure from year to year. This information provides a historical database and also helps determine the relatively efficacy of various transgenic traits (e.g., Bollgard, Bollgard II and WideStrike). From 2002 – 2009, boll damage attributed to caterpillar pests in non-Bt cotton has ranged from 0.7 to 9.4 % (Table 1). In these years, Bollgard II and WideStrike cottons have reduced this damage by about 90% with Bollgard II being slightly more effective. Boll damage attributed to hemipteran pests such as plant bugs and stink bugs has ranged from 3.0 to 9.2% during this same time period.

Table 1. Summary of boll damage surveys from 2002 to 2010 showing average percent damage caused by caterpillar pests in West Tennessee.

Trait	2002	2003	2004	2005	2006	2007	2008	2009	Avg.
Non Bt	9.39	8.29	2.04	1.50	5.13	0.72	1.48	2.85	3.93
Bollgard	2.41	3.21	0.31	0.08	1.25	0.18	0.33	---	1.11
Bollgard II	---	1.05	0.13	0.08	0.15	0.08	0.05	0.33	0.26
WideStrike	---	---	---	0.12	0.35	0.13	0.10	0.41	0.32

Note: total bolls sampled ≈ 134,000

In 2010, as part of the County Standard Testing program, WideStrike and Bollgard II cotton varieties were planted in grower fields throughout West Tennessee. Unfortunately, a non-Bt cotton variety was not included in the testing program during 2010. Two varieties within these tests were surveyed to compare insect injury including a WideStrike (PHY 375 WRF) and Bollgard II (DP 0912 BGII/RF) cotton variety. Note that varieties with the original Bollgard technology are no longer available. Damage surveys were done from 17-20 August. At each of nine locations, three samples of 100 consecutive bolls each were taken in each variety. This number of locations was fewer than expected. Several tests were lost because of flooding associated with the 15-20 inch rainfall event that occurred in early May. County tests included in the survey were Carroll, Shelby, Gibson (2), Lake, Tipton, Fayette (2) and Hardeman. The data recorded included numbers of bolls with "worm" injury primarily caused by bollworm, tobacco budworm or fall armyworm; numbers of bolls with "bug" injury (stained lint, etc.) caused by hemipteran pests such as plant bugs or stink bugs; and the number of bolls with boll rot not apparently caused by insect injury. It is almost certain that no boll damage occurred from tobacco budworm because non-Bt cotton was not included. Only bolls which potentially could contribute to yield were sampled. Application of foliar insecticides was similar across varieties within each location. It should be noted that these one-time, late season survey is not intended to estimate yield loss caused by these pests. It almost certainly underestimates yield loss caused by insects which may have caused previous fruit shed. Rather, this survey is designed to provide information concerning the relative efficacy of Bt technologies and to help document annual variation in populations.

Outcomes: Boll damage caused by caterpillar pests averaged 0.78% in WideStrike cotton and 0.19% in Bollgard II cotton across all locations in 2010 (Table 2). This level of injury was consistent to previous years for Bollgard II but higher than usual for WideStrike (Table 1). All other locations except one had < 1% boll damage from caterpillar pests. Unfortunately, without having a non-Bt variety in the survey, it is difficult to put these numbers in context to previous years. Boll damage from bollworms was not high in two areas where the moth flight was high (i.e., Tipton and Shelby Co.).

Boll damage caused by hemipteran pests (i.e., plant bugs and stink bugs) was about average compared with previous years, averaging 3.8% across both varieties in 2010. However, boll damage was considerably lower than the previous two years which averaged about 6.2 and 9.1%, respectively. Overall boll damage caused by hemipteran pests was consistent with average but highly variable populations of tarnished plant bug and stink bugs observed across the state. The worse damage was observed at the Shelby County location (15%). Owing to the lack of rain during late season, no boll rot was observed at any location. This was starkly opposite of what was observed in 2009 when cool and wet conditions persisted during the season.

Table 2. Average percent boll damage by variety across nine locations in 2010.

Variety	Bugs	Caterpillar	Rot	Total
PHY 375 WRF	4.07	0.78	0.00	4.85
DP 0912 B2RF	3.56	0.19	0.00	3.74
Average	3.81	0.48	0.00	4.30

Damage = penetration of boll wall.
Each location = 3 samples of 100 consecutive, harvestable bolls per variety.

3) Resistance Monitoring. Insects are well known to develop resistance to insecticides. There is increasing documentation of bollworm resistance to pyrethroid insecticides in parts of the lower Midsouth. Although pyrethroid and acephate resistance in some tarnished plant bug populations has also been documented in at least part of the Midsouth, until recently there have been no monitoring efforts in Tennessee. Therefore, an insecticide resistance monitoring program was instigated in 2006 for both bollworm and tarnished plant bug populations collected in West Tennessee. Monitoring resistance of key insect pests helps to document resistance and implement insect resistance management plans. Vial assays of adults are used in both cases.

Populations of tarnished plant bugs were not tested in 2010. Vial assays using 5 ug/vial cypermethrin, a synthetic pyrethroid, were again performed on bollworm moths in 2010. This represents a discriminating dose where 90% or higher of susceptible moths are expected to die after 24 h exposure. Fresh bollworm (i.e., corn earworm) moths were collected from traps that were baited with pheromone lure on the previous night. All moths were collected in Madison County at the West Tennessee Research and Education Center. For several years and as part of a cooperative effort, moths from the above tests have been submitted to scientists in Mississippi (F. Musser, R. Jackson) who are assaying moths using a technique that determines if the larval host was a C_3 or C_4 plant. These data are being collected to better understand the population dynamics of bollworm and determine the impact of host origin on resistance levels. C_3 plants are broadleaves such as cotton and soybean. C_4 plants are usually grasses, and presumably any bollworms testing positive for C_4 plants developed on corn or sorghum because these are primary hosts during the time frame of moth trapping.

Outcomes: 1074 moths were used in the vial tests that were done between 12 June and 9 September, 2010. Percent survival after 24 h was recorded for moths in treated and untreated vials (see figure below). The average, corrected percent survival of moths to the 5 ug/vial dose of cypermethrin was about 10%, similar to 2008 and 2009, and less than observed in 2006 (16%) and 2007 (21%). In 2010, peak moth survival in treated vials was about 25% in early August (Fig. 6). These data indicate some level of resistance but not levels that should result in field control insecticide failures when spraying pyrethroid insecticides for the control of bollworm infestations. In perspective, 25-45% of bollworm moths collected in Louisiana during July of recent years have survived when exposed to this same discriminating dose (Fig. 7). However, across a broad geography, there has been an overall reduction in moth susceptibility to cypermethrin in vial assay test in the last decade (Table 2).

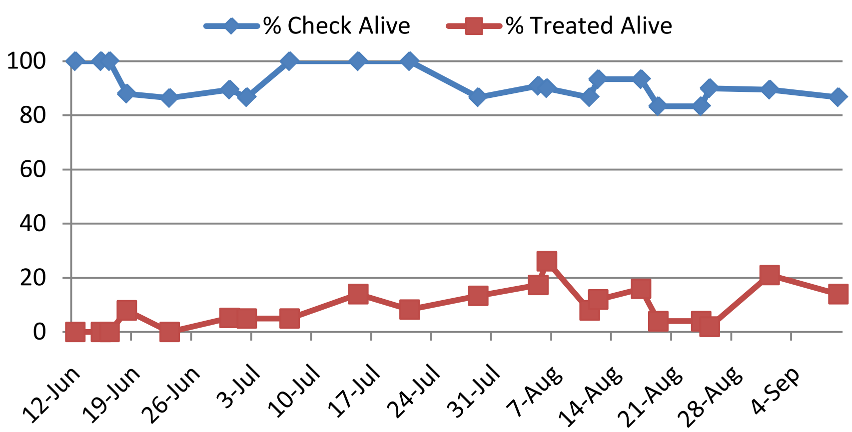

Figure 6. Percent survival of bollworm moths to cypermethrin in vial assays (24 h exposure).

Table 3. Percent survival of CEW to 5 ug cypermethrin in vial assays tests during July for three year periods separated by a decade. Numbers are statewide averages during those times. Table courtesy of F. Musser.

State	% Survival in July @ 5 µg/vial		
	1998-2000	2008-2010	Change
Arkansas	3.8	18.7	14.9
Georgia	9.6	15.4	5.8
Louisiana	11.7	47	35.3
Mississippi	0	12.6	12.6
Missouri	12.4	8.4	-4
S. Carolina	10.9	9.9	-1
Tennessee	0	14.6	14.6
Texas	4.5	6.3	1.8
Virginia	9.5	31.2	21.7
Overall	8.2	18.2	10

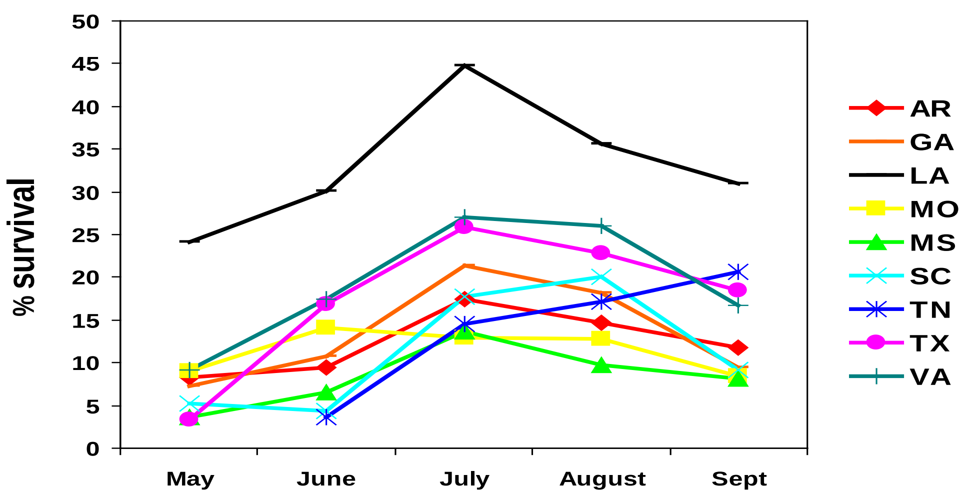

Figure 7. Percent survival of CEW to 5 ug cypermethrin in vial assays tests. Numbers are statewide averages during 2007-2010. Figure courtesy of F. Musser.

C_3 and C_4 analyses indicate that across a large area over 80% of corn earworm moths in the landscape during late July and August are originating from grass hosts, likely corn (Fig. 8). Increased survival in vial assays also observed in July and August may be partially related to the increased fitness of moths originating from corn, as corn is a relatively good larval host compared with most other. The data show that production of moths from corn fields is probably the dominate factor influencing subsequent corn earworm pressure in cotton. Thus, implications are that new Bt corn traits that caused more mortality in corn will reduce corn earworm populations in cotton and other crops.

Unrelated to pyrethroid vial assays, three colonies of bollworm/corn earworm were collected from cotton or corn. Larvae were sent to Ryan Jackson (USDA-ARS, Stoneville) as part of a resistance monitoring program for Bt cotton. Dr. Jackson has reported the results of his efforts elsewhere.

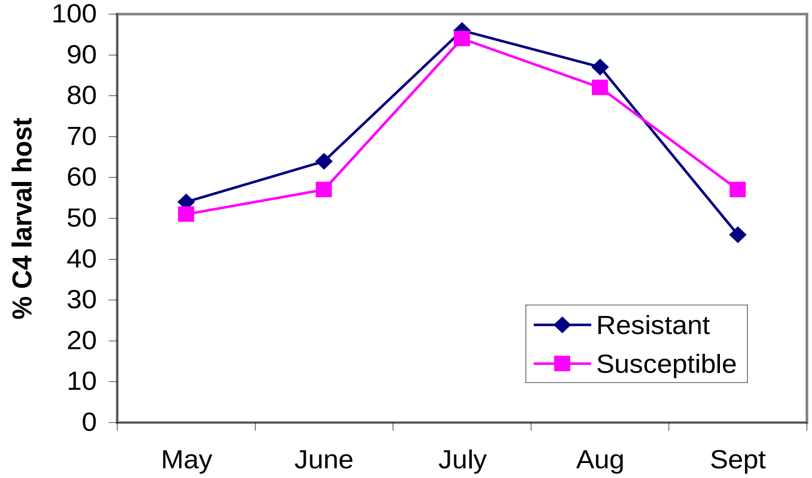

Figure 8. Percent of bollworm (corn earworm) moths whose larvae host was a C4 plant, typically a grass and likely corn or sorghum during late July and August (2007-2009). Figure courtesy of F. Musser.

4) Regional Projects. In 2010, about $10,000 in core Cotton Incorporated funding was received to support several regional projects. Full reports on these efforts have been submitted separately by project leaders. However, shortened summaries are included here because state-support funding is substantially used to complete these efforts.

a) In-season use of Temik for insect management in cotton and efficacy of selected insecticides for control of the tarnished plant bug (PI: Don Cook, 08-457). The cotton-corn interface has proven to be a hot spot for tarnished plant bug. In this study, scientists from five states are evaluating the value of side-dressing Temik (aldicarb) in cotton rows adjacent to corn as a means to control tarnished plant bug populations both in this interface and in the remainder of the cotton field. In 2010, one test was done in Lauderdale County, TN as part of this effort, and tarnished plant bug infestations were very high at this location. Another component of this regional project was the standardized evaluation of insecticides for the control of tarnished plant bug, including their impact on square retention and yield.

Outcomes: Across LA, AR, MS, TN, and MO, trials were conducted during 2008 (nine trials), 2009 (ten trials) and 2010 (ten trials) to evaluate the impact of in-season application of aldicarb on tarnished plant bug infestations and yield. Selected sites were fields with a corn-cotton interface with cotton rows running parallel to the corn. Corn and cotton fields were not separated by more than 40 feet of uncultivated land (turn-row, ditch, etc.). The trials included 2 treatments (Temik 15G and a non-treated control) that were applied in addition to all normal production practices. Temik 15G was applied to the first 32 rows from the edge of the field next to corn at 10 lb/acre as a side-band when plants in the adjacent corn field were at the green silk stage or the cotton had reached the match-head square stage. Plots were at least 100 ft long, with a minimum of three replications. All of the plots within a trial were arranged along the corn–cotton interface using a randomized complete block design. With the exception of the Temik applications, the fields were managed according to the growers' standard production practices, including insecticide applications over the entire field.

Sampling for tarnished plant bugs was initiated at the time of Temik application and collected weekly for 4-6 weeks. Across all years, there were trends for lower numbers of TPB adults and nymphs were observed beginning 2-3 three weeks after application of Temik (e.g., Table 4). When averaged across locations, there were also strong trends for increased yield in plots treated with Temik (Figs. 9). The sample locations, rows 9-16 and 17-24, in the Temik treated plots produced significantly more yield compared to the same locations in the non-treated plots. Also, the sample locations 150 ft outside of the Temik plots yielded significantly more than the same sample locations adjacent to the non-treated plots, thus indicating there may be whole field benefits to treating border rows with Temik. Across all rows the Temik treated plots produced significantly more yield compared to the non-treated plots (Fig. 10). Unfortunately, it appears that Temik will no longer be available after 2014. However, these data suggest the possibility of border management as a method to help control infestations of TPB in cotton adjacent to corn.

Table 4. Impact of side dress application of Temik 15G on tarnished plant bug densities across rows sampled by drop cloth during 2010. Table courtesy of D. Cook.

	Total Tarnished Plant Bugs[1]/10 row ft				
Rows/Treatment	Week 1[2]	Week 2[2]	Week 3[2]	Week 4[2]	Week 5[2]
Temik	-	1.9	4.1	4.5a	5.2
Non-Treated	-	1.8	4.8	5.7b	6.4
P>F	-	0.84	0.07	0.02	0.08

Means with a common letter are not significantly different (FPLSD, *P*<0.05).
[1]Adults plus nymphs. [2]Weeks after application.

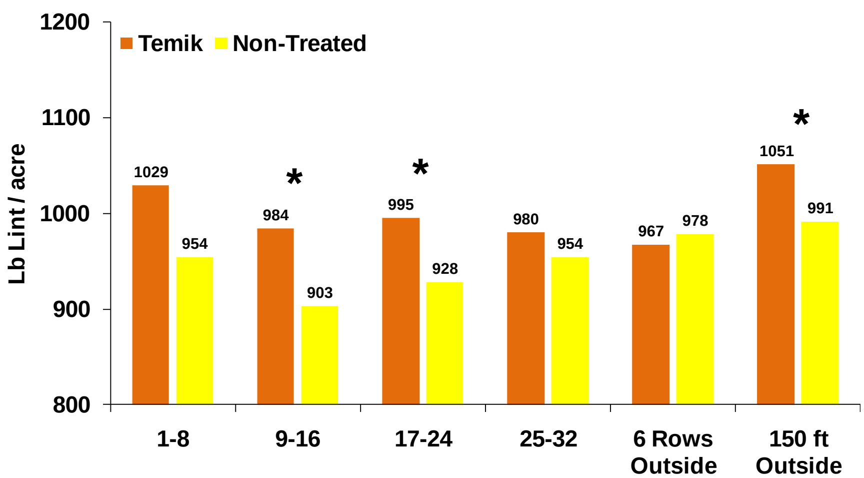

Figure 9. Average effect side-dressing Temik on cotton yields during early squaring, 2008-2010. Results are shown for rows at increasing distance from a bordering corn field. Rows 1-8 from interface with corn; Rows 9-16 from interface with corn; Rows 17-24 from interface with corn; Rows 25-32 from interface with corn; 6 rows outside of and adjacent to the treated and non-treated plots; 150 feet outside of and adjacent to the treated and non-treated plots. An asterisk indicates a significant difference (P < 0.05). Figure courtesy of D. Cook.

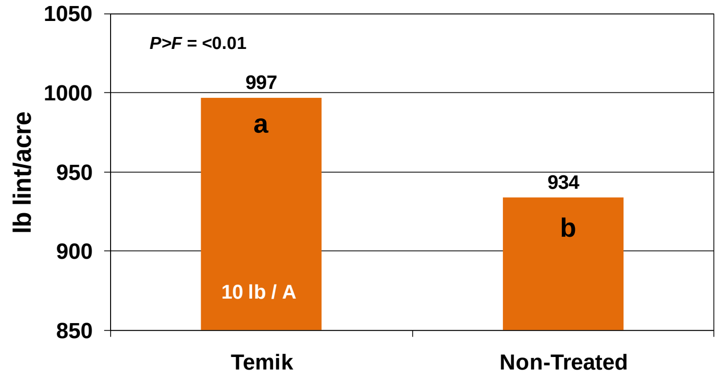

Figure 10. Average effect side-dressing Temik on cotton yields during early squaring, 2008-2010. Figure courtesy of D. Cook.

The results of the standardized efficacy trial indicated that several insecticides or insecticide pre-mixes provide better control than alternative compounds, but all treatments reduced tarnished plant bug numbers (Fig. 11) and increased square retention (data not shown). Orthene 90 (0.75 la/a), Bidrin (6 oz/a), Centric (2 oz/a), Endigo (5 oz/a) and Diamond (9 oz/a) reduced tarnished plant bug populations the most (as was also observed in 2009). The Tennessee location experienced heavy infestation of both TPB and stink bugs with a total of four applications being needed. Yield data were variable, however, all treatments improved yield compared with untreated plots (Fig. 12). Carbine, Trimax and Intruder provided the least yield protection when used in this manner. It is important to recognize that although these data provide good relative comparison of insecticide efficacy for TPB they are not intended to simulate actual use patterns. Other patterns may include various rotations of different chemistries for resistance management and the control of other pests and may also be more economical.

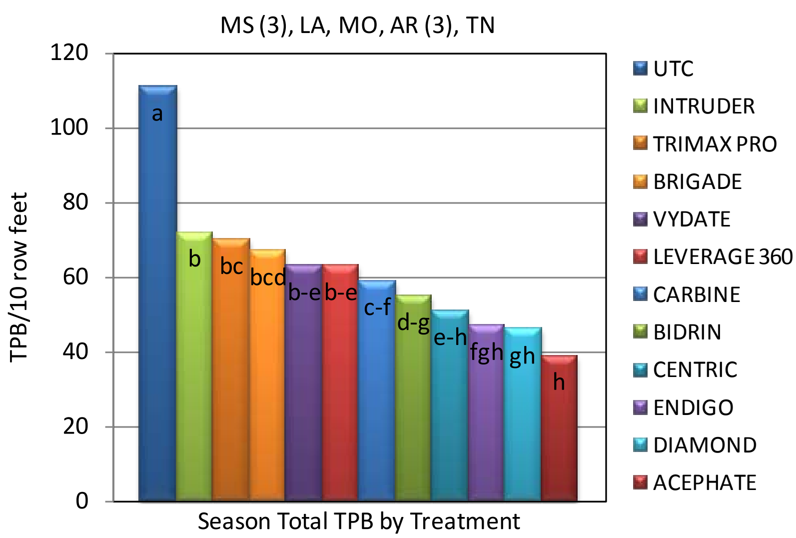

Figure 11. Seasonal average total number of TPB from a standardized TPB assessment trial across nine locations in 2010. Bars not followed by a common letter are significantly different (P < 0.10). Figure courtesy of G. Lorenz.

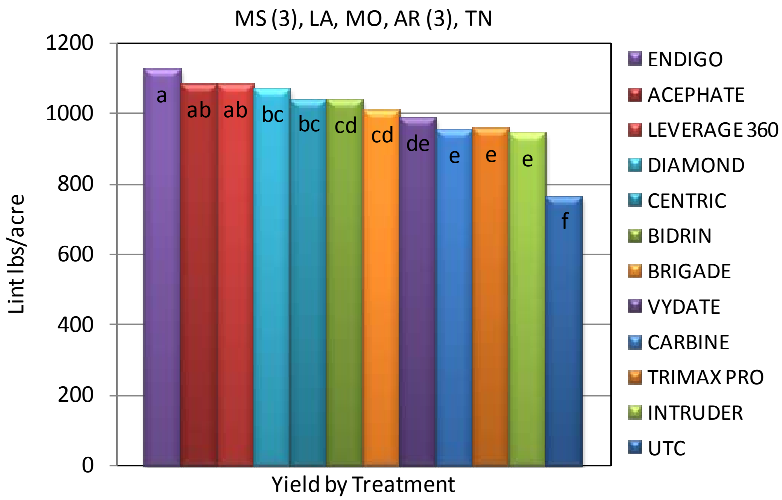

Figure 12. Average yield from a standardized TPB assessment trial across nine locations in 2010. Bars not followed by a common letter are significantly different ($P < 0.10$). Figure courtesy of G. Lorenz.

b) Evaluation of automatic insecticide applications following preventative insecticides for thrips (PI: Scott Akin). For a second year, a standardized experiment was implemented at 18-19 locations across the Cotton Belt including a location in Madison Co., Tennessee. The main intent of this study is to determine in which conditions do scheduled, foliar applications of insecticide for the control of thrips on seedling cotton result in improved yield. Another component of this project was the survey of thrips species that are present across a wide geography.

Plot size was 4 rows x 50 feet and arranged in a randomized complete block design with factorial arrangement of treatments (3 x 4, 4 replications). Treatments consisted of two factors including 'Factor A' (at-plant insecticide) and 'Factor B' (automatic application timing of foliar insecticide). 'Factor A' consisted of no seed preventative insecticide, Aeris® seed treatment, or Temik® 15G (5.0 lbs/A) applied in-furrow. 'Factor B' consisted of no foliar application, an automatic application at 1-2 true leaves, an automatic application at 3-4 true leaves, or automatic applications at 1-2 and 3-4 true leaves. Varieties were chosen based on optimal agronomics/insect protection (e.g., PHY375 WRF in TN) for each location. Seed-cotton yield was recorded from the middle two rows and analyzed with various secondary data such as thrips numbers, weather data, nematode samples, plant stage at each sampling, and a maturity rating of the approximate date when the plots reached NAWF5.

<u>Outcomes:</u> Data from this test are not fully analyzed. As in 2009, tobacco thrips were by far the most common species observed across the Cotton Belt during 2010 (data not shown). Western flower thrips were the dominate species at a few locations (e.g., Texas). In Tennessee, soybean thrips were common in both years. Overall, the data showed that at-planting insecticide treatments improved yields at some but not all locations (Fig. 13). This was similar to results in 2009. Also similar was that subsequent foliar applications with acephate only slightly (and non-significantly) increased yields about those of at-planting treatments alone (Fig. 14). In Tennessee, neither at-planting treatment nor foliar insecticide sprays significantly impacted yield.

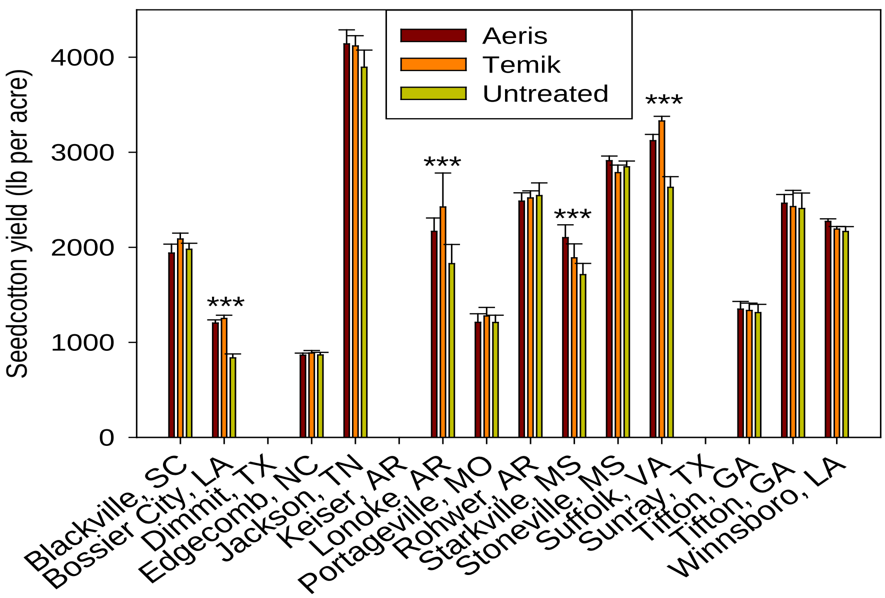

Figure 13. Impact of at-planting cotton treatments on yield at 13 locations in 2010. Locations with a significant yield increase from at planting insecticides are designated by asterisks (***). Figure courtesy of S. Akin.

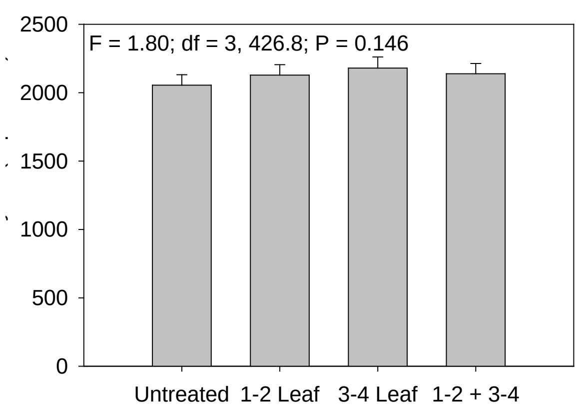

Figure 14. Yield effects from foliar applications of acephate on seedling cotton made at the 1st leaf, 3rd leaf of 1st and third leaf. Data are averaged across 13 locations in 2010. Figure courtesy of S. Akin.

c) Evaluation of cotton yield loss caused by two-spotted spider mite and efficacy of selected miticides (PI: Jeff Gore). One component of this test is investigating how the timing and intensity of spider mite infestations impact yield. Five states were involved in this test, including Tennessee. In each state, spider mites were infested onto cotton at different growth stages, and the intensity and duration of infestations were noted as well as the impact on the plant and yield. One possible outcome of this experiment is to determine a point in which applications to control infestations can be terminated based on crop maturity. A second component of this project is the standardized evaluation of miticides across the Midsouth, including determining treatment effects on yield.

Outcomes: Spider mites significantly impacted yields where data was able to be generated (Fig. 15). Infestations initiated at the 3-leaf stage resulted in significantly lower yields compared to all other treatments. On average, no significant yield loss was found where infestation began at first flower + 400 DD60s or later. However, infestations beginning at 400 heat units beyond first bloom resulted in a significant yield reduction at one location each in 2009 and 2010 (data not shown). In Tennessee, spider mite infestation crashed beginning in mid July as a result of a fungal epizootic. The cotton subsequently recovered from injury, and there was no impact on yield. These data suggest that spider mites are unlikely to cause yield loss if infestations begin at first flower + 600 DD60s; however, more data is needed.

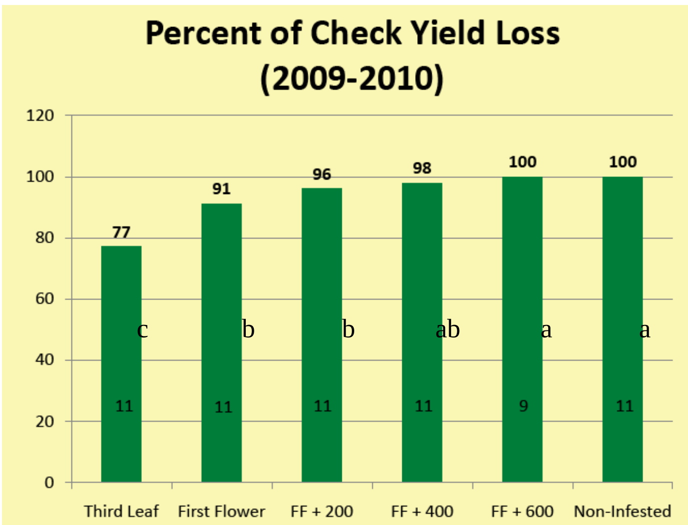

Figure 15. Yield (lb lint/acre) of plots infested with spider mites at various growth stages (9-11 Locations, 2009-2010). Mites were infested at third leaf, first flower, and at 200 heat unit increments past first flower. Figure courtesy of A. Catchot.

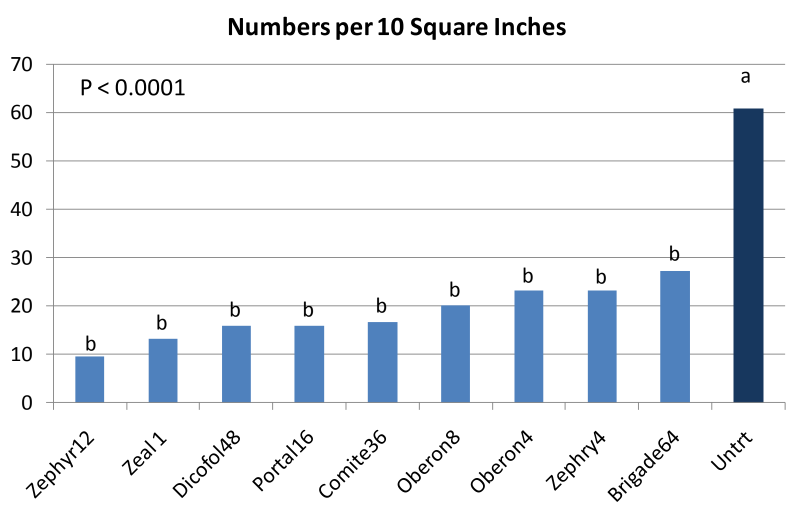

Figure 16. Regional spider mite efficacy trial - numbers of spider mites in cotton at 7-9 days after treatment with multiple acaricides (10 Locations, 2009-2010). Rates are shown on the x-axis in oz product per acre.

The standardized miticide efficacy trial showed that all miticides provided statistically significant control of spider mites (Fig. 16). Portal, Zephyr (12 oz/a), Zeal and Brigade provided the best yield protection, but all miticides numerically improved yield (Fig. 17).

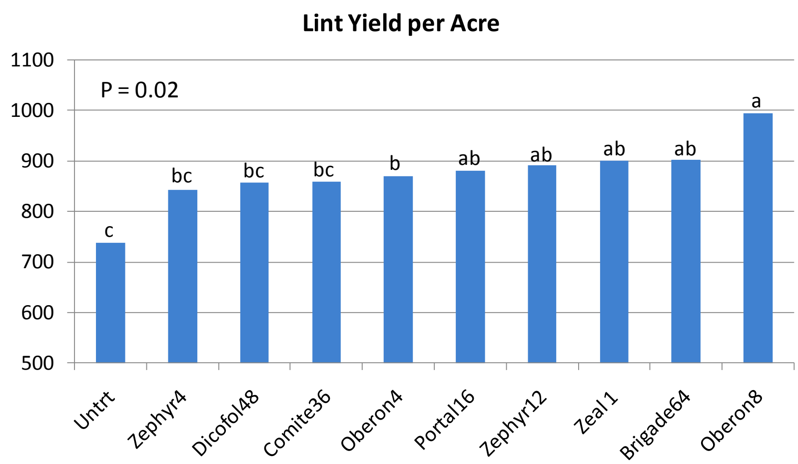

Figure 17. Regional spider mite efficacy trial - yield (lb lint/acre) after treatment with acaricides (5 Locations, 2009-2010). Rates are shown on the x-axis in oz product per acre.

5) Other Activities. Funding for this project is used to support general IPM Extension activities in Tennessee and an insecticide screening program. This includes the delivery of the annual Cotton Scout School held at the West Tennessee Research and Education Center. Scouts are delivered classroom-style and in-field training related to cotton plant development, insect management (identification, sampling, etc.) and disease and weed identification. A scouting notebook was prepared for each attendee. This project also supports the preparation and publication of *Insect Control Recommendations for Field Crops* (UT Publication, PB1768) which contains IPM information for cotton. This publication is also available on the web at www.utcrops.com. In addition, numerous insecticide trials and other experiments were established in 2009 to investigate various insect control practices and strategies for cotton pests. In all cases, replicated trials were established in an RCB design, usually with four replicates, and analyzed using appropriate statistical methods.

Outcomes: Because of decreased cotton acres in the state, only 50 scouts participated in the Cotton Scout School during 2010. A scouting notebook was prepared for each attendee. About 1,500 copies of the *Insect Control Recommendations for Field Crops* (PB1768) were distributed to clientele groups. Demand for this publication has nearly doubled since insect control recommendations for cotton, corn, soybean, wheat, sorghum and pasture were included in one publication.

Approximately 20 other experiments were successfully established in cotton to investigate various insect control practices and strategies. The data generated from these activities are used to validate and modify extension insect control recommendations for Tennessee. These evaluations included insecticide efficacy trials for thrips, spider mites, plant bugs, stink bugs and bollworm. For example, tank mixes for the control of multi-pest complexes were investigated in several experiments. Rate responses for tarnished plant bug and stink bug were also studied for acephate, bifenthrin (Fanfare), and dicrotophos (Bidrin). Tests included several new insecticides and insecticide formulations such as sulfoxaflor (Transform, Dow AgroSciences) and clothianidin (Belay, Valent) for control of plant bugs and stink bugs. Tank mixes of Ignite and Sequence with and without foliar insecticides were done to determine injury potential on seedling cotton, specifically PHY375 WRF cotton being planted on the majority of acres in Tennessee. The results of these experiments have been individually summarized and are available on www.utcrops.com at the link below. The same website also serves as a data warehouse for some efficacy trial done by other universities in the Midsouth.

Insecticide Trials - http://www.utextension.utk.edu/fieldCrops/MultiState/MultiState.htm.