SUMMARY

EXTENSION SUPPORT - COTTON INSECT MANAGEMENT
Agreements 07-961TN and 07-962TN
Scott Stewart, The University of Tennessee

Funding for this project 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. Pheromone moth trapping for bollworm, tobacco budworm, and beet armyworm provides insight into the timing and intensity of moth flights. 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. In 2008, moth catches for each county were reported weekly in the Tennessee IPM newsletter. This information was posted on the internet at www.utcrops.com and was distributed to agents, producers, consultants and other agricultural professionals. Moth catches were generally low in 2008 with peak bollworm catches occurring in mid August. This was consistent with the generally low populations observed in fields. Corresponding data from an annual boll damage survey also confirmed the relatively low incidence of caterpillar infestations in West Tennessee. Assays using bollworm (i.e., corn earworm) moths indicated low resistance to pyrethroid insecticides that would probably not result in noticeable field control failures unless larval populations were unusually high. Assays with tarnished plant bugs collected from wild hosts in selected cotton growing areas indicated low levels of resistance to pyrethroid insecticides and acephate. There was no indication that tarnished plant bugs were becoming resistant to the neonicotinoid class of insecticides (e.g., Trimax Pro or Centric).

About 20 separate experiments related to insect pest management in cotton were successfully completed in 2008. These evaluations included an evaluation of Bt cotton traits and insecticide efficacy trials for thrips, spider mites, plant bugs, stink bugs, aphids and bollworm. The data generated from these above experiments are used to validate and modify extension insect control recommendations in Tennessee. Only selected results are shown in this report. However, the results of all experiments have been individually summarized and published on the utcrops.com website at http://www.utextension.utk.edu/fieldCrops/MultiState/MultiState.htm. This website is also being maintained as a data warehouse for many insecticide trials conducted in the Midsouth. Unlike 2007, several experiments indicated that Temik did not provide as good of control of thrips populations in seedling cotton compared with insecticide seed treatments, probably because of very heavy rainfall in the two weeks following planting. Newly labeled premixed (Bidrin XP and Endigo ZC) and tank mixed insecticides provided good control of plant bugs, at least comparable to traditional foliar treatments. Dicofol (e.g., Kelthane) continues to provide consistent and economical control of early season spider mites. However, several other miticides gave statistically similar levels of control. Bifenthrin (e.g., Brigade or Discipline) and Dimethoate did not provide adequate control of early season spider mite infestations. A foliar insecticide tests again showed that a new insecticide, rynaxypyr (Coragen, DuPont) is providing excellent control of bollworm infestations in non-Bt and Bollgard cotton. An evaluation of new Bt corn traits (YieldGard VT Pro and SmartStax, Monsanto) suggests these technologies will reduce bollworm moths emerging from corn fields and subsequently infesting cotton.

FULL REPORT

EXTENSION SUPPORT - COTTON INSECT MANAGEMENT
Agreements 07-961TN and 07-962TN

Scott Stewart, The University of Tennessee

Justification and Approach

Funding for this project 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, these funds were also used to help support a multi-state evaluation of tarnished plant bug sampling methodologies and threshold levels. The complete activities for this project (Agreement No. 07-240) have been reported separately by the project director (Musser, Mississippi State University).

1) Moth Trapping. Despite the use of Bt-transgenic cotton on about 95% of the acreage in Tennessee, bollworm and tobacco budworm 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 result 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.

2) Boll damage survey in non-Bt, WideStrike, Bollgard and Bollgard II cotton. A late season survey of boll damage in grower fields has been performed annually since 2003. In recent years, 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 crop losses. This information provides a historical database and also helps determine the relatively efficacy of various transgenic traits (e.g., Bollgard, Bollgard II and WideStrike).

In 2008, as part of the County Standard Testing program, non-Bt, WideStrike, Bollgard and Bollgard II cotton varieties were planted in grower fields throughout West Tennessee. Four varieties within these tests were surveyed to compare insect injury in non-Bt (DP121 RF), WideStrike (PHY375 WRF), Bollgard (DP444 BR) and Bollgard II (STN4427 BGII/RF) cotton. Damage surveys were done from August 14-22. At each of 14 locations, three samples of 100 consecutive bolls each were taken in the above varieties. Counties included in the survey included: Carroll, Chester, Crockett, Dyer, Fayette, Shelby, Gibson (2), Hardeman, Haywood, Lake, Lauderdale, and Madison (2). 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. Only bolls which potentially could contribute to yield were sampled. Application of foliar insecticides was similar across varieties within each location.

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 parts 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 were used in both cases.

a) Tarnished Plant Bug. Populations of tarnished plant bugs were collected from wild hosts in cotton growing areas of West Tennessee and sent to Dr. Gordon Snodgrass (USDA ARS, Stoneville, MS). As part of a regional effort, scientists from Mississippi and Arkansas also submitted samples. Indeed, Tennessee scientists assisted in collecting four populations from northern Arkansas. However, only data for Tennessee (2006-2008) are shown. Three classes of insecticides were evaluated including synthetic pyrethroids (permethrin) and organophosphates (Monitor or acephate). If sufficient numbers of insects were collected, assays with neonicotinoid insecticides (imidacloprid or thiamethoxam) were done to generate baseline susceptibility data to this class of insecticides. The results of insecticide treated vial assays for each population are presented, and populations were considered at least moderately resistant if:

- permethrin or Monitor --- discriminating dose mortality < 75%, or
- acephate --- LC50 Value > 7.50

b) Bollworm. Vial assays using 5 ug/vial cypermethrin, a synthetic pyrethroid, were again performed on bollworm moths in 2008. 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. Moth survival in untreated and treated vials was recorded after a 24-h period. Both surviving and dead moths from treated vials have been submitted to scientists in Mississippi (F. Musser, R. Jackson) who are assaying moths to determine host origin (C3 vs. C4 plants). These data are being collected to better understand the population dynamics of bollworm and determine the impact of host origin on resistance levels. As in previous years, most moths were collected in August because trap catches were low in previous months

4) 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. Because of decreased cotton acres in the state, only about 40 scouts participated in the Cotton Scout School in 2008. 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 UTcrops.com.

Numerous insecticide trials and other experiments were established in 2008 to investigate various insect control practices and strategies for cotton pests. The data generated from these activities are used to validate and modify extension insect control recommendations in Tennessee. Selected results are presented in this report. In all cases, replicated trials were established in an RCB design, usually with four replicates. Data were analyzed with ANOVA procedures using Fischer's Protected LSD ($\alpha = 0.05$) for mean separation.

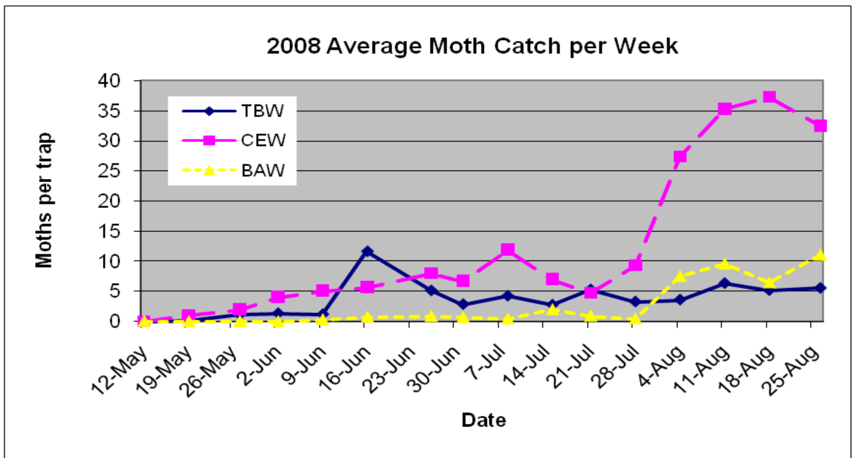
Results, Progress, and Accomplishments

1) Moth Trapping. 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.

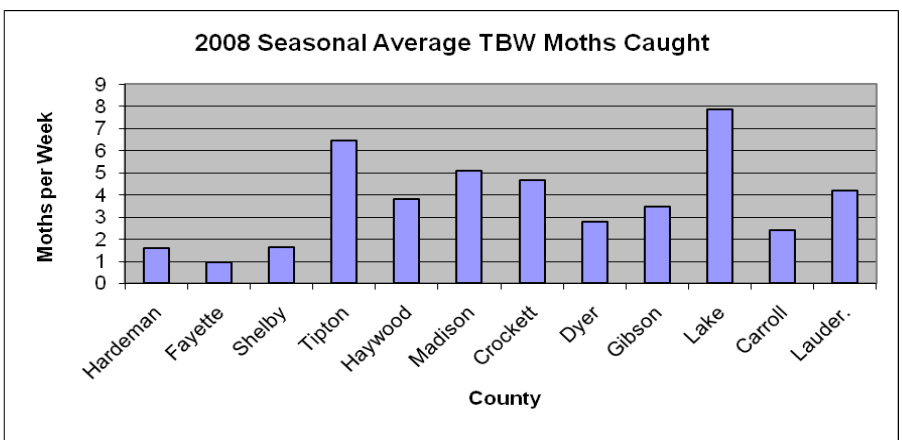
Tobacco budworm moth catches were similar to 2006 and 2007 with an early June peak reflecting emergence from alternate hosts. Most tobacco budworm moths were caught in Tipton, Haywood, Madison, Crockett and Lake Counties. It is not surprising that very few fields of cotton were treated for tobacco budworm considering the low acreage of non-Bt cotton and the generally low populations of tobacco budworm. The highest single-trap capture was recorded in north Madison County where 47 tobacco budworm moths were caught the week preceding June 16.

Catches of corn earworm (i.e., bollworm) moths in pheromone traps were also relatively low in 2008, although they were about twice as high as those observed in 2007. 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 2008 occurred in mid to late August, about two weeks later than usual and when most fields were too mature to be at significant risk. It is likely that the unusually late corn crop caused by heavy spring rains also resulted in a delayed emergence of corn earworm from corn. More corn earworm moths were caught in Madison, Gibson and Lake Counties than other areas. The highest single trap capture was 223 moths in Lake County during the week preceding August 18. Few beet armyworm moths were caught in 2008 with an average peak in trap catches in August of about 10 moths per trap per week. The highest single trap catch was 72 moths in Lauderdale County during the week preceding August 18.

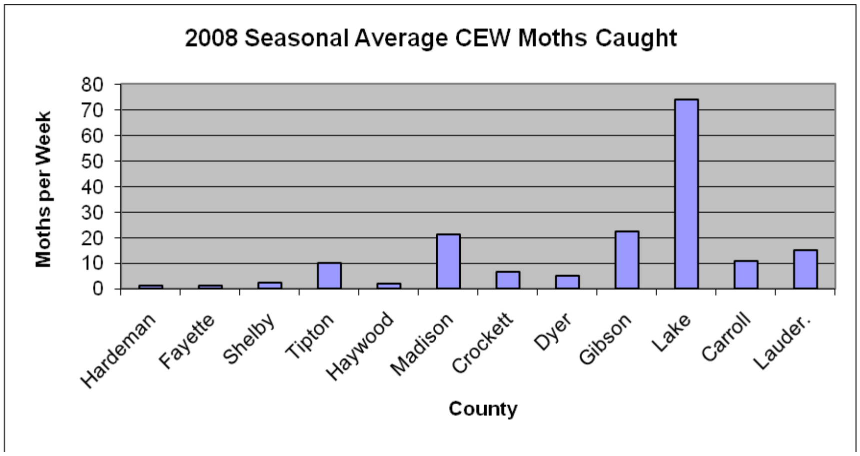
Trapping did not necessarily reflect all local variations in pest densities observed in cotton fields, in part because trap density was not high and because other factors influence oviposition and survival of these pests in cotton. However, the pheromone trapping program did an excellent job of predicting the relatively late occurrence of corn earworm populations observed in 2008. This correlated well with reduced late season boll damage (see below).



Average number of tobacco budworm (TBW), corn earworm (CEW), and beet armyworm (BAW) moths caught per trap in pheromone traps across West Tennessee (2008).



Seasonal average number of tobacco budworm moths caught per trap per week in 2008.



Seasonal average number of corn earworm moths caught per trap per week in 2008.

2) Boll Damage Survey in Non-Bt, WideStrike, Bollgard and Bollgard II Cotton. A survey has been conducted in late season annually beginning in 2003. In 2003, caterpillar-induced boll damage was 9.2, 3.8 and 1.3% in non-Bt, Bollgard and Bollgard II cotton, respectively. About 5.8% of surveyed bolls were injured by hemipteran pests (i.e., bugs). In 2004, boll damage attributed to worms was 2.04, 0.31 and 0.13% in non-Bt, Bollgard and Bollgard II cotton, respectively. Approximately 3.5% of bolls were injured by bugs in 2004. Survey results from 2005 indicate that, like 2004, there was relatively little injury from caterpillar pests. Significantly more worm damage was observed in non-Bt cotton (≈ 1.5%) varieties than in Bollgard (0.08%), Bollgard II (0.08%) and WideStrike (0.12%) cotton. Across all varieties, about 4.3% of bolls had evidence of bug damage in 2005. The 2006 survey of boll damage indicated low bug injury to bolls across the state (average ≈ 1.5%). This was consistent with unusually low stink bug and plant bug populations observed in most areas of West Tennessee. Boll injury caused by caterpillar pests, primarily bollworm, was about 5% in non-Bt cotton in 2006. In 2007, boll damage caused by caterpillar pests was the lowest recorded since this survey began, averaging only 0.72% in non-Bt cotton across all locations. Caterpillar induced boll damage in Bollgard, Bollgard II and WideStrike varieties was inconsequential. Despite low infestations of plant bugs or stink bugs in many areas during 2007, bug induce boll damage was only slightly lower than in previous years (≈ 3% across all varieties).

In 2008, boll damage caused by caterpillar pests was again low, averaging only 1.48% in non-Bt cotton across all locations (see table below). Caterpillar damage in non-Bt cotton averaged 3.0%, 7.7% and 3.7% at the WTREC, Lauderdale County and Haywood County locations, respectively. All other locations had < 2% boll damage from caterpillar pests. Bollgard, WideStrike and Bollgard II cotton averaged 0.33%, 0.10% and 0.05% damage from caterpillars, respectively. This low level of injury was consistent with moth trapping data and in-field observations of larval infestations. Boll damage caused by hemipteran pests (i.e., plant bugs and stink bugs) was the highest recorded since the survey began in 2003 (overall average of 6.16% across varieties, range = 0.3 – 33.3%). This increase was also consistent with higher than normal populations of stink bugs observed in many areas during 2008. We continue to observe slightly more bug damage in non-Bt cotton. This indicates that some caterpillar injury is being confused with stink bug or plant bug injury.

Late season survey - average percent boll damage by variety (14 locations, 2008)

Variety	Worm Damage	Bug Damage	Boll Rot	Total Damage
DP 444 BG/RR	0.33	5.43	0.02	5.79
PHY 375 WR*	0.10	5.05	0.00	5.14
ST 4427 B2RF*	0.05	5.79	0.00	5.85
DP 121 RF*	1.48	6.40	0.00	7.88

Damage = penetration of boll wall
Each location = 3 samples of 100 consecutive, harvestable bolls per variety
* Phy370 WR, ST4554 B2RF and PHY425 RF used at one location

3) Resistance Monitoring. Resistance to selected insecticide was monitored for two important insect pests, the tarnished plant bug and bollworm.

a) Tarnished Plant Bug. Data from Tennessee (below) indicated relatively low levels of resistance compared with the lower mid-southern states, particularly Mississippi and Louisiana. However, survival in assays using acephate indicated all populations had at least moderate levels of resistance to this insecticide. The same was true for populations collected for northern Arkansas. A trend toward decreasing susceptibility to acephate appears to be occurring, but thus far, obvious field control failures have not been observed in Tennessee. No populations showed significant levels of resistance to permethrin, indicating that pyrethroids should still provide adequate plant bug control in cotton if populations are not unusually high. No resistance issues have been identified for neonicotinoid insecticides (imidacloprid or thiamethoxam) indicating that Trimax Pro and Centric should provide control of tarnished plant bugs similar to that observed in previous years.

Tarnished plant bug insecticide assay data from Tennessee from 2006 - 2008. Bolded numbers indicate populations with potential resistance.

Year	Collection Site (County)	Discriminating Dose (% Mortality)		LC50 Value (ug)	
		Monitor	Permethrin	Acephate	Imidacloprid
2006	Haywood*	86	100	**---**	0.81
	Lauderdale*	90	100	---	0.86
	Madison*	98	100	---	0.71
	Gibson*	98	100	---	0.93
	Crockett	**60**	86	4.92	---
	Dyer	86	**68**	---	2.21
2007	Haywood*	**72**	98	7.22	---
	Lake*	88	**75**	**---**	---
	Madison*	**68**	96	**9.62**	---
	Dyer	96	96	**10.53**	1.04
	Crockett	90	100	4.89	---
	Tipton	88	84	**10.64**	---
2008	Crockett	---	86	**11.03**	---
	Lauderdale	---	96	**---**	---
	Madison	---	96	**7.82**	---

	Tipton	---	86	**9.43**	1.13**

* Spring or early summer samples (other samples were made late summer or early fall).
** Thiamethoxam (i.e., Centric) used in this assay.

b) Bollworm. Vial assays with cypermethrin, a synthetic pyrethroid, were done using bollworms moths collected from pheromone traps (table below). Across all locations, corrected mean percent survival to the 5 ug/vial dose of cypermethrin was about 5% and substantially lower than observed in the previous two years (16% in 2006, 21% in 2007). This level of resistance should not result in field control insecticide failures when spraying pyrethroid insecticides for control of bollworm infestations. In perspective, 30-45% of bollworm moths collected in Louisiana during July of recent years have survived when exposed to this same discriminating dose.

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

Untreated Vials

Date	# Moths Treated	% Alive
8-Jul	9	66.7
9-Jul	6	83.3
15-Jul	11	72.7
30-Jul	30	80.0
31-Jul	30	70.0
1-Aug	30	100.0
5-Aug	30	93.3
7-Aug	30	93.3
9-Aug	30	100.0
13-Aug	30	96.7
14-Aug	27	92.6
20-Aug	15	73.3
28-Aug	25	96.0
29-Aug	39	97.4
5-Sep	2	100.0
Total	344	89.8

Rate (5 ug/vial)

Date	# Moths Treated	% Alive
8-Jul	8	25.0
9-Jul	7	28.6
15-Jul	12	8.3
30-Jul	59	15.3
31-Jul	38	26.3
1-Aug	51	11.8
5-Aug	100	22.0
7-Aug	35	7.7
9-Aug	50	8.0
13-Aug	36	0.0
14-Aug	27	0.0
20-Aug	14	0.0
28-Aug	25	16.0
29-Aug	38	13.2
5-Sep	3	0.0
Total	503	13.32

4) Other Activities. Because of decreased cotton acres in the state, only about 40 scouts participated in the Cotton Scout School during 2008. A scouting notebook was prepared for each attendee. About 2,000 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 18 insecticide trials were successfully established in 2008 to investigate various insect control practices and strategies for cotton pests. 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, aphids and bollworm. They also include the testing of several new insecticides and insecticide formulations. Only selected results are presented in this report, but the complete results of all experiments have been individually summarized and published on the utcrops.com website at http://www.utextension.utk.edu/fieldCrops/MultiState/MultiState.htm. The same website also serves as a data warehouse for other insecticide trials done by other universities in the Midsouth. Besides these tests, funding from the Cotton Incorporated State Support Program was also used to partially support a core project. This regional project is reported separately (by Musser et al., Mississippi State University) and is evaluating treatment thresholds and alternative management approaches for tarnished plant bugs.

a) Selected Thrips Test – Insecticide Treatment by Variety. Identical experiments were done in Tennessee and Virginia (Ames Herbert, Virginia Tech) to evaluate how different cotton varieties responded to thrips injury. Three commonly grown varieties were selected (ST4554 B2RF, PHY370 WR, PHY375 WRF). The same insecticide treatments were applied to each variety (untreated, Temik @ 5 lb/acre, Gaucho @ 0.375 mg ai/seed). Data were collected on thrips numbers and injury (Figs. 1 and 2), various plant growth and maturity parameters (Figs. 3-6) and yield (Fig. 7). Both Temik and Gaucho treatments significantly reduced thrips numbers and injury. Consequently, plants grew and matured more quickly in treated plots, and yields were also higher. In Tennessee, Temik generally did not provide the same level of plant protection as Gaucho, presumably because of excessive rainfall in the few weeks after planting. Temik tended to perform slightly better than Gaucho at the Virginia location. Second-pick yield data indicated that all varieties partially compensated for thrips injury, but unlike a previous study, the response to thrips injury was similar across varieties.

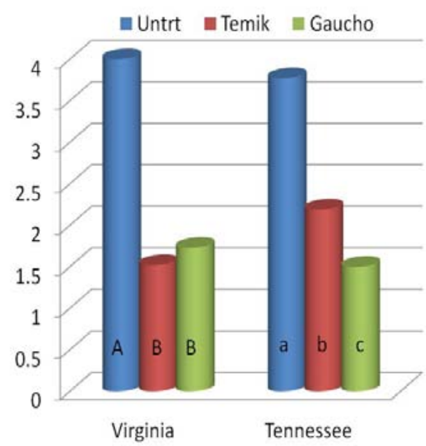


Figure 1. Thrips injury (0-5 scale) on 5/27 (VA) and 5/20 (TN) in each of three treatments: Untreated, Temik 15G (5 Lb/A) and Gaucho (0.375 MG AI/Seed)

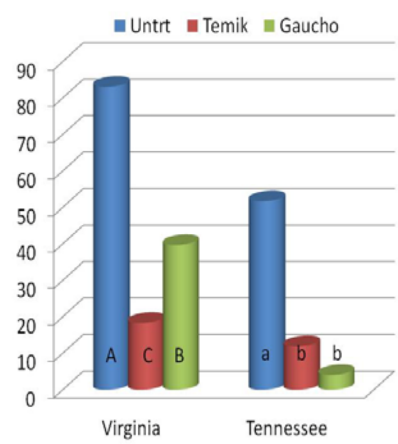


Figure 2. Numbers of thrips per five plants on 6/2(VA) and 5/20 (TN) in each of three treatments: Untreated, Temik 15G (5 Lb/A) and Gaucho (0.375 MG AI/Seed)

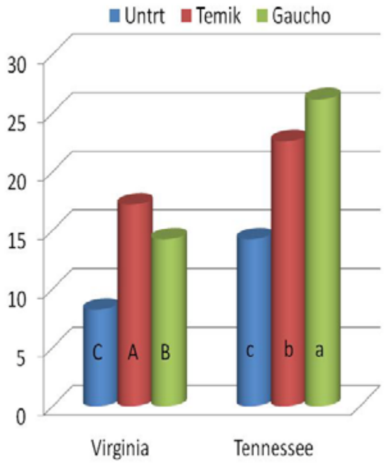


Figure 3. Plant height (cm) on 6/25 (VA) and 6/16 (TN) in each of three treatments: Untreated, Temik 15G (5 Lb/A) and Gaucho (0.375 MG AI/Seed)

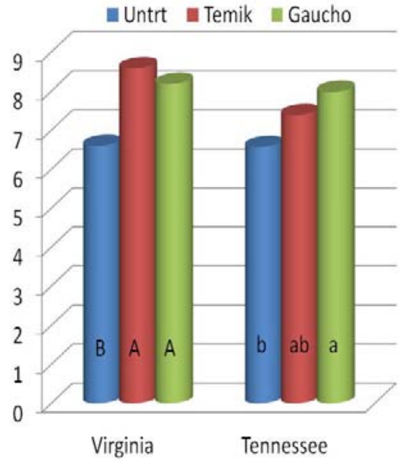


Figure 4. Numbers of plant nodes on 6/25 (VA) and 6/16 (TN) in each of three treatments: Untreated, Temik 15G (5 Lb/A) and Gaucho (0.375 MG AI/Seed)

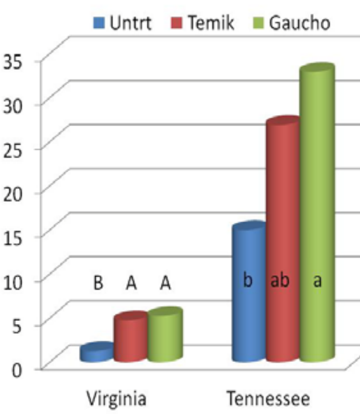


Figure 5. Numbers of squares per meter of row on 7/2 (VA) and 6/16 (TN) in each of three treatments: Untreated, Temik 15G (5 Lb/A) and Gaucho (0.375 MG AI/Seed)

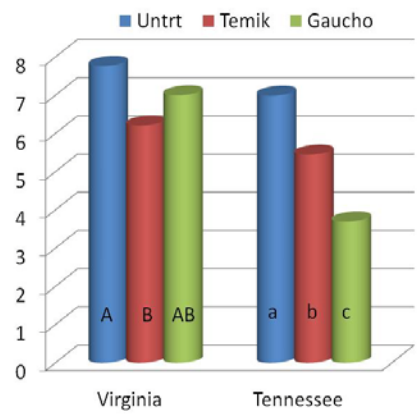


Figure 6. Nodes above cracked boll on 9/19 (VA) and 9/9 (TN) in each of three treatments: Untreated, Temik 15G (5 Lb/A) and Gaucho (0.375 MG AI/Seed)

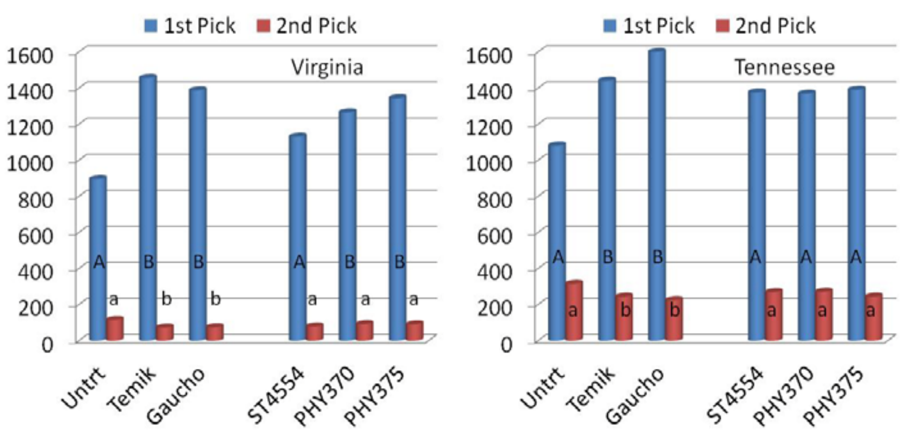


Figure 7. Lint yield from first and second pickings in each of three treatments: Untreated, Temik 15G (5 Lb/A) and Gaucho (0.375 MG AI/Seed)

b) Selected Plant Bug/Stink Bug Insecticide Tests. Hemipteran pests including plant bugs and stink bugs have become the primary pest complex of cotton during mid to late season. Seven trials were established during July and August of 2008 to evaluate insecticide control of these pests. Across all tests, traditional insecticides such as Bidrin and acephate provided consistent control of plant bug infestations (e.g., test 1 below). Centric (2 oz/acre) was comparable to these treatments. Premixed insecticides such as Bidrin XP (= dicrotophos + bifenthrin) and Endigo ZC (lambda-cyhalothrin + thiamethoxam) also performed well. Pyrethroid insecticides, imidacloprid (Trimax Pro, Couraze), Intruder and Carbine were generally less effective. However, pyrethroid insecticides in combination with other classes of chemistry (e.g., acephate, Bidrin, some premixes) also provided good plant bug control. A test in Madison County was designed to evaluate the effectiveness of Diamond (novaluron) on plant bugs (test 2 below). Treatments with Diamond were effective in controlling plant bugs, but green stink bugs were the dominate pest in this study. This test demonstrated that Diamond only treatments will not provide satisfactory control of stink bug infestations because it lacks activity on the adult stage. Tank mixes of Diamond with a relatively low rate of Centric (thiamethoxam) greatly reduced boll damage and improved yield compared with Diamond only treatments.

Test 1. Mid season plant bug insecticide trial in Lauderdale County (selected data shown).

Location: Lauderdale County, TN

Variety: PHY 375 WRF (planted 5-23-08)

Application: 8-1-08 and 8-11-08, High clearance sprayer (8 GPA, 46 PSI, FF 8801)

Rating: 2 drop cloths per plot (10 row ft)

Plots: 4 rows X 50 ft (RCBD, 4 Reps)

Total PB = tarnished plant bug + clouded plant bugs (mostly tarnished plant bug)

Total Bugs = total plant bugs + stink bugs (green and brown)

Description				Total PB	Total Bugs	Total PB	Total Bugs
Rating Date				8/5/2008	8/5/2008	8/15/2008	8/15/2008
Pest Stage				Total	Total	Total	Total
Trt-Eval Interval				4 DA-A	4 DA-A	4 DA-B	4 DA-B
Treatment			Rate/Acre				
1	Must. Max	0.8 EC	3.68 oz	7.0 ab	7.8 b	4.3 bc	4.8 b
2	Must. Max Bidrin	0.8 EC 8 EC	3.68 oz 6 oz	2.8 bcd	2.8 cd	0.0 c	0.3 c
3	Brigade	2 EC	3.2 oz	0.5 d	0.8 d	0.5 bc	0.5 c
4	Hero	1.24 EC	4.13 oz	3.3 bcd	3.5 bcd	0.0 c	0.0 c
5	Hero Bidrin	1.24 EC 8 EC	4.13 oz 8 oz	1.8 cd	1.8 cd	0.0 c	0.0 c
6	Endigo	2.06 SC	4.97 oz	5.3 bcd	5.5 bcd	1.3 bc	1.7 bc
7	Cobalt	30 EC	24 oz	3.0 bcd	3.3 bcd	0.7 bc	1.0 c
8	Leverage NIS	2.7 SE 100 SL	3.8 oz 3.83 oz	5.8 bc	6.0 bc	4.7 b	4.7 b
9	Leverage NIS	2.7 SE 100 SL	5 oz 3.83 oz	2.5 bcd	3.0 bcd	0.7 bc	0.7 c

10	Bidrin 8 EC	6 oz	2.5 bcd	2.5 cd	1.7 bc	2.0 bc
11	Orthene 90 SP	0.75 lb	1.0 cd	0.8 d	1.3 bc	1.3 bc
12	Untreated		11.3 a	12.8 a	14.3 a	16.8 a

Means followed by same letter do not significantly differ (P=0.05, LSD)

Test 2. Stink bug and plant bug insecticide trial in Madison County (selected data shown).

Location: West Tennessee Research and Education Center at Jackson

Variety: ST 4554 B2RF (planted 5-19-08)

Applications A-D: 7-2-08, 7-8-08, 7-23-08, 8-6-08, High clearance sprayer (8 GPA, 46 PSI 8001)

Ratings: 2 drop cloths per plot (10 row ft), Boll dam. = bug damage bolls per 10 bolls

Plots: 4 rows X 35 ft (RCBD, 4 Reps)

PB= total plant bugs (tarnished + clouded), SB= total stink bugs (green + brown)

Description		PB	SB	PB	SB	PB	SB	Boll dam.	Seed cotton /A (Lb)
Rating Date		7/30	7/30	8/6	8/6	8/11	8/11	8/12	
Trt-Eval Interval		7 DA-C	7 DA-C	14 DA-C	14 DA-C	5-DA-D	5-DA-D	6 DA-D	
Treatment	Rate/A								
1 Diamond 0.83 Lb	3 oz	1.5 a	2.5 a	0.4 c	2.0 a	0.3 b	10.3 a	7.8 ab	2701 d
2 Diamond 0.83 Lb	4 oz	1.3 a	2.0 a	0.0 c	3.5 a	0.0 b	2.3 a	6.0 bc	2939 cd
3 Diamond 0.83 Lb	6 oz	0.0 a	1.5 a	0.0 c	2.5 a	0.0 b	2.0 a	5.0 c	3145 bc
4 Diamond 0.83 Lb	3 oz	0.0 a	1.5 a	0.2 c	3.0 a	0.3 b	2.3 a	3.8 cd	3465 ab
Centric 40 %	2 oz								
5 Diamond 0.83 Lb	4 oz	0.5 a	1.3 a	0.0 c	4.3 a	0.0 b	2.3 a	2.3 d	3203 bc
Centric 40 %	2 oz								
6 Diamond 0.83 Lb	8 oz	0.0 a	0.8 a	0.4 c	3.0 a	0.0 b	1.3 a	2.3 d	3585 a
Centric 40 %	2 oz								
7 Centric 40 %	2 oz	1.3 a	1.3 a	3.2 b	3.0 a	4.5 a	2.5 a	3.8 cd	3033 cd
8 Untreated		4.3 a	3.3 a	10.6 a	4.3 a	6.5 a	5.5 a	9.3 a	2211 e

Means followed by same letter do not significantly differ (P=0.05, LSD)

c) Selected Spider Mite Tests. Both early and late season spider mites have been problematic in West Tennessee in recent years. Several miticide experiments were implemented to evaluate control in 2008, and the results of two early season tests are presented below. As seen in previous years, Dicofol continues to provide consistent and relatively economical control of early season spider mites. However, several other miticides gave statistically similar levels of control. With the exception of the Dimethoate treatment in test one (below), all treatments significantly reduced spider mite populations by eight days after application. However, bifenthrin (e.g., Brigade or Discipline) and Dimethoate did not provide adequate control of early season spider mite infestations. In test two, various tank mixes were tried including mixtures that could potentially control both spider mites and tarnished plant bugs at relatively low cost. Mixtures of Dimethoate and Brigade with reduced rates of other miticides performed reasonably well at controlling spider mites. Similar mixtures may be valuable when both spider mites and plant bug infestation occur simultaneously.

Test 1. Early season spider mite trial in cotton.

Location: Carroll County, TN

Application: 6-25-08, backpack sprayer (12.4 GPA, 40 PSI, FF 80015)

Plots: 3 rows x 50 ft (RCBD, 3 Reps)

Rating Date Sample Size Trt-Eval Interval						6/30/2008 10 Sq. Inches 4 DA-A		7/3/2008 10 Sq. Inches 8 DA-A	
Treatment				Rate/Acre		No. Mites		No. Mites	
1	Untreated					72.3	a	95.7	a
2	Dicofol	4	F	32	fl oz	6.3	d	5.0	c
3	Zephyr	0.2	EC	4	fl oz	18.0	bcd	6.0	c
4	Brigade	2	EC	5	fl oz	59.0	a	56.7	b
5	Acramite	4	SC	16	fl oz	43.3	abc	65.0	ab
6	Oberon	4	SC	4	fl oz	23.7	bcd	17.0	c
7	Dimethoate	4	EC	8	fl oz	50.7	ab	90.0	ab
8	Denim	0.2	EC	10	fl oz	12.7	cd	14.0	c
9	Zeal	72	WP	0.75	oz wt	20.3	bcd	10.3	c

Means followed by same letter do not significantly differ (P=0.05, LSD)

Test 2. Early season spider mite trial in cotton using tank mixes.

Location: Carroll County, TN

Application: 6-25-08, backpack sprayer (12.4 GPA, 40 PSI, FF 80015)

Plots: 3 rows x 50 ft (RCBD, 3 Reps)

Rating Date Sample Size Trt-Eval Interval						6/30/2008 10 Sq. Inches 5 DA-A		7/3/2008 10 Sq. Inches 8 DA-A	
Treatment				Rate/Acre		No. Mites		No. Mites	
1	Untreated					89.0	a	140.0	a
2	Dicofol	4	F	32	fl oz	10.7	b	58.7	bc
3	Dicofol Brigade	4 2	F EC	16 2.5	fl oz fl oz	24.3	b	25.7	cd
4	Zephyr Oberon	0.15 4	EC SC	2 2	fl oz fl oz	4.7	b	5.3	d
5	Zephyr Dimethoate	0.15 4	EC EC	2 6	fl oz fl oz	7.7	b	11.7	d
6	Zephyr Brigade	0.15 2	EC EC	2 2.5	fl oz fl oz	12.4	b	24.1	cd
7	Oberon Dimethoate	4 4	SC EC	2 6	fl oz fl oz	25.3	b	32.7	cd

8	Oberon Brigade	4 2	SC EC	2 2.5	fl oz fl oz	13.0	b	21.3	d
9	Zephyr	0.15	EC	4	fl oz	6.7	b	8.7	d
10	Oberon	4	SC	4	fl oz	10.7	b	38.0	cd
11	Dimethoate	4	EC	6	fl oz	32.7	b	82.7	b

Means followed by same letter do not significantly differ (P=0.05)

d) Evaluation of Bt Cotton Traits and Foliar Insecticides for Lepidoptera. An experiment was done to evaluate the level of caterpillar control provided by Bollgard II and WideStrike as compared with non-Bt cotton (test 1 below). No insecticides were used to control lepidopteran pest populations. Bollworm was the primary pest encountered in this study. Both WideStrike and Bollgard greatly reduced bollworm injury and larval numbers compared with non-Bt cotton plots, and yields were also higher in Bt cotton plots. Previous testing indicates that generally more terminal and square damage will be observed in WideStrike cotton than in Bollgard II, and this trend was also observed in this experiment. However, total bollworm populations in WideStrike and Bollgard II were similar.

An experimental insecticide was evaluated for control of bollworms in both Bollgard and non-Bt cotton. Foliar applications of rynaxypyr (Coragen, DuPont), with and without a pyrethroid partner, were compared with a pyrethroid only treatment (Asana XL) and an untreated control. The test was performed in a split-plot fashion on both DP444 BR and PHY315 RF (test 2 below). Both Coragen, even at this relatively low use rate, and Asana XL provided good control of bollworm infestations in both Bollgard and non-Bt cotton. Insecticidal control of bollworms in non-Bt cotton was better than control provided by Bollgard that was not treated with insecticide.

Test 1. Comparison of Non-Bt, Bollgard, Bollgard II and WideStrike in controlling caterpillar pests (selected data shown).

Location: West TN Research and Education Center (Jackson)

Planted: 5-19-08; Plots: 4 rows x 30 ft (RCBD, 4 Reps)

Rating: 20 plants per plot on 8-1-08, 8-6-08, 8-12-08 and 8-19-08

Comment: No insecticides applied for caterpillar pests

Treatment/Variety		Bt Trait	Numbers per 80 Plants - Season Total						Seedcotton / Acre (Lb)	
			Terminal Damage		Total Fruit Damage		Bollworm Larvae			
1	PHY375WRF	WideStrike	3.25	cd	8.00	c	1.25	c	3939	a
2	PHY485WRF	WideStrike	6.50	bc	13.00	c	3.75	c	3564	ab
3	PHY315RF	Non-Bt	11.00	ab	63.50	b	15.50	b	2673	b
4	PHY425RF	Non-Bt	14.25	a	84.25	a	22.00	a	2947	b
5	DP 141B2RF	Bollgard II	0.75	d	3.50	c	3.25	c	4155	a

Means followed by same letter do not significantly differ (P=0.05, LSD)

Test 2. Comparison of foliar insecticide treatments on control of bollworm in Bollgard and non-Bt cotton (selected data shown).

Location: West TN Research and Education Center (Jackson)

Planted: 5-19-08; Plots: 4 rows x 35 ft (4 Reps)

Application: 8-4-08 and 8-11-08, high-clearance sprayer (8 GPA, 46 PSI, FF 8001)

Ratings: 8-8-08, 8-14-08 and 8-20-08 (20 plants per plot)

Description Rating Data Type Sample Size							Boll Damage Season Total 60 Plants		Tot. Fruit Season Total 60 Plants		Bollworm counts Season Total 60 Plants	
Variety and Treatment					Rate/Acre							
1	DP444 BR	Coragen	1.67	SC	3.07	fl oz	4.25	b	6.5	b	1.25	c
2	DP444 BR	Coragen Asana XL	1.67 0.67	SC EC	3.07 5.73	fl oz fl oz	1.75	b	3	b	0.5	c
3	DP444 BR	Asana XL	0.67	EC	7.64	fl oz	2.5	b	4.5	b	1	c
4	DP444 BR	Untreated					11.75	b	18	b	6.75	b
5	PHY315 RF	Coragen	1.67	SC	3.07	fl oz	3.75	b	10	b	3	c
6	PHY315 RF	Coragen Asana XL	1.67 0.67	SC EC	3.07 5.73	fl oz fl oz	6.75	b	11	b	2	c
7	PHY315 RF	Asana XL	0.67	EC	7.64	fl oz	7	b	11.75	b	2.75	c
8	PHY315 RF	Untreated					36.25	a	59.5	a	17.25	a

Means followed by same letter do not significantly differ (P=0.05, LSD)

e) Efficacy of Foliar Insecticides for Control of Cotton Aphids. An experiment was done to evaluate aphid control with insecticides (table below). Heavy rain occurred about 4-5 hours after the first application (July 25) and may have influenced the results. At three days after treatment, all insecticides significantly reduced aphid populations. Plots treated with Bidrin, Carbine and Intruder had the lowest numbers of aphids. These same treatments were also best 6 days after application, but only Intruder statistically reduced populations compared with the control. At this time, aphid numbers were higher in Trimax Pro, Centric (low rate) and Dimethoate than in untreated plots. Control was improved with all products following a second application, but aphid populations in all plots crashed by 5 days after the second application. Intruder is widely regarded as the best treatment for aphids, and this was observed in this test. Carbine, a relatively new compound with a unique mode of action, also provided good control of aphids and co-occurring infestations of plant bugs and stink bugs (whereas Intruder did not). These data suggest that Carbine (> 2.0 oz/a) and Centric (> 1.5 oz/a) would be good choices to control co-occurring populations of aphids and hemipteran pests. The performance of Bidrin in controlling aphids can vary considerably, but it performed well in this experiment and also provided excellent control of plant bugs and stink bugs. Higher rates of Intruder or Trimax Pro may be needed to achieve adequate control of this pest complex.

Location: West TN Research and Education Center (Jackson)

Variety: ST 4554 B2RF (planted 5-19-08); Plots: 4 rows x 50 ft (RCBD, 4 Reps)

Applications: 7-25-08 and 8-1-08, high-clearance Sprayer (8 GPA, 46 PSI, FF 8001)

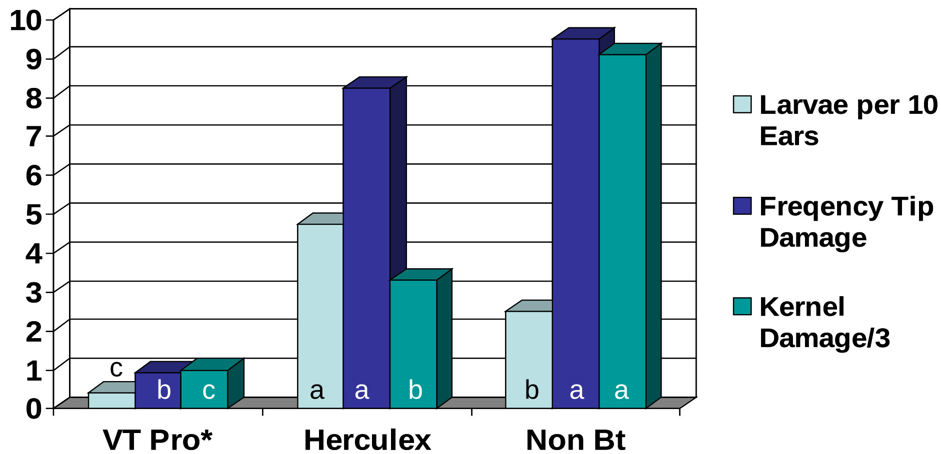
Comment: Heavy rainfall 4-5 hours after first application (A)

Description Rating Date Sample Size Trt-Eval Interval					No. Aphids 7/28/2008 10 Leaves 3 DA-A		No. Aphids 7/31/2008 10 Leaves 6 DA-A		No. Aphids 8/4/2008 10 Leaves 3 DA-B		PB + SB* 8/6/2008 10 RowFt 5 DA-B	
Treatment			Rate/Acre									
1 Carbine	50	WG	2.02	oz	33.0	d	41.5	bcd	10.8	cde	1.25	c
2 Centric	40	WG	1.5	oz	78.8	cd	76.3	bcd	12.3	cde	1.25	c
3 Intruder	70	WG	0.8	oz	43.3	d	26.5	d	2.0	de	3.50	ab
4 Trimax Pro	4.44	L	1.5	fl oz	167.0	b	182.5	a	36.8	ab	1.50	bc
5 Bidrin	8	EC	6	fl oz	35.8	d	38.3	cd	1.5	e	0.75	c
6 Dimethoate	4	EC	8	fl oz	138.5	bc	208.3	a	19.0	bc	2.25	bc
7 Centric	40	WG	1	oz	87.3	bcd	82.5	bcd	12.3	cd	2.75	bc
8 Centric UAN 28%	40 28	WG SL	1 1.5	oz qt	103.0	bcd	143.5	ab	5.8	cde	1.25	c
9 Untreated					266.5	a	118.8	abc	63.8	a	5.50	a

Means followed by same letter do not significantly differ (P=0.05, LSD)

* PB + SB = total plant bug and stink bug populations

f) Potential Implications of Stacked Bt Corn Traits on Bollworm Management in Cotton. Research continued in 2008 to evaluate the efficacy of new Bt corn traits on bollworm populations and the potential implications of this technology on bollworm management in cotton. Corn varieties that have multiple Bt traits that are active on caterpillar pests will be marketed in 2009 (e.g., YieldGard VT Pro®). YieldGard VT Pro® produces two Bt toxins, Cry1Ab and Cry1A.105, that have activity on lepidopteran pests. Even newer technology (i.e., SmartStax®) is under development and also has multiple lepidopteran-active Bt proteins. In contrast, most Bt corns produce only one toxin with activity on caterpillar pests (i.e., Cry1Ab in YieldGard® and Cry1F in Herculex®). YieldGard, Herculex and YieldGard VT Pro provide excellent and similar levels of control of southwestern corn borer (data not shown). However, YieldGard VT Pro and SmartStax hybrids had much better activity on corn earworm, i.e. bollworm, than either YieldGard or Herculex corn (figure below). The same was true in 2007 when both YieldGard and Herculex hybrids had significantly more corn earworms than YieldGard VT Pro. Annually, corn may produce 50 - 80% of bollworms within the landscape of some cropping environments. The percentage of bollworm moths originating from corn may be even higher at certain times of the season. Cotton growers will benefit from reduced numbers of bollworms emigrating from corn into cotton if new Bt corn technologies are widely adopted. Because new, stacked-Bt technologies have greater efficacy on bollworm, and because similar Bt traits are present in cotton, the impact on Bt resistance management for bollworm should also be considered.



* Bars labeled VT Pro are an average of three isolines including VT Pro (2) and SmartStax (1) hybrids.

Numbers of corn earworm larvae per 10 ears, frequency of ear tip damage and damaged kernels per ear (divided by 3) in VT Pro, Herculex and Non-Bt corn observed during 2008 (P < 0.05, LSD).