62ND ANNUAL CONFERENCE REPORT ON COTTON INSECT RESEARCH AND CONTROL

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Abstract

There were 7.755,000 acres of U.S. Cotton (Upland and Pima) harvested with an average of 810 pounds of lint per acre (USDA –January 2009 report) in 2008.

Arthropod pests of cotton reduced yield by 3.80% in 2008. *Lygus* reduced yields by 1.003% attaining losses greater than all other pests. The bollworm /budworm complex were second at 0.764%. The bollworm was the predominant heliothine species to attack cotton in 2008. Bollworms were estimated to make up 76% of the population Stink bugs (0.747%) were 3rd and Thrips (0.5167%) were 4th. Cotton fleahoppers (0.231%) rounded out the top five cotton arthropod pests for the year. Beltwide, direct insect management costs amounted to $55.53 acre. Cost plus loss is estimated at $543 million. **(see M.R. Williams, this proceedings).**

Crop and Arthropod Pest Conditions:

Alabama

With the exception of a few relatively small localized areas, the 2008 cotton production season in Alabama was much improved over recent years. The rainfall pattern was good with no extended droughty periods. Alabama was fortunate to receive some rainfall from the multiple hurricanes but no excess rainfall and little or no wind damage. The average yield will be in the 850 lbs of lint range, which is about 100 lbs higher than the previous record. Acreage planted was 290,000, with the largest percent decrease from previous years coming from the Tennessee Valley region. Crops that replaced cotton were primarily wheat, double cropped with soybeans, in the northern areas and peanuts in the central and southern areas.

Early season insects, thrips and tarnished plant bugs, were below average in number. Aphids built slowly and were very late in crashing from the natural fungus. A heavy infestation of tobacco budworms occurred during the first two weeks of July in the central and southern regions. This was followed by heavy corn earworm pressure during the last two weeks of July. Some fields experienced the heaviest "worm" pressure seen since the pre-Bt cotton era (1994-95). Many conventional cotton fields experienced heavy fruit damage during the month of July due to poorly timed applications and/or incorrect choice of chemistry.

Single gene Bt cotton received measurable boll damage (1-4%) from the late July early August bollworm population. More oversprays were necessary in 2008 for escape worms on Bt cotton.

Stink bugs occurred in above normal numbers requiring 2 to 5 sprays, depending on the planting date of the cotton. Stink bugs were a greater problem where the cotton was planted late or near other stink bug host crops such as wheat, corn or peanuts.

Armyworms, loopers, mites and whiteflies were relatively minor or localized problems. The silverleaf whitefly occurred on late maturing cotton in the southeastern area of the state **(Ron Smith)**.

Arkansas

The season started out cool and wet, delaying planting in many areas of the state. Many growers struggled with poor stands and seedling disease being faced with tough decisions on whether to replant. Much of the cotton in the state was planted 3 weeks behind schedule. Growing conditions were much better in June and July and much of the cotton grew well and "caught up" despite a poor start. Cool conditions in the fall caused some problems with defoliation. Yields were average.

Overall insect pressure was light throughout the season. Thrips pressure was generally light across the state with the heaviest pressure in the south. Many growers made at least one foliar application for thrips out of fear that even low populations would delay and already late crop. Spider mites began showing up early, but only reached heavy levels in some areas. Tarnished plant bugs were also light throughout the year. There were areas that did have significant plant bug pressure. Bollworms were heavy in some areas in the southern part of the state. In these areas, Bollgard, Bollgard II and Widestrike cotton did require a few oversprays with a pyrethroid **(Glenn Studebaker)**.

California

There were 270,490 acres of cotton planted in CA in 2008, a reduction of 40% from 2007. The San Joaquin Valley planted 95% of the total acres with the remainder being cultivated in the Southern Desert Valleys (9,570) acres) and Sacramento Valley (3,350 acres). There were 152,190 acres planted to Pima cotton and 118,300 acres planted to upland cottons. Most of the upland Bt cotton were planted primarily in the Southern Desert Valleys.

Yield was estimated to be 1,518 lbs/acre for upland and 1,272 lbs/acre for Pima. In the SJV, planting conditions in March and April were generally good with 70% of the days recording ideal to adequate conditions recorded at the Westside REC between March 10 through May 28. A cold snap occurred in mid April, the duration of marginal to unfavorable planting temperatures being longer the further north cotton was planted. Most cotton planting occurred during mid to late April.

Conditions for early growth and development were generally good through June. Temperature conditions were fair through most of the growing season with high daytime (100° F+) and high nighttime temperatures (70° F +). Fruit retention was generally good but conditions varied by location, depending on pest pressure. Water was scarce or expensive, and some fields suffered loss due to moisture stress. The fall was open and harvest continued through November.

Insect pressure was generally light to moderate in most locations. Western flower thrips were problematic during May, especially in some Pima cotton fields. A lack of rainfall in late winter and early spring eliminated external pest pressure. Lygus were problematic in scattered areas in June and July, especially near safflower. In the worst areas, Lygus were at treatable levels for over 5 weeks, causing extensive damage and requiring many more treatments than normal. Population densities in some fields exceeded 20 – 30 per 50 sweeps Nymph population densities were generally low with migrating adult populations causing the primary problem. Usually a single pulse migration occurred and reproduction was limited in most cotton fields. Aphids were not widely reported as problems, however, treatments were required in some locations. Worm pests were not widely reported. Silverleaf whitefly was not a major concern in the San Joaquin Valley but was noted in widely scattered locations and in some organic fields caused severe damage to cotton quality. Spider mite populations were at “normal” levels and generally required one acaricide application, especially in the upland cotton **(Peter Goodell)**.

Georgia

Approximately 950 thousand acres of cotton were harvested in Georgia during 2008. Production was highly variable depending primarily on rainfall. In spite of droughty conditions in some areas and excessive rainfall in others, the 2008 season was another in which we made more cotton than we thought we would or should. Droughty conditions occurred in many areas during June, but scattered showers returned during July and early August and sustained the crop in many areas. Tropical storm Fay brought heavy rainfall in the southernmost and southwest counties, causing considerable damage in some fields. In excess of 15 inches of rain was reported in some southwest counties. In central and east Georgia, Tropical Storm Fay brought much needed rains which helped finish those crops. Unlike previous years, we had a relatively cool fall and an early frost which limited yield potential in later maturing fields. Harvest conditions were generally good. Although yields were highly variable, average yield was estimated at about 840 lbs/acre.

Thrips populations were moderate to heavy on cotton planted prior to mid-May and tended to be less of a concern in later plantings. Seedling pests such as grasshoppers, cutworms, and false chinch bugs were rarely reported. Aphid populations were generally low, but built to moderate numbers in most areas. Few acres were treated for aphids as the naturally occurring fungus eliminated infestations as numbers increased. Spider mites continued to be observed in some South Georgia fields; however infestations rarely built to treatable populations but did influence management decisions for other pests.

Corn earworm populations were low to moderate with high populations in localized areas. Control of corn earworm with pyrethroids was generally good; however concern remains relative to pyrethroid susceptibility. Results of adult vial tests to monitor pyrethroid susceptibility indicated reduced survival compared with recent years. Very high populations of tobacco budworm were observed during May and June, especially on peanuts. Field observations suggested that most populations of tobacco budworm continue to be resistant to the pyrethroid insecticides. Bt cottons provided excellent control of tobacco budworm and without this technology 2008 would likely have been a difficult year in terms of insect management. Fall armyworm infestations were localized and sporadic but heavy in some fields. Beet armyworm and soybean looper populations were generally low.

Stink bug populations were generally low to moderate. However, very high populations of brown stink bugs were observed during June, especially in field corn. Brown stink bugs moved into early maturing cotton and required treatment. Southern green stink bug populations did not develop to the same degree as we had observed with brown stink bugs. Populations of green stink bugs were greater than southern green stink bugs in some areas which is atypical for Georgia. The majority of fields exceeded threshold levels for stink bugs at some point during the year. Silverleaf whiteflies were present in localized areas but generally did not build to high populations. No boll weevils were captured in Georgia during 2008 **(Phillip Roberts)**.

Louisiana

Cotton was planted on about 295,000 acres in Louisiana during 2008 which relates to a reduction of about 10 percent from acreage planted in 2007. However, only 240,000 acres were harvested with an average yield of <550 lb/acre in 2008. The relatively high number of abandoned acreage resulted from the occurrence of two substantial hurricanes. Weather-induced yield losses from these two storms were the primary limiting factor for cotton production in Louisiana.

Greater than 95% of the cotton acreage was planted with varieties containing Bollgard, Bollgard 2, or WideStrike technologies. In addition most of the cotton seed planted in Louisiana was treated with an insecticide and fewer than 5% of the acres received an application of Temik 15G as an infurrow granule at-planting. The wheat acreage was substantially higher during spring 2008 and produced high numbers of thrips. Early season thrips problems on cotton were severe in many areas, especially in fields near winter wheat. In addition, cotton seedling growth was delayed from low temperatures in April and May. In spite of the insecticide seed treatments widely used by many producers, many fields were treated with 1-2 applications of insecticide sprays for thrips. Cotton aphid problems were far less numerous in 2008 compared to that in 2007. A few fields experienced less than satisfactory control and required multiple applications of neonicotinoids or carbine for effective control during June and early July. Epizootics of the entomopathogenic fungus, *Neozygites fresenii,* developed in cotton aphid populations and effectively eliminated any subsequent problems with this pest for the remainder of the season. Tarnished plant bugs remained the most significant and widespread cotton pest, but again problems were less severe than that experienced during 2007. In several instances, unsatisfactory control was observed with applications of acephate (regardless of formulation). Insecticide susceptibility surveys and on-farm screening trials validated acephate resistance in tarnished plant bug populations are contributing to chemical control issues. Bollworm was a minor problem in Bollgard fields which received 1-2 sprays of a pyrethroid for this pest. In Bollgard 2 and WideStrike fields, bollworm was a common pest, and with few exceptions, did not require supplemental sprays or result in significant yield losses. Other caterpillar pests such as fall armyworm, beet armyworm, soybean/cabbage looper were isolated problems on limited acreage and generally were effectively managed with timely insecticide sprays. Southern green and brown stink bugs occurred in higher numbers than normal and likely migrated from senescing fields of field corn and soybean adjacent to cotton. Acreage infested with spider mites was lower than observed during the previous three years. No significant problems were reported, but detection and intervention with chemical control occurred earlier than in the past. Frequent reports occurred during the early season on infestations of slugs. Plant stands were reduced to a level in a few fields that required re-planting. Those cotton fields with the heaviest infestations were planted no-tillage into previous crop residue of grain sorghum or field corn. No effective chemical control strategies were identified for that problem. Mechanically removing the residue from the seed bed and allowing the soil surface to dry for a few hours before re-planting was the best solution. **(B. Rogers Leonard)**

Mississippi

Cotton producers in Mississippi planted approximately 360,000 acres of cotton in 2008. This was a 46% decrease in acres compared to 2007 and down 70% from 2006 plantings. Approximately 58% of cotton in MS was planted to transgenic single gene Bt varieties and 37.5% of cotton acres was planted to dual toxin transgenic Bt varieties. The most popular varieties planted in 2005 was Stoneville 4554BGII/F, Stoneville 5242BG/RR, DeltaPine 555BG/RR, and DeltaPine 444BG/RR. These four varieties made up approximately 57.2% of the total acres planted in 2008. The most widely planted dual toxin Bt variety planted was Stoneville 4554BGII/F, making up 16.75% of cotton acres.

Total insect losses in MS were slightly lower in 2008 than in 2007. Overall losses from insect pests in 2008 were 2.34% compared to 2.63% in 2007. Mississippi averaged 6.4 foliar applications to control pests in 2008 for an average foliar insect control cost of $66.44 per acre. Final cotton yield estimates for 2008 was 867 pounds per acre, down 108 pounds per acre from 2007. Cotton yields in the delta averaged approximately 925 pounds per acre while the hill region of the state averaged approximately 663 pounds per acre.

Thrips pressure across the state was moderate both in the hills and delta region. Seed treatments continue to gain popularity in MS for control of thrips due to convenience and ease of use. Approximately 46% of the cotton acreage received a foliar application for thrips averaging 0.46 foliar applications for this pest.

Tarnished plant bug ranked as the number one damaging pest in 2008. The delta region of the state averaged 5.0 spray applications for plant bugs while the hill region of the state averaged only 1.1 spray applications. The chloro-nicotinyl class of chemistry, such as, Trimax and Centric was widely used in pre-bloom cotton to control tarnished plant bugs in 2008 with "standards" such as Orthene, Bidrin, and Vydate getting more use in post-bloom cotton. Plant bug numbers in parts of the delta region of the state were extremely high again in 2008 but isolated to fewer areas and later in the season. This was partly due to a significant rainfall during July.

Bollworm/Budworm pressure was moderate on average in 2008 with average number of foliar sprays at 0.75 for cotton in the delta region of the state. The hill region of the state received on averaged 0.25 foliar applications. Fall armyworm pressure was extremely light in 2008.

Spider Mites were the most notable problem producers faced in the central and south delta region of the state prior to bloom in 2008. Spider mites once again ranked as Mississippi's third most damaging pest. July rains that persisted for several weeks slowed spider mite development late season with populations rebounding in August. Approximately 106,000 acres were treated for spider mites in the state in 2008.

In summary, total insect control cost for the state in 2008 was $124.28 per acre up approximately $6.44 per acre compared to 2007. This was largely due to increased costs of insecticides and application fees **(Angus Catchot)**.

New Mexico

For a third year no boll weevils were captured in New Mexico. The south central eardication zone has not captured a weevil in six years. Boll weevil eradication programs in the eastern half of the state were initiated later and are administered by the Texas Boll Weevil eradication program. The Pecos Valley had no weevils for the third year. Last captures there were 3 weevils in 2005.

A pink bollworm eradication program is ongoing in the Mesilla Valley in south Cenral new Mexico in conjunction with nearby Texas counties. Pink bollworm numbers in the Mesilla Valley have been reduced over 99.9% since the program's inception. Pink bollworm populations outside the eradication zone have also been greatly reduced.

Insect pressure in general was low. However two insects had higher than normal populations. Grasshoppers, in particular, were much more numerous than usual. Beet armyworm also had above average numbers but no significant damage.

Yields were good despite a number of cool days in September and more than average hail in the spring.. Total cotton acreage was down in 2008 **(Jane Pierce).**

North Carolina

Thrips levels were generally moderate to high in most area of the state in 2008. Slow grow-off conditions only made things worse, with the resulting plants in a thrips-susceptible state for longer, and uptake of Temik 15G and seed treatments often poor. Up to two or three foliar insecticide treatments were required for some growers, sometimes with less than desired results. Approximately 96% of our state's cotton acreage received one or more foliar applications for thrips, a record high for North Carolina. Temik was used on approximately 50% of the cotton acreage, seed treatments on the remaining 50%, and some growers (10%) used both a seed treatment and Temik. The presence of western flower thrips added to control headaches in some fields.

Cotton aphids were generally a minor problem on most farms, with 0.5% of our cotton acreage treated in 2008. Growers and consultants appear have become more confident in the effectiveness of beneficial insects, primarily aphid "mummies" and in the fungus *Neozygites fresenii* in reducing cotton aphids to subeconomic levels in most cases.

Plant bugs were also very light during the pre-bloom period in 2008. Additionally, *Lygus* levels did not build into a significant late season problem this past growing season.

Spider mite levels were similarly very low in 2008, with 0.4% of the cotton acreage (on which a consultant made the recommendation) treated following Temik and 1.1% the state's cotton acreage being treated for spider mites following a seed treatment.

Stink bug damage was again light across most of the state in 2008, primarily a result of the generally dry weather during most of our growing season. Based on our project's fall damaged boll survey, stink bugs caused year end boll damage of 4.4, 3.7, 4.4 and 3.7% in conventional, Bollgard, WideStrike and Bollgard II cotton lines, respectively.

Bollworm damage from bollworms was light in 2008, with average late season boll damage of 1.5, 0.55, 0.21 and 0.12% found in conventional, Bollgard, WideStrike and Bollgard II cotton lines, respectively based on our project's fall survey. An average of 1.5 and 0.75 late season insecticide applications for bollworms and stink bugs was used on conventional and Bollgard cotton, respectively, in 2008.

Other caterpillars were generally very light in 2008. Fall armyworms persisted, but not at treatable levels. Beet armyworms and cabbage loopers, although detected in scattered areas, were again little more than curiosities the year. European corn borers remained (for more than a decade now) at almost undetectable levels, even on conventional cotton.

As of this mid-December writing, North Carolina cotton producers are expected to harvest approximately 700 pounds of lint per acre on 433,000 acres **(Jack Bacheler).**

South Carolina

Cotton was planted on about 135,000 acres in South Carolina during 2008. That was a reduction of about 55% from that planted in 2006. Most of the reduction was due to increased acreage planted to soybeans and corn. Over 96% of cotton acres were planted with varieties containing Bt technology. Early-season problems were characterized by dry conditions and moderate levels of thrips. Mid-to-late-season insect problems consisted of bollworm and stink bugs primarily. There were some areas that developed problems with fall armyworms. Bt cotton performed well in suppressing numbers of bollworm but supplemental control was necessary. Populations of secondary pests such as aphids and spider mites were generally not problematic. Populations of stink bugs were high very late in the season. More-than-adequate rainfall amounts late in the season were extremely beneficial to final yields. Losses were due mostly to the dry conditions early in the season, resistant weeds, and moderate levels of pestiferous insects.
(Jeremy Greene).

Tennessee

Tennessee planted and harvested about 280,000 acres of cotton in 2008, over 200,000 fewer acres than the previous year. About 97% of the crop was *Bt* cotton, and 60-65% of the acres were planted with Bollgard II® or WideStrike® varieties. Commonly planted varieties included STN4554 B2RF, DP444 BG/RR, PHY370 WR and PHY375 WRF. There was a short planting window in late April followed by heavy rainfall. Thus, most cotton was planted from May 10 to May 20. Few problems were encountered with stand establishment. Rainfall patterns varied considerably, and some areas experienced drought conditions during the entire season. However, rainfall events in late July and early August greatly improved yield potential in most areas. The average lint yield for Tennessee in 2008 is estimated at 900 lb/acre. This contrasts with an average yield of 500-550 lb/acre in 2007.

The 2008 season was characterized by variable but high populations of hemipteran pests, primarily early season tarnished plant bugs and late season green stink bugs. Statewide insect-induced yield losses were estimated at 6.24%. Most of this loss was associated with infestations of thrips, hemipteran pests (plant bugs and stink bugs) and twospotted spider mites. *Bt* cotton traits performed well in controlling infestations of lepidopteran pests. However, bollworm and fall armyworm populations were low. Few *Bt* cotton fields required a foliar insecticide application for these pests. The estimated average cost of insect control was $80/acre. About one-half of this cost was for foliar insecticide applications. The remaining costs included fees for *Bt* technology, boll weevil eradication, insecticide seed treatments and scouting.

Boll weevil eradication efforts continued throughout West Tennessee, and no yield losses caused by boll weevils have been reported for seven consecutive years. A total of 22 boll weevils were captured during 2008 in West Tennessee. This represents a 99.7% reduction in the number of weevils captured compared with 2007. Middle Tennessee, representing about 20,000 acres of cotton, is in a maintenance phase of eradication and continues to be free of boll weevils.

Thrips infestations on seedling cotton were variable but significant in many fields. Tobacco thrips were the most common species. At-planting insecticides for the control of thrips are used on nearly 100% of the acreage, with seed treatments being used in over 90% of cotton fields in Tennessee. Nevertheless, a foliar insecticide application was made for thrips in the majority of fields. Sustained and high populations of tarnished plant bug were observed in some areas prior to bloom, and 2-4 applications were sometimes needed to control this pest and maintain adequate square retention. As consistently observed in recent years, early-season spider mite infestations occurred in several areas (primarily Carroll, Gibson, Dyer and Lake Counties). Late season infestations of spider mites were sporadic but affected some fields in all areas of the state. Dicofol was the primary miticide used during the early season, and it provided good control. Other products commonly used to control mites were Oberon, Zephyr and Brigade (primarily late season).

Tobacco budworms were relatively uncommon in non-*Bt* cotton fields in 2007, but some non-*Bt* fields reached treatment threshold during the early season in the southern counties of West Tennessee. As previously mentioned, bollworm populations were low. There was a moderate moth flight during mid August that was too late to seriously affect many acres. In a late season survey, we found an average of 1.48% boll damage caused by caterpillar pests in non-*Bt* fields. On average, only 0.33% of bolls in Bollgard cotton fields were damaged by caterpillar pests. Fields of Bollgard II or WideStrike averaged 0.05% and 0.10% boll damage, respectively.

Treatment level infestations of stink bugs and plant bugs (including clouded plant bugs) were common after first bloom, and green stink bug populations were unusually high in some areas. In a damage survey, late-season boll injury caused by stink bugs and plant bugs averaged about 5.7%, over twice that observed in 2007. A window approach encouraging the rotation of insecticide classes for plant bugs continues to be recommended because of concerns with insecticide resistance. In particular, the University of Tennessee recommends avoiding the use of pyrethroid and organophosphate insecticides until after first bloom (except for organophosphate insecticides used for thrips control on seedling cotton).

Cotton aphid populations were somewhat higher than observed in recent years, but relatively few insecticide applications were needed to control this pest. Beet armyworm, loopers, whiteflies, European corn borers, other insect pests and slugs were of little or no importance in 2008. Various insecticide and insect management trials were performed in 2008. The results of many tests and other information are available on-line at www. utcrops.com **(Scott Stewart).**

<u>Texas</u>

The 2008 Texas cotton crop was disappointing coming off the 2007 crop where near record yields and unsurpassed quality was the norm. There was 5,015,500 acres of cotton planted in Texas in 2008, but only 3,415,000 acres were harvested. Much of the failed cotton originated on the High Plains, and the Lower Rio Grande Valley lost a high percentage of its cotton due to Hurricane Dolly. The average yield across the state was estimated at 650 lbs/acre, resulting in approximately 4.6 million bales.

Most of Texas experienced extremely hot and dry conditions early in the season, and drier than normal conditions mid season. Adequate late season precipitation helped prevent further crop deterioration. Cool late season temperatures hampered boll filling and maturity in much of West Texas, especially in the northern High Plains.

Most of the state relied heavily on Roundup Ready, Roundup Flex, or Liberty Link weed management technologies with approximately 90% of the acreage utilizing these traits. Bt technology, primarily Bollgard II and Widestrike, was planted on approximately 56% of the acreage, slightly higher than in 2007. However, Bt-cotton acreage was up in some areas, particularly in the High Plains, but the increase there may have been more dependent on the loss of non-Bt dryland acreage rather than a shift in trait selection. Many producers continue to make cotton variety selection decisions based on the yield and fiber characteristics for their production region and not necessarily on the need for bollworm/tobacco budworm control.

Overall, insect pressure was much lower in 2008 than in 2007. Thrips, although lighter in 2008, were a problem in the production regions north of Lubbock and localized areas of the Rolling Plains, and were more troublesome than usual in the Blacklands. In these areas, most thrips damage was averted with the utilization of preventive at-planting insecticides.

Cotton fleahopper populations were lower than normal throughout the state, but much of the acreage in the Blacklands and Coastal Bend regions required 1 to 2 insecticide applications for this pest. Cotton aphid problems were very sporadic and most outbreaks were naturally mitigated by lady beetles and other natural enemies. Similarly, *Lygus* were much lower than in 2007 and sporadic in the High Plains and the El Paso area. Whiteflies were relegated to the Lower Rio Grande Valley and Far West Texas in the El Paso area, but damage was light and few treatments targeting this pest were necessary. Stinkbugs were also less of a problem than in 2007, and primarily relegated to the Coastal Bend and Blacklands areas, but required few insecticide applications.

Cotton bollworm/tobacco budworm pressure was very low throughout the state. By far bollworm was the most predominate species encountered, and because of the high percentage of Bt cotton (particularly in areas where bollworms are a consistent problem), few insecticide applications were made targeting this pest complex. Very little Bt cotton was treated for bollworms, although approximately 10% of the Bt cotton in the Coastal Bend area required a late season insecticide application. Beet armyworms were a problem in some non-Bt cotton in the High Plains and although over 1 million acres was infested with this pest, only 35,000 acres required treatment.

Boll weevil eradication in West Texas is progressing well with the number being trapped being very low. The only area where weevils were being captured was the Southern Rolling Plains zone where migration from the south has occurred during the last two years. Foundation employees know of no boll weevil reproduction in 4.8 million acres of cotton in the western and northwestern part of the state.

The 713,190 acres of cotton in the southern and eastern zones in Texas still have reproducing populations of boll weevils, but population reductions were seen in most areas this year. Northern Blacklands, Upper Coastal Bend and Lower Rio Grande Valley made significant progress in boll weevil population reductions while the Southern Blackland made slight progress. The South Texas/Winter Garden zone developed mid and especially late season population increases in some areas this year due to storms, migration and extremely wet weather. The weevil populations in the southern parts of this zone are still considerably higher than they are further north. By far, most of the weevils captured were in the Lower Rio Grande Valley, South Texas and Winter Garden zones.

Coastal Bend, Lower Rio Grnade Valley and Winter Garden Areas (CB, LRGV & WG). Texas Gulf Cotton was characterized by dry weather in most areas and Hurricane Dolly in the Lower Rio Grande Valley. Yields ranged from 100 to 1000 lb lint /acre with an average of about 753 lb/acre.

Generally, light insect pest pressure was observed throughout the season. Thrips were heavier on the Upper Gulf Coast but did not affect yield. Aphids were sporadic throughout with early season buildup which declined rapidly although some acreage was treated for aphids before the decline was observed. Fleahoppers generally required 1 or 2 treatments, and in the drier regions their control had little impact on yield. Stink bugs were low except in isolated areas which required one insecticide treatment.

Caterpillar pest pressure was unusually low with only the bollworm requiring treatment, and generally one insecticide application was necessary where treatment threshold was exceeded. The percentage of transgenic-Bt cotton acreage increased dramatically from past years, partly due to lack of conventional varieties. The Bt cotton acreage amounted to about 70%.

The boll weevil eradication program continued with good progress in the Upper Gulf Coast, but boll weevil numbers increased in the South Texas/Winter Garden Zone to levels higher than in the last several years. The increase was due to events in 2007 to include rain almost every day interfering with field treatment, lack of enough aircraft to do the job, cotton growing in other crops, and late crop destruction. The problems were then manifested in the 2008 crop year and were sustained throughout the season.

Blacklands (BL). Like much of Texas, the Blacklands experienced below average rainfall in June and July and subsequently, produced average yields. Yields ranged from 250 to 720 lbs of lint/acre. Yields for early April planted cotton averaged about 380 lbs/acre. However, much of the cotton (about 60 percent) was not planted until early to mid May, the result of wet conditions during that time. Rainfall in early to mid August greatly improved yields for late planted cotton. The average yield for May planted cotton was 630 lbs/acre.

Thrips were heavy throughout the area. Despite the fact that about 98 percent of the acreage was planted to seed treated with Gaucho Grande or Cruiser, approximately 80 percent of the 31,000 acres of cotton received a foliar insecticide treatment for thrips once seed treatment deteriorated. About 70 percent of the acreage received 1 insecticide treatment for cotton fleahopper.

Boll weevils were held in check by efforts of the eradication effort. This was the third full season of boll weevil eradication in the northern Blacklands and the program has significantly reduced the numbers of weevils caught in pheromone traps compared to 2007. Secondary pests; cotton aphid, spider mites, beet and fall armyworms were not a factor. However, stink bugs are becoming a more frequent pest with more fields requiring treatment.

Unlike 2007, bollworm damage was relatively light. The widespread planting of two Bt gene technology has decreased the number of one gene varieties that are more susceptible to sustained bollworm populations. Approximately 98 percent of the cotton planed was Bollgard/Roundup Ready or Bollgard II/Roundup Flex. Boll weevils were held in check by boll weevil eradication efforts.

Rolling Plains (RP). Conditions started off mild with average soil moisture and cotton development was good. However, growing conditions soon deteriorated during the month of May, with hot, windy and dry conditions that limited the potential of the crop. The region did receive some beneficial rains in August that contributed to average yields across the region ranging from 300 lbs lint per acre in the northern region to 425 lbs of lint per acre in the southern region.

Insect populations were at historic lows for the region and growers had limited inputs for pest management for the crop. Cotton fleahoppers and thrips were the primary insect pests. Producers are investing in seed treatments to protect their investment of the transgenic crops and thus very little foliar treatments for thrips were required. A few fields developed high thrips (primarily western flower thrips) populations near bloom but populations were not sustainable for more than a week. Unlike 2007, bollworm populations were extremely low in 2008.

High Plains and Panhandle (HP & PH). In the High Plains and Panhandle regions of Texas in 2008, approximately 3.1 million acres of cotton was planted. However, the 2008 season started off hot, windy and dry, and much of the dryland acreage did not survive the early drought and high winds, and additional acreage was lost in June to hail. Approximately 950,000 acres of cotton was lost due to weather, about 76% of this was dryland. Poor early season conditions were compounded by unusually cool conditions late season. Because of an early frost on October 21, yield from late season bolls was lost and lint quality was compromised in regard to low micronaire and bark content. Later maturing varieties were especially affected. The yield across irrigated acreage was estimated at about 800 lbs/ac while dryland was expected to average about 400 lbs/ac. Approximately 3.5 million bales were harvest in 2008, down substantially from 2007 when 5.41 million bales were harvested.

Insect pressure was relatively light in 2008 resulting in an estimated 0.4% reduction in yield. Thrips infestations were high in early planted cotton north of Lubbock, but fairly light in late plantings, and in areas south of Lubbock.

Western flower thrips was the predominant species encountered and at planting and foliar treatment targeting thrips were effective in mitigating thrips populations. However, because of the warm conditions, damage due to thrips was generally not severe or yield threatening in most areas.

Cotton fleahopper and *Lygus* populations were much lower relative to 2007. In fact, cotton fleahoppers were a non-issue except in a few late planted fields north of Lubbock. *Lygus* were problematic in isolated fields adjacent to alfalfa late season.

Aphid populations rose sharply in mid to late August, but lady beetle populations quickly reduced these outbreaks in most cases. Late season aphids threatened, but rarely developed into treatable populations.

We experience some threatening populations of bollworms and beet armyworms in non-Bt cotton at mid season in some western areas of the High Plains, and during late August and September in some areas north of Lubbock. But overall, bollworm and beet armyworm populations were light. Approximately 50% of our 2008 acreage was planted to Bt varieties which is up substantially from 2007. However, this is probably more a reflection of the loss of dryland acreage (primarily non-Bt cotton varieties) due to weather than a substantial shift in variety trait selection. Much of the Panhandle area was restricted from planting Bt cotton in 2008, but bollworm and beet armyworms populations were light in this area. Boll weevils were non-existent due to the boll weevil eradication program.

Far West Texas (FWT). Approximately, 94% of all upland cotton planted was Bt transgenic. Unfortunately, cotton producers across the Far West Texas dryland production area experienced extreme drought, which resulted in an 80% reduction in cotton yields.

Although, the most abundant insect pests were bollworms and cotton fleahopper, population densities were very low which resulted in only 4 % of the cotton acreage being treated. Typically, the El Paso area is the only area in Far West Texas that experienced damaging densities of Western tarnished plant bug and silver leaf whitefly. This year was no exception, with 15% of the El Paso cotton acreage being treated for these pests. Boll weevils have been declared suppressed in all Far West Texas reporting areas. The pink bollworm program continues in the El Paso/Trans Pecos (zone 12) region and has been very successful, with only 23.7% of the sample dates finding moths in 2008 relative to 81.6% in 2007 **(Submitted by David Kerns and Colleagues).**

Virginia

An estimated 61,000 acres of cotton were planted in Virginia, up from 56,000 in 2007. Cotton got a 'late start' as it was warm early, but temperatures dropped during the later half of May. There was ample rainfall through July but cut off through much of August. Thrips pressure was extreme and presented a challenge to growers. The prolonged late-season drought caused early cutout, reduced susceptibility to insects, and greatly reduced yield potential in some areas. The average yield is estimated at 750 to 800 lb lint/acre with losses due mainly to dry weather. Palmer amaranth was confirmed in many locations.

An estimated 10% of the acreage was planted to RR or RF varieties, 25% to RR/BG varieties, and 65% was planted to BG2/RFlex varieties.

Thrips—Thrips pressure was very heavy. Two large adult migration peaks occurred (usually only one). Western flower thrips were confirmed in at least three fields, all where the grower had previously applied one or two foliar insecticide applications. There were a few problem fields where multiple foliar sprays failed to provide control (most had received an insecticide seed treatment).

Plant bug/Stink bug— Populations were spotty, heavy in isolated fields, field edges next to corn, field pockets next to trees/shrubby areas. An estimated 25% of growers made pre-bloom treatments with neonicotinoid insecticides, more based on 'fear' or sales pressure than documented need.

Bollworm—*H. zea* levels were high in field corn (avg. 45% infested statewide). The moth flight was delayed, moderate but lasted several weeks longer than normal. Boll damage was more severe than in 2007 (40% vs. 25% in unprotected cotton). An estimated 75% of the cotton acreage was treated for worms with pyrethroid insecticides. Based on the AVT pyrethroid monitoring program, there were very high levels of adult survivorship compared with previous years, and documented spray failures in a few soybean fields.

Spider mite—Infestations were spotty during the seedling to pre-bloom stages, then abated. No miticides were applied by growers.

Aphid—None were observed or reported.

Other Leps—None were observed or reported **(Ames Herbert).**

Research Progress and Accomplishments:

Alabama

Research for this grant focused on several different aspects of stink bug management, plus an evaluation of various genetic technology and chemistry for caterpillar control. Four threshold regimes were evaluated for stink bug control in cotton planted both in the normal planting window, and late, which simulated cotton behind wheat in the coastal plains of the southeastern U.S. Both the dynamic and aggressively sprayed treatments had less damage and higher yields than the 20% internal injury and the untreated. However, when considering the number of sprays needed, the level of damage and the yields, the dynamic threshold was the most economical and reasonable threshold to follow. The length of period when stink bug susceptible bolls are present is much shorter (by 2-3 weeks) in cotton planted in the normal planting window, as opposed to late planted cotton, where the entire boll set period occurs during the period when stink bugs are moving from other hosts into cotton.

The choice of chemistry, or chemical class, did not appear to be as important as the interval of application in a trial conducted to measure the residual control of stink bugs along field borders that interface with other host crops. Similar control was obtained with phosphate, pyrethroid, and a combination of pyrethroid plus neonicotinoid when all were applied on a two week interval.

A systems/technology study was conducted at two sties in Alabama to determine how the genetically altered varieties compare to conventional varieties sprayed with new and existing chemistry. In cotton that had not been previously sprayed with "hard" chemistry for bug and sucking pests, caterpillar pressure and damage was much lower. This resulted in higher yields in conventional varieties with minimal input for caterpillar control. More sprays were necessary for worm control where fewer beneficial insects were present. Results indicate the appropriate chemistry must be chosen when tobacco budworms make up a significant percent of the worm population. Products such as Tracer and Steward, or the newer products such as Coragen and Belt gave superior control of budworms when compared to pyrethroids. Caterpillar oversprays with appropriate chemistry, timed to target small larvae, can be as effective as the Bt technology in reducing worm damage (**Ron Smith).**

Arkansas

The second year of a study on an early season treatment threshold for tarnished plant bugs was completed. This was part of a multi-state cooperative project with Missouri, Tennessee, Mississippi and Louisiana. Results indicate the threshold should be 8-12 plant bugs per 100 sweeps prior to bloom.

First year of a study on Temik side-dress for suppression of plant bugs next to corn was completed. This was also part of a multi-state cooperative project with Missouri, Tennessee, Mississippi and Louisiana. This study will be continued in 2009.

Studies continue investigating varietal resistance to tarnished plant bugs. Initial results indicate significant differences in tolerance/attractiveness of some varieties to tarnished plant bugs. ST4554B2RF appear to be less attractive to tarnished plant bugs. Studies in larger plots appear to correlate with small plot results. Initial research on the utility of frego-bract cotton as a trap was also investigated with promising results.

Studies investigating the threshold for bollworm on Bollgard, Bollgard II and Widestrike cotton were initiated in 2008 in several locations across the state.

A study was completed investigating the economic benefits of bollgard, bollgard II and Widestrike varieties across the state. Each technology along with a non-bt variety was compared in large plots in 3 locations across the state from north to south. Economic inputs will be analyzed to determine the returns for each technology for Arkansas growers in different regions of the state **(Glenn Studebaker)**.

California

Efficacy studies were conducted against thrips, spider mites, lygus bugs, and cotton aphids. The lygus bug and thrips studies encountered high pressure and this resulted in excellent separation of treatments and significant yield responses in the lygus studies. Lygus bug insecticide susceptibly, against active ingredients from four classes of chemistry, was monitored during June and July at three SJV locations. Research on thermal defoliation, and the role it may play in mitigating late-season insect problems and the potential for sticky cotton, was conducted at the Shafter REC in October.

Landscape monitoring studies for Lygus continued as part of the USDA-CREES-RAMP grant to examine sampling, natural enemy community, and inter-field movement as a function of host-plant. Large scale areas were sampled weekly to monitor Lygus, natural enemies and cotton development. Forty focus fields were sampled weekly as well as surrounding crops.

Research was also conducted on biological control of *Lygus hesperus* by generalist predators and the impact of *Lygus hesperus* on cotton yield.

Mark-release-recapture studies at the Shafter Research and Extension Center indicated the sweepnet collected about 20% of Lygus adults in plants less than 20 inches tall, but collection efficiency was lower and more variable in taller plants **(Peter Goodell)**.

Louisiana

Several studies were continued to collect information that can be used to improve sampling methods and action levels (thresholds) for triggering insecticide applications against tarnished plant bug (TPB), *Lygus lineolaris* (Palisot de Beauvois). Louisiana's contribution to the regional (Mid-South) early season action threshold project showed that costs associated with TPB are minimized when average TPB density is <10 per 100 sweeps and when average square retention is >80%. In a summary of all data points during the previous three years, the existing thresholds of 8 TPB per 100 sweeps and square retention of 80% are validated and should currently be maintained. Another series of studies (2005-2008) focused on the development of an action threshold for TPB that would trigger insecticide applications based on external and internal feeding evidence on squares. These results indicate that to manage square feeding evidence (SFE) at levels of ≤5%, insecticides would likely need to be applied at least weekly, or in some instances more often. Lint yields were comparable in plots receiving sprays applied weekly, or triggered at ≥5% and ≥10% SFE. These results suggest that an action threshold of 10-20% SFE for TPB could be effective in reducing insecticide applications without sacrificing cotton lint yield.

The effects of an insecticide application on the distribution of TPB nymphs within a cotton plant were examined in Louisiana field trials during 2007 and 2008. The location of TPB nymphs was described by vertical sympodial node below the plant terminal, horizontal fruiting position, and specific fruiting form (square, white flower, and boll) in both pre- and post insecticide application samples on insecticide-treated and non-treated cotton plants. Acephate, a standard insecticide recommended for TPB control, was used for the insecticide treatment. The majority of TPB were observed on squares (73% - 94%) compared to white flowers (3%-18%) and bolls (4%-15%) pre-treatment and 72 hours after treatment (HAT), respectively, regardless of insecticide treatment. The vertical distribution of nymphs within the upper 10 sympodial nodes was not significantly different between the pre-treatment and 72 HAT samples on non-treated plants. On the insecticide-treated plants, significantly fewer nymphs were observed on fruiting structures in the top five sympodial nodes compared to the number recorded on fruiting structures within sympodial nodes five-ten. The results of this study indicate that TPB nymphs prefer squares and insecticide application does not affect this trend. However, an insecticide application did influence the vertical distribution of TPB nymphs on cotton plants.

The effect of nectariless cotton was evaluated on TPB abundance and plant susceptibility in a sprayed/non-sprayed environment during 2007-2008. Selected cotton varieties and spray regimes were evaluated at the Macon Ridge Research Station near Winnsboro, LA (Franklin Parish). During both years treatments included nectariless (MCS0701B2RF) and nectaried (DP164B2RF) varieties that were either Non-sprayed or sprayed when TPB exceeded action thresholds (10 TPB/100 sweeps or 4-6 TPB/10 ft row). In 2007 and 2008, there were no significant differences in the average number of TPB among the treatments during the pre-flowering period. However, during both years, number of TPB adults, nymphs, and total TPB were higher in the nectaried (DP164B2RF) non-sprayed treatment compared to the nectariless (MCS0701B2RF) non-sprayed and sprayed treatments and the nectaried sprayed treatment after flowering. There were no significant differences among treatments for damaged squares. Lint yield was significantly higher in the nectariless sprayed treatment compared to the nectariless non-sprayed, nectaried sprayed, and nectaried non-sprayed treatments.

In 2008, pheromone-baited wire cone traps and the adult vial test (AVT) were used to survey pyrethroid susceptibility in bollworm. Susceptibility levels of >2,100 bollworm moths to a pyrethroid, cypermethrin, were determined using the adult vial test (AVT) from May to Sep in Louisiana. Adult survival at a discriminating dose of 5 µg/vial during May, Jun, Jul, Aug, and Sep was 25%, 23%, 42%, 36%, and 54%, respectively, with a mean annual survival of 34%. These survival levels were lower when compared to survival levels recorded during 2007. The LD_{50} values of a field-collected bollworm colony from Winnsboro, Louisiana in topical bioassays were 6.12, 3.48, 3.50, 2.80, and 2.00 µg/g larval weight, respectively in 2004, 2005, 2006, 2007, and 2008. The LD_{50} value for the 2004 Winnsboro colony was the highest observed for a field collection from Louisiana and demonstrated resistance ratios (RR) of 7 to 22-fold above a LD_{50} range of previously established pyrethroid-susceptible bollworm colonies. The cypermethrin LD_{50} values of two pyrethroid-susceptible colonies (LSU and DuPont) were determined to be 0.20 and 0.21 µg/g larval weight, respectively. These results continue to show that field populations of bollworms are becoming less susceptible to pyrethroids in laboratory tests. Another compound, rynaxypyr, was tested in insecticide-treated diet assays against bollworm. The 2008 bollworm colonies had similar LC_{50} values ranging from 0.055-0.099 µg/ml diet. These colonies were collected from five states and represent a broad geographical range across the United States.

Laboratory studies evaluated fall armyworm, *Spodoptera frugiperda* (J. E. Smith), survivorship on fruiting forms of transgenic *Bacillus thuringiensis* (Bt) cotton lines. Third instars from a laboratory colony were offered freshly harvested flower buds (squares) or flowers (white blooms) of a conventional non-Bt, VipCot™ (Vip3A + Cry1Ab) and Bollgard® (Cry1Ac) cotton lines in a no-choice test. Plant tissue was replaced every two-three days and a record of survivorship was recorded at the same intervals. Fall armyworm larvae readily consumed squares of the non-Bt control cotton line. Larval survivorship on non-Bt cotton squares was 56% at 22 DAI, when all surviving larvae had successfully pupated. On Bollgard® squares, survivorship was 34% at 22 DAI. On VipCot™ squares complete (100%) mortality of fall armyworm at 12 DAI and no larvae survived to pupate. Cumulative survivorship on squares was 46% on non-Bt cotton and 22% on Bollgard® at 36 DAI (adult eclosion). Third instars also actively fed on flowers of the non-Bt line. Larval survivorship on non-Bt cotton flowers was 75% at 16 DAI, when all surviving larvae had successfully pupated. On Bollgard® flowers, larval survivorship was 70% at 16 DAI. On VipCot™ flowers, complete mortality was observed at 16 DAI and no larvae survived to pupate. Cumulative survivorship at 34 DAI (adult eclosion) was similar at 52% on non-Bt cotton and 53% on Bollgard® cotton flowers. No-choice tests with fall armyworm infestations on cotton squares, flowers, and bolls will be repeated during 2009. The final results indicated that fall armyworm larval survivorship, pupation and cumulative survivorship were significantly affected by VipCot™ compared to that observed on conventional non-Bt and Bollgard® cotton lines. **Louisiana State University Agricultural Center's Northeast Research Station, St Joseph and Winnsboro, LA; Louisiana Cooperative Extension Service, Winnsboro, LA; and Department of Entomology, Baton Rouge, LA) (B. Rogers Leonard).**

North Carolina

Much of this project's applied research effort was directed toward thrips and stink bug management and in efficacy evaluations of new *Bt* cottons in 2008. Most of our project's 2008 applied research results may be found at: http://ipm.ncsu.edu/cotton/insectcorner/Research/2008/index.html

Six at-planting insecticide tests evaluated the impact of granular insecticides, seed treatments, foliar applications, and combinations on plant development, maturity, and yield. Two of these tests were in cooperation a Ph.D. student in Crop Science; these tests primarily focused on the feasibility of "hill dropping" Temik. Two other at-planting tests included at-planting granular insecticides, seed treatments, and various seed coats, and granular and foliar insecticides. An additional test evaluated the utility of a foliar biorational insecticide for thrips control, and a final test compared an organic vs. selected conventional approaches in managing thrips.

Four stink bug threshold tests were conducted as part a follow-up to a southeast regional Cotton Incorporated State Support grant "Identifying Practical Knowledge and Solutions for Managing the Sucking-Bug Complex in Cotton:

Research in the Southeast Region" in cooperation with Jeremy Greene of Clemson and Phillip Roberts of UGA. One additional "progressive spray" test was carried out to provide additional information on the return on investment of treating at various periods of the bloom period. Results to date appear to confirm that protection from stink bugs appears most critical during weeks 4, 5 and 6 of blooming, and less so during the first 2-3 weeks of blooming and after the 6th week of blooming. PhD graduate student and now postdoc Eric Blinka, along with Dr. Ames Herbert (VA Tech) and John Van Duyn, along with Michael Toews (UGA) investigated the utility of using external boll damage as an alternative scouting method of scouting for stink bug damage.

A series of additional tests were carried out to evaluate 1) the efficacy of Widestrike vs. conventional against bollworms, 2) the efficacy of 3 new and other conventional insecticides against bollworms in non-*Bt* cotton, compared with untreated WideStrike and Bollgard II lines, and 3) the efficacy of several new insecticides in controlling cotton aphids and spider mites.

Our project's annual damaged boll survey,
http://ipm.ncsu.edu/cotton/insectcorner/Research/2008/Damaged%20Boll%20Survey-County%20Data.2008.pdf,
continued in 2008 and included 130 total conventional, Bollgard, Bollgard II, and Widestrike producer managed cotton fields. Stink bug damage to bolls was 2.5, 3.2, 3.7 and 4.1% for the above technologies, respectively. Bollworm damage to bolls was 1.5, 0.55, 0.12, and 0.0.21%, respectively, for these technologies. Although the BG2 fields showed only slightly lower bollworm damage than the Bollgard cotton fields (0.12 vs. 0.55%), very small in both cases, the approximately 5-fold higher survivorship (an assumption based on the number of worm-damaged large bolls) in the Bollgard cotton fields, in line with numerous other studies, illustrates the resistance management advantage for this higher toxin dose technology. European corn borer and fall armyworm damage to bolls was virtually nonexistent in 2008.

An annual survey of North Carolina's licensed independent crop consultants working on cotton was continued in 2008
http://ipm.ncsu.edu/cotton/insectcorner/Research/2008/2008.Crop.Consultants.Insect.Survey.pdf
to gather data on how thrips, cotton aphids, and plant bugs, bollworms and stink bugs were managed by these individuals in conventional and in *Bt* cotton lines. Additional growers and selected county agents were contacted to make the survey more representative of North Carolina's producer population. Most of the results from this survey are provided in the North Carolina Cotton Insect section above. Of interest in 2008 was the continued finding that the proportion of cotton acres treated for cotton aphids and spider mites was higher following seed treatments than following Temik **(Jack Bacheler).**

Texas

Field studies conducted in the Coastal Bend included four studies to compare seed treatments with Temik for thrips and aphid control. Temik was consistently better in reducing thrips numbers whereas Gaucho Grande and Cruiser, as in previous studies, did the best job on aphids. Generally no affect was observed on yield by any of the treatments probably due to the late planting date in which cotton growth was rapid under the warmer conditions. Three other field studies were conducted to evaluate insecticides for fleahopper control or to determine the impact of treatment timing for fleahopper. Centric, Intruder, and Trimax Pro were generally more effective than Carbine and Orthene, but all insecticides kept numbers below the established economic treatment threshold of 15 per 100 plant terminals. Bollworm moths were monitored for resistance with reduced resistance observed in 2008 compared with any of the last 5 year period. Trap catches of bollworm and tobacco budworm were also very low compared with any year in memory. (**Parker, Texas AgriLife Extension Service, Corpus Christi**).

A thrips trial using growth chambers was conducted to determine the impact of thrips feeding on a current variety. The trial looked at two different temperature regimes (51 F (night time) and 82 F (daytime) and 61 F (night time) and 92 F (daytime) and three different populations of thrips (0 per true leaf, 1 per true leaf and 3 per true leaf). Thrips populations were manipulated by adding only 2nd instar thrips so adult thrips were never present on the trial. Due to a delay in the start of the trial because of limited growth chambers, no yield was collected on the plants. However, as expected temperature had a significant impact on growth factors on the plant. The plant was not affected by thrips numbers when grown in the high temperature regime. When plants were grown at the low temperature regime, thrips significantly reduced key growth factors. Preliminary data indicates that the combination of thrips and low temperatures causes a negative additive affect on the plant**. (Chow, Texas AgriLife Research and Sansone, Texas AgriLife Extension Service).**

A project to evaluate the population dynamics and economic thresholds for cotton fleahopper was established in three growing regions (Blacklands, Southern Rolling Plains and High Plains). Population dynamics are still not well understood in the western part of the state where wild hosts are not as plentiful. The population dynamics study also incorporates a molecular component study host associated differentiation. Preliminary studies in the Blacklands indicate that cotton fleahoppers may fly into fields from two primary hosts and that those populations do not interact in cotton. Threshold work indicates that current thresholds are adequate in the eastern part of the state but the number of applications needed to maintain populations below damaging levels can be reduced. Threshold work in the western part of the state shows that thresholds may need to be revised upward. This may be due to the lack of wild hosts and thus less long term invasion on cotton. (**Medina, Texas AgriLife Research; Parajulee, Texas AgriLife Research, Lubbock; Barman, Texas AgriLife Research; Sansone, Texas AgriLife Extension Service, San Angelo and Suh, USDA-ARS, College Station**)

The statewide monitoring program that evaluated pyrethroid resistance in male bollworm (*Helicoverpa zea* (Boddie)) was conducted from April to September 2008, surveying twelve Texas Counties, as well as Tamaulipas, Mexico. Moths were trapped near cotton fields using pheromone, Hercon Luretape® with Zealure. Vials were prepared in the Toxicology Laboratory, Department of Entomology at Texas A&M University, College Station, Texas, and shipped as needed to Texas Cooperative Extension personnel (Texas AgriLife Extension Service). Data from all areas in Texas were sent to Texas A&M University Toxicology Laboratory for analysis, including estimation of lethal concentration of cypermethrin that kills 50% of the population (LC50), 90% of the population (LC90), resistance ratios (how many more times resistant the field population was than a susceptible population at the LC50 and LC90), and the statistical significance test for these resistance ratios. Overall, bollworm resistance levels were reduced in 2008, probably due to the drought conditions and less spraying of bollworms in grain sorghum. The highest survivor was at 60 micrograms in the Williamson County area. (**Pietrantonio, TAMU/Texas AgriLife Research, College Station and Texas AgriLife Extension Service collaborators**).

We examined the indirect effects of cotton aphids on arthropod pests of cotton via aphid-induced changes in plant chemistry and predator abundance and behavior. First, aphid-induced cotton plants were analyzed for changes in defensive compounds relative to non-induced cotton plants. Aphid-induced plants showed a significant increase in gland density ($T_{1, 26} = 2.62$, $P = 0.015$), glands that contain toxic compounds such as gossypol, compared to control (non-induced) plants. Subsequently, we examined the impact of aphid-induced cotton plants on beet armyworm (*Spodoptera exigue*) caterpillar and moth performance. In choice-tests, mated female moths deposited 85% more eggs on control plants versus aphid-induced cotton plants ($\chi^2_1 = 11.3$, $P < 0.001$). Furthermore, beet armyworm larvae weighed significantly less ($F_{1, 81} = 6.23$, $P = 0.014$) and development was longer ($F_{1, 81} = 5.78$, $P = 0.018$) on aphid-induced plants than control plants. Finally, field and laboratory experiments were used to test the impact of cotton aphid on predator attraction and resulting beet armyworm suppression. Cotton plants with aphids had significantly more insect predators (e.g. lady beetles and green lacewings) that resided longer on the plant than control plants. Additional tests revealed higher beet armyworm mortality due to predators on cotton plants with aphids compared to plants with no aphids. The effect of aphids and predators together reduced beet armyworm survival by 66% compared to aphids and predators alone, 23% and 46% respectively. The indirect effects of aphids via these mechanisms (i.e., aphid induction and predator enhancement) on beet armyworm were strong. Aphids induced the production of defensive compounds in cotton plants that negatively affected moth oviposition behavior and caterpillar performance. In addition, cotton aphids attracted predators that had strong, negative effects on the survival of caterpillars. Caterpillars and other non-aphid pests can cause greater economic loss than cotton aphids in cotton. Indirect suppression of these herbivores by cotton aphids is likely to result in increased cotton yield under a wide range of conditions (e.g., moderate to high densities of other pests) **(Ramirez & Eubanks, TAMU/Texas AgriLife Research, College Station; Frank, North Carolina State University; Zehnder, Georgia College & State Univerity).**

First year of a multi-year field experiment was conducted to quantify the effect of nitrogen fertilizer on cotton aphid population dynamics under the drip irrigation system. Five levels of nitrogen (0, 50, 100, 150, and 200 lbs per acre) were evaluated in a randomized block design with 4 replications at the Helms Farm near Halfway. Soil residual nitrogen was determined for each treatment plot before treatment application and leaf nitrogen was monitored for 5 weeks during August-September. Cotton aphid populations did not develop in this field in 2008, but several plant growth and development parameters were measured (**Parajulee, Texas AgriLife Research, Lubbock)**.

Experiments were conducted to quantify the age of the boll (degree-days from boll formation) that is safe from *Lygus hesperus* damage. Boll damage assessment based on heat unit-delineated maturity provided a boll-safe cutoff value of 350 HU for *L. hesperus*, similar to that found for the tarnished plant bug in the Southeast. A penetrometer was used in determining how much pressure was required to penetrate the carpel wall of a cotton boll of different ages. Linear regression analyses established the relationship between *L. hesperus* damage and the amount of pressure required to puncture the carpel wall of a boll. It is estimated that cotton bolls are relatively safe from *Lygus* damage when the pressure required to penetrate the carpel wall is >0.69 lb/ft^2 (**Parajulee, Texas AgriLife Research, Lubbock)**.

A project investigating the development of landscape-level pest management guidelines to reduce Lygus infestations in cotton was repeated in 2008. The project involves surveying and sampling the agricultural landscapes of several sub-regions of the southwestern United States, including the Southern High Plains of West Texas for *Lygus hesperus*. It is a 4-year project that began in 2007. Geographic information from the 2007 study has been compiled using a software-based geographic information system. In June and July of 2008, fifty-six cotton fields (the majority of which were under irrigation) were selected as "focal fields" for the 2008 Texas Lygus Project landscape insect survey. This was done in coordination with the Texas AgriLife Extension Integrated Pest Management County Extension Agents representing six counties in West Texas. A goal was set to sample fifty of the fifty-six fields each week, with the remaining six fields designated as auxiliaries. This effort included the sampling, via sweep net, of up to six occurrences of non-cotton target insect habitats within a three-kilometer radius of ten of the aforementioned fields. For eleven weeks, beginning on 14 July 2008, the survey study was executed. In contrast to 2007 efforts, our ability in 2008 to confine our weekly efforts to a period of five days per week was not compromised, however, at times, the mission to sample fifty fields, with ten involving adjacent non-cotton habitat sampling, was not 100% met due to circumstances which were primarily climatic in nature, and which ultimately precluded physical access to “missed” fields. Processing of retrieved samples was performed in tandem with weekly surveying and sweeping activities (**Parajulee, Texas AgriLife Research, Lubbock)**.

The influence of non-cotton hosts on life history characteristics of Lygus Hesperus was investigated. Four selected host plants from the field choice test in 2005-2006 [alfalfa (*Medicago sativa*), pigweed (*Amaranthus palmeri*), Russian thistle (*Salsola iberica*), and cotton (*Gossypium hirsutum*)], green beans (*Phaseolus vulgaris*)], and artificial diet were used to conduct a no-choice feeding trial. The study was conducted in an environmental growth chamber at 27±1 ^{o}C, 65±10% RH, and a 12:12 (L:D) photoperiod. Newly eclosed *L. hesperus* nymphs were caged individually on each host substrate and recorded development and survivorship through the adulthood. Lifetime fecundity was evaluated for artificial diet, green beans, cotton, and alfalfa. Total nymphal development was longest for cotton bolls (<2 d old bolls) followed by cotton squares and alfalfa. Nymphal development was shortest in Russian thistle. Together with the longest developmental period, nymphal survivorship was lowest on cotton bolls indicating that the young bolls were not satisfactory host substrate for *L. hesperus* development. Both squares and bolls were inferior hosts to other host substrates evaluated. Preliminary fecundity data suggest that artificial diet, green beans, and alfalfa are superior substrates compared with cotton squares. Data from choice field test and no-choice laboratory test collectively suggest that cotton may be a much less preferred host than other non-cotton hosts for *L. Hesperus* (**Parajulee, Texas AgriLife Research, Lubbock)**.

Studies were conducted investigating the compensation of *Lygus* and fleahopper-induced fruit loss in cotton. Objectives of this project were to: a) Quantify compensation of *Lygus*-induced fruit loss in pre-flower and early flower cotton under limited-irrigation production, b) Quantify compensation of *Lygus*-induced fruit loss in pre-flower and early flower cotton under high input drip irrigation production system, and c) Compare the compensation potential of cotton in limited versus full irrigation after cotton fleahopper-induced square loss. These three sub-projects will collectively provide information to growers in determining the level and timing of *Lygus*/FH infestation that they can tolerate without having to treat with insecticides if we know the amount of compensation plants can attain for a given level of fruit loss. Timing is even more critical because the compensation of square or early boll loss will have much different impact on boll maturity delays and lint quality. Research projects during the past several years has addressed these sub-objectives where we established four treatment regimes for each set of the study: i) natural infestation of *Lygus* or FH, ii) insecticide sprayed control, iii) 1 plant bug (*Lygus* or FH) per plant, and iv) 3 plant bugs per plant. Bugs were released for three consecutive weeks before (pre-flower) or after (early flower) the initiation of flowering. Plant mapping was conducted weekly throughout the study period until crop cut-out. It appears that cotton can compensate 20-25% pre-flower fruit loss while the compensatory ability may be reduced as plants enter boll formation stage (**Parajulee, Texas AgriLife Research, Lubbock)**.

A ontogenic morphometric study was conducted to characterize the biology (growth and developmental process) of *Lygus hesperus* under laboratory conditions. Digital pictures were taken of 40 *Lygus* bugs from egg to adult stage every day (20-25 days) using a digital camera mounted on a stereomicroscope. The shape and size of the *Lygus hesperus* (male and female) bugs were measured by both outline based elliptical fourier analysis and landmark based partial warp analysis. The preliminary analysis showed the morphometric data can clearly differentiate the sex and different nymphal instars of *Lygus hesperus*. The development of ontogenic growth trajectories for this species will allow us to predict the shape and size of the *Lygus* in a given insect age. This can be used in comparative studies of other species of *Lygus* to evaluate if the heterochrony in shape and size has evolved during speciation of *Lygus*. The morphometric technique can be used to evaluate the host suitability for *Lygus* growth and development and also to evaluate the effect of different ecological factors like temperature, host plant and crowding in the growth and development of *Lygus* which will indicate the fitness of *Lygus hesperus* in a particular ecological niche. In addition to the ontogenic morphometry, the effect of manual handling during digital imaging has been evaluated. Forty additional *Lygus* were photographed only 5 times (after each molt) during their developmental cycle and their shape and size were compared with that of the insects photographed daily. Data analysis is in progress (**Parajulee, Texas AgriLife Research, Lubbock)**.

A genetic diversity study of *Lygus hesperus* populations from different Texas High Plains locations was conducted. This study is a portion of a larger study entitled, "development, characterization and comparison of various nuclear and mtDNA markers for their potential use in a genetic diversity study of *Lygus hesperus*." *Lygus* samples (n=40) were collected from 5 different locations, each spaced 40-60 miles apart on a north/south orientation through the Texas High Plains region. DNA extraction and *Lygus* genotyping using 6 different SSR markers has been completed. Genotype alleles were separated in vertical polyacrylamide gel and visualized by silver staining. The genetic diversity study of *L. hesperus* using 6 SSR markers revealed that the number of alleles for the SSR per marker ranged from 3 to 6 and PCR product size ranged from 105 to 205 bp. All SSR markers had a Shannon diversity index value equal to or greater than 0.5. For all four populations, most of the loci were significantly different from Hardy-Weinberg's equilibrium status and few other loci were in Hardy Weinberg's equilibrium. Thus, *Lygus* were not mating at random because at some locus the observed allele frequency was significantly different than the expected. It might be due to some level of natural selection, migration or genetic drift. UPGMA cluster analysis of the genetic distances among four populations showed that the Idalou and Lamesa populations were genetically the closest populations, which is in accordance with the geographical distance. These two sites were within about 80-mile distance. *Lygus hesperus* populations were genetically differentiated and the SSR markers used were able to detect the within species genetic variation in *L. hesperus* High Plains populations. Development and characterization of other molecular markers (ISSR, RAPD and AFLP) is in progress (**Parajulee, Texas AgriLife Research, Lubbock)**.

A study was conducted to determine the optimization of indirect ELISA system for EW and NFDM protein detection. The indirect ELISA protocol has been optimized in various steps. We evaluated various volumes and time for antigen protein extraction from marked *Lygus*, various antigen loading volumes, different kinds of blocker solution and their different volume, various concentrations of the primary and secondary antibodies, various amounts of EDTA in extraction buffer, various times of incubation, various strengths of the washing buffer, various frequencies of plate washing, and various temperatures for plate incubation. We optimized all of the above mentioned factors for both eggwhite and non-fat dairy milk protein detection systems. Now we have a very efficient optimized ELISA protocol which allows detect at 1ppm of egg albumin and 10 ppm of milk casein. We are in the process of also optimizing the indirect ELISA protocol for soy milk proteins (**Parajulee, Texas AgriLife Research, Lubbock)**.

A research project was conducting investigating the optimization of internal, external and field marking by animal proteins. The internal, external and field marking of *Lygus* with milk casein and egg albumin proteins has been performed with a series of laboratory and field experiments. The optimum protein concentration required for field marking of alfalfa and cotton was evaluated by spraying 5 different concentrations of eggwhite (EW) and non-fat dairy milk (NFDM) in these two crops and collecting the *Lygus* specimens from each field and testing them with indirect optimized ELISA procedure. The 20% NFDM and 15% EW sprayed plots each yielded 100% positive

Lygus from the fields; therefore, we recommend these concentrations for future studies. The foraging time required by *Lygus* to pickup the field marking protein from marker sprayed crop plants was evaluated for both protein markers in a field cage study. Alfalfa inside the cages was sprayed with these marker proteins and 500 live adult *Lygus* were release per cages. *Lygus* were collected in various time intervals to determine the effect of foraging time to the number of positively marked *Lygus*. The 72-h foraging time gave the highest number of positive *Lygus* in the NFDM sprayed cages but in the EW sprayed cages we observed a similar number of positive-marked *Lygus* after only 24 h of foraging. For *Lygus* to acquire enough protein to be detected by the ELISA system, these results suggest that NFDM requires a longer foraging time as compared to EW. The longevity of the marker protein on the *Lygus* body was evaluated by externally marking the *Lygus* in the laboratory and releasing them into field cages and sampling them in different time intervals. The external body marker proteins were detected even after 15 days which is a sufficient length of time to use this protein in various ecological studies such as *Lygus* intercrop movement studies. The time and method of feeding *Lygus* with the EW and NFDM and their longevity in *Lygus* digestive system was evaluated in laboratory. The effect of molting and the transfer of protein markers from one adult insect to another during copulation were evaluated in a laboratory study. The samples from these studies have not been processed to date (**Parajulee, Texas AgriLife Research, Lubbock)**.

Intercrop movement behavior of *Lygus* in alfalfa-cotton system was characterized. The intercrop movement behavior of *Lygus* in an alfalfa-cotton system has been evaluated by field studies where the movement of *Lygus* from one crop to another was monitored weekly throughout the cotton growing season. For this test we planted an alfalfa strip (about 40 x 600 ft) in the middle of a cotton field near Lubbock, Texas. We sprayed 10% EW in the alfalfa and 10% NFDM in the cotton field weekly for 10 weeks beginning from when cotton was at the 3-4 true leaf stage. The *Lygus* were sampled from both crops after 24 h of foraging every week. We used a blower sampler on a 100 ft long patch replicated three times for both crops. The *Lygus* numbers were undetectable in the cotton but when the cotton started squaring and flowering *Lygus* started moving into the field. The specimens collected from these alfalfa and cotton plots are being stored at -20 ^{o}C in the laboratory until processed by ELISA. So we do not have needed data available at this time to make the inference about the direction and quantity of net movement. We have also evaluated the effect of alfalfa mowing height in the intercrop movement of *Lygus* in cotton blooming and boll maturing stage. We had 3 levels of alfalfa (not mowed, 2-inch mowed height, and 6-inch mowed height) replicated 3 times. We sprayed the alfalfa with EW in 2-inch mowed plots and NFDM in 6-inch mowed plots and the *Lygus* were sampled from all plots including nearby cotton after 24 h following the alfalfa mowing. *Lygus* collected are being processed by ELISA. With this season-long intercrop movement research we will be able to predict the time and direction of movement. This approach can be used in evaluating different crop management practices (irrigation, soil fertility, insecticide spray, herbicide spray, etc.) and other ecological and environmental factors in the movement of *Lygus* into cotton in the future. Such data will be useful in developing a model to predict the intercrop movement behavior of *Lygus* by incorporating the major factors in a single model (**Parajulee, Texas AgriLife Research, Lubbock)**.

An insecticide bioassay on adult *Lygus hesperus* was conducted in 2008. Glass vial bioassays were performed with three technical grade insecticides, cypermethrin (94.3% AI), acephate (97% AI) and flonicamid (99% AI). Sweep nets were used to collect *Lygus* adults from an alfalfa field near Levelland, TX. The live adults were returned to the laboratory and used to conduct the acephate and cypermethrin bioassays. For flonicamid, *Lygus* from lab colony were used. Mortality observations for the analyses were taken at 24 h after exposure (HAE) for acephate and cypermethrin, whereas for flonicamid, the mortality evaluations were taken at 72 HAE due to a different mode of action which extends the time required to kill the insects. Results indicated the LC_{50} value for acephate was 1.29 ug/mL and for cypermethrin, 0.19 ug/mL. Flonicamid showed a LC_{50} of 22.46 ug/mL. A probit regression analysis will be used to determine the sublethal doses of these insecticides to be used in future experiments to study the sublethal effects on life history parameters and behavioral changes in *Lygus* (**Parajulee & Kerns, Texas AgriLife Research & Extension, Lubbock)**.

Laboratory glass vial assays with sub-lethal dosages were conducted with female *Lygus hesperus* during the oviposition stage. Sublethal doses of flonicamid were dissolved in an ethyl alcohol solvent and then the solution was applied to the vials at rates of 10, 25, 50, 100, 250 ug/mL were tested. The selected control treatment was ethyl alcohol (99% molecular grade). A total of 25 females were tested for each concentration and a fresh green bean piece was provided to serve as a food source plus an oviposition substrate. At 48 h HAE, observations were made to count the number of eggs and mortality. Surviving adults were then moved to fresh untreated glass vials with a similar food/oviposition substrate. Observations for oviposition and mortality were taken on the fresh vials after 48 h (total 96 HAE). This was done to check whether the effect on oviposition after exposure to flonicamid caused a permanent suppression of oviposition or not. Results indicate that flonicamid suppressed oviposition. There were significant differences in the mean number of eggs at both 48 HAE and 96 HAE. At 48 HAE, the mean number of eggs laid per female was 15.9 in the untreated control whereas, in the other treatments mean values were <1.0. At 96 HAE, females in the untreated control again laid significantly more eggs than the females previously exposed to flonicamid. Increases in mortality were positively correlated with increases in flonicamid concentration and time which might be due to starvation. Ovipositional capacity was regained in 50% of the surviving individuals at 96 HAE when transferred to non treated vials held under the same conditions (**Parajulee & Kerns, Texas AgriLife Research & Extension, Lubbock)**.

Potted cotton plants of two varieties, Bt (DP141B2RF) and Non Bt (DP174RF), were sprayed at the 2-4 true-leaf stage with three different solutions of insecticides to evaluate the impact on oviposition of *Lygus hesperus*. The replicated treatments included: 1) a sublethal dose of Carbine® 50 WG (flonicamid) in a concentration of 1.72g/L, 2) water as a control, and 3) Ammo 2.5 EC (cypermethrin) at 4ml/L as a positive control. Five pots with two plants each were treated with each treatment solution. Plants were caged 3 days after spraying. Two adult females in their oviposition phase (7-10 day old) were selected at random from a laboratory colony and then released into each cage. Five days after the releases, mortality observations were made and surviving adults were removed. Plants were dissected and eggs counted using a stereomicroscope at 20X magnification. The results indicated that *Lygus* oviposition on cotton plants treated with the sublethal doses showed significant differences on the Bt cultivar plants, whereas with the non Bt cultivar, Carbine® and the untreated plants were not different. The control Bt plants were found to have a mean of 17 eggs/female whereas, plants treated with Carbine® and Ammo possessed 10.2 and 0.7 eggs, respectively. The results of this study are preliminary and additional research is needed to validate the findings (**Parajulee & Kerns, Texas AgriLife Research & Extension, Lubbock)**.

A series of field studies were conducted to develop a data base for formulating an action threshold for thrips in seedling cotton. Data from 2007 suggested that under cool weather conditions, the current recommended threshold is too high and that the threshold during the first two weeks following plant emergence may be close to 0.5 thrips per plant. Across six test sites in 2008 under hot conditions, data suggests that more than 1.5 thrips per plant can be tolerated without affecting yield. These studies suggest that the action threshold for thrips in West Texas should be dependent on temperature (**Kerns, Texas AgriLife Extension Service, Lubbock; Vandiver, Texas AgriLife Extension Service, Farwell; Cattaneo, Texas AgriLife Extension Service, Seminole; Siders, Texas AgriLife Extension Service, Levelland**).

Two studies investigating the efficacy of in-furrow and seed treatments for thrips management were conduted in Parmer and Gaines counties. Although efficacy was apparent for Temik, Aeris, Avicta Complete and Cruiser, the thrips populations were low and did not impact yield. However, a significant correlation of *Liromyza* sp. leafmining and cotton leaf area reduction was observed. Although there was no correlation with yield, there is speculation that this pest may impact yield under cool conditions similar to thrips; more research is required to verify this (**Kerns, Texas AgriLife Extension Service, Lubbock; Vandiver, Texas AgriLife Extension Service, Farwell; Cattaneo, Texas AgriLife Extension Service, Seminole**).

A test was conducted investigating the efficacy of insecticides to cotton aphids and the impact on aphid natural enemies. Bidrin, Carbine and Intruder all exhibited excellent activity followed by Centric. Trimax Pro exhibited initial activity but the aphid population quickly resurged in the lower plant canopy. Although the data for lacewing larvae were inconclusive, none of the treatments differed from the untreated, aphicide impact on lady beetle larvae was clearer. At 3 DAT, the number of lady beetle larvae did not differ between the Carbine, Bidrin or the untreated plots, while all of the neonicotinoids (Centric, Intruder and Trimax Pro) contained fewer lady beetle larvae than the untreated. Trimax Pro had fewer lady beetle larvae than either Carbine or Bidrin. Regression analysis indicated that lint yield decreased as the population increased over 50 aphids per leaf which validates the Texas AgriLife Extension Service threshold (**Kerns & Baugh, Texas AgriLife Extension Service, Lubbock)**.

A study was conducting investigating the efficacy of insecticides to *Lygus* and the impact of *Lygus* on bolls and yield in late season cotton on the High Plains. Carbine at 2.3 oz, Ammo at 5.1 fl-oz, Orthene 97 at 0.75 lbs, Vydate at 17 fl-oz, Centric at 2.5 oz and Diamond at 10.5 fl-oz were the products evaluated. All products were efficacious under low *Lygus* pressure but under high pressure, Centric was marginal. Diamond and Carbine, as expected since they are an IGR and anti-feedent respectively, were somewhat slow acting, but by 6 DAT the total number of *Lygus* were statistically equivalent and lower than the untreated for all the insecticides. However, the Centric plots had more adults than the other insecticides except Diamond. At 6 DAT, the untreated plots were averaging about 48% bolls with external *Lygus* feeding damage, and about 30% bolls with internal feeding damage. All of the insecticides had fewer external feeding marks than the check. External feeding damage was similar among the insecticides except Centric had more damage than Ammo. Results were similar for the percentage of bolls with internal damage, but Centric did not differ from the check. Regression analysis suggests that the current threshold of 4 *Lygus* per 6 ft-row is a good threshold **(Kerns & Parajulee, Texas AgriLife Research & Extension Service, Lubbock).**

A study was conducted to evaluate insecticides for efficacy toward bollworms. Emphasis was placed on insecticides that may also have efficacy towards beet armyworms as well; these included Belt, Coragen, Steward, and Karate as a bollworm standard. Due to usually cool temperatures, all insetcides were slow acting, but Karate appeared to be least impacted by the cool temperature. By 9 DAT, all of the insecticides had significantly fewer larvae than the untreated, but at this time only Karate had reduced the population below threshold (**Kerns, Texas AgriLife Extension Service, Lubbock; Nino, Texas AgriLife Extension Service, Dimmitt; Baugh, Texas AgriLife Extension Service, Lubbock; Cronholm, Texas AgriLife Extension Service, Plainview**).

Insecticides were evaluated for efficacy towards beet armyworm. Belt, Coragen, Demin, Intruder, Diamond and Steward all appeared to have excellent activity towards small, medium and large beet armyworm larvae in cotton. Cobalt and Tracer exhibited good activity towards small beet armyworms but were weak against medium and large sized larvae (**Kerns & Baugh, Texas AgriLife Extension Service, Lubbock)**.

An end of the season bollworm boll damage survey was conducted throughout the South Plains. A total of 77 fields were surveyed. Non-Bt cotton with 3.16% damaged boll had significantly more damaged bolls than Bollgard (0.53%), Bollgard II (0.04%) or Widestrike (0.18%). The non-Bt fields required 0.41 insecticide applications per field whereas the Bt cotton fields did not require any (**Kerns, Texas AgriLife Extension Service, Lubbock; Cattaneo, Texas AgriLife Extension Service, Seminole; Siders, Texas AgriLife Extension Service, Levelland; Nino, Texas AgriLife Extension Service, Dimmitt; Baugh, Texas AgriLife Extension Service, Lubbock; Cronholm, Texas AgriLife Extension Service, Plainview; Doderlein, Texas AgriLife Extension Service, Lamesa**).

A Bollgard II and a Widestrike variety were evaluated relative to a non-Bt variety for resistance to first and fourth instar saltmarsh caterpillars at the seedling stage. Both Bt varieties caused 100% mortality of the first instars and suffered no feeding damage, whereas mortality was 0% in the non-Bt and feeding was extensive after 3 days. Against fourth instars, mortality was 90, 80 and 10% in the Bollgard II, Widestrike and non-Bt respectively, after 5 days. Feeding damage was minimal on the Bt varieties, while the non-Bt variety lost about 50% of its leaf surface **(Kerns & Kesey, Texas AgriLife Extension Service, Lubbock)**.

Virginia

Test 1. The goal of this test was to evaluate 16 cotton varieties, with and without foliar bollworm insecticide treatments, for bollworm damage to bolls and yield. Varieties were selected from two groupings based on level of insect resistance: non-insect resistant, or conventional (RF), and double insect resistance gene, or double-gene (BG2, WS, or D). Varieties were selected based on official variety test performances in Virginia and North Carolina using only the highest yielding varieties from each grouping. Plots were 4 rows (36-inch row center) by 35' long. Experimental design was a four-replicate split-plot, with insecticide treated vs. untreated as the main plot and variety as the sub-plot. In treated plots, plant bug and stink bug were managed with two insecticide applications, one in mid-July (Centric at 2 oz/acre), the second in late July (Orthene 97 at 8 oz/acre). Treated plots received bollworm protection with an application of Baythroid XL at 2.6 oz/acre on August 12. The treated plots of the conventional variety 'PHY 425 RF' also received Baythroid XL at 1.6 oz/acre eight days prior to the 2.6 oz/acre application. Plant bug and stink bug were monitored by assessing square retention on five randomly selected plants per plot. There was no difference in percent square retention between treatments (with or without insecticide) or varieties. Percent internal bug-induced boll damage was assessed on five randomly selected bolls per plot from the unprotected plots on July 31, with significant differences among varieties. Bollworm was monitored by assessing external boll damage on 25 randomly selected bolls per plot on three dates. There was no difference in bollworm damage on any date when the varieties were protected with a bollworm treatment; however, unprotected PHY 425RF experienced much greater bollworm damage than the double-gene varieties on all three dates. Cotton was harvested on October 27 from two rows of each plot using a commercial John Deere cotton picker. A one-pound subsample was ginned from each plot to determine the lint:seed/trash ratio. The value of each variety was determined by comparing lint value ($0.55/lb) to insecticide treatment cost, based on Baythroid XL at $1.68/oz (PHY 425 RF with 1.6 oz + 2.6 oz, and all other varieties with 2.6 oz) with an application cost of $5 per acre. A single insecticide application targeted at bollworm in double-gene varieties increased yield by 0-254 lb lint/acre (mean = 80 lb lint/acre), while two applications in the conventional variety increased yield by 716 lb lint/acre. Under our cost parameters, insecticide application resulted in a loss of $9 to a gain of $63/acre in BG2/D (double-gene) varieties; a gain of $89-130/acre in WS (double-gene) varieties; and were most valuable for the RF (conventional) variety, gaining $377/acre.

Test 2. The goal of this test was to determine the efficacy of cotton varieties with and without WideStrike under no chemical bollworm control. Five Phytogen varieties were planted in small plots (4 rows x 35' long) at TAREC using a four-replicate randomized complete block experimental design. Plant height (cm) and the number of nodes per plant were measured on two dates. There were significant differences in height on June 26, but no difference in the number of nodes. Plant bug and stink bug were monitored by assessing square retention on five randomly selected plants per plot on July 11—there was no difference between varieties. Percent internal bug-induced boll damage was assessed on five randomly selected bolls per plot from the unprotected plots on July 30, with no significant differences among varieties. Bollworm was monitored by assessing external worm-induced boll damage on 25 randomly selected bolls per plot on August 19, 26, and September 3. Varieties containing WideStrike had significantly less damage than the two conventional varieties on two of three sample dates. Cotton was harvested on October 27 from two rows of each plot using a commercial John Deere cotton picker. A one-pound sub-sample was ginned from each plot to determine the lint:seed/trash ratio for determining yield. The trend in bollworm damage was reflected in yield, with the WideStrike varieties averaging 461 lb lint/acre more than conventional varieties.

Test 3. The goal of this test was to evaluate seven foliar-applied insecticides for bollworm damage to bolls and yield. 'DP 434 RR' cotton was planted in small plots (4 rows x 40' long) at TAREC using a four-replicate randomized complete block experimental design. Thrips were managed with in-furrow Temik and an Orthene application on May 29. Plant bug and stink bug were managed with two Orthene applications in July. Bollworm treatments were applied using a CO_2 pressurized backpack sprayer on August 4 (broadcast at egg threshold) and/or August 12 (broadcast at 8 days after egg threshold). Bollworm was monitored by assessing external worm-induced boll damage on 25 randomly selected bolls per plot on August 19, 26, and September 2. All insecticide treatments resulted in significantly less bollworm damage than the untreated control on all three sample dates, with differences between treatments only on August 19. Cotton was harvested on October 21 from two rows of each plot using a commercial John Deere cotton picker. Four representative one-pound sub-samples were ginned to determine the lint:seed/trash ratio for determining yield. Insecticide treatment resulted in an average yield increase of 358 lb lint/acre over the untreated control, with significant differences between treatments.

Test 4. Treatments, goals, and methods used in this test were the same as in test 3; the only difference was that it was in another field at TAREC. All insecticide treatments resulted in significantly less bollworm damage than the untreated control on all three sample dates, with no differences between treatments. Insecticide treatment resulted in an average yield increase of 399 lb lint/acre over the untreated control, with no significant difference between treatments.

Test 5. The goal of this test was to evaluate the efficacy of 10 foliar-applied insecticide/rate combinations for stink bug (mostly green stink bug) in cotton. Plots consisting of 2 rows x 40' long were established in 'DP 444 BG/RR' cotton at the Cherry & Bateman farm (Terrell Co., NC) using a four-replicate randomized complete block experimental design. The number of stink bugs per 10' beat cloth sample was recorded at 1 and 4 days after treatment. All treatments had significant reductions in green stink bug adults at 1 day after treatment, with Venom 70SG at 3 oz/acre and Karate Z at 2.56 oz/acre the most efficacious. At 4 days after treatment there were fewer green stink bug adults in the untreated control, making treatment comparisons difficult. Louis Smith, Ken Cherry, and Hal Bateman are acknowledged for their assistance with this test.

Test 6. The goal of this test was to evaluate insecticide seed treatments, with and without Orthene 97 foliar sprays, for thrips injury and yield. 'ST 4498 B2RF' cotton was planted in small plots (4 rows x 35' long) on May 2 at TAREC using a four-replicate randomized complete block experimental design. Foliar Orthene treatments were applied using a CO_2 pressurized backpack sprayer on May 23 (broadcast at first true leaf). Thrips injury was rated on a 0-5 scale, where 0 = no injury and 5 = dead plants. All insecticide treatments resulted in significantly less thrips damage than the untreated control on all three sample dates, with differences between treatments on all dates.

The number of nodes above cracked boll was determined by sampling ten plants per plot on September 16 and the number of open bolls in one row was recorded on September 22. These data indicated that plots receiving "Aeris + Temik" matured earlier than others. Cotton was harvested on October 21 from two rows of each plot using a commercial John Deere cotton picker. Four representative one-pound sub-samples were ginned to determine the lint:seed/trash ratio for determining yield. Insecticide treatment resulted in an average yield increase of 577 lb lint/acre over the untreated control, with no significant differences between treatments.

Test 7. The goal of this test was to evaluate the efficacy of Radiant (spinetoram) for thrips management in cotton. Orthene 97 was included as a standard treatment. 'DP 444 BG/RR' cotton was planted in small plots (4 rows x 35' long) on May 6 at TAREC using a four-replicate randomized complete block experimental design. Foliar treatments were applied using a CO_2 pressurized backpack sprayer on May 21 (broadcast at first true leaf) and May 30 (broadcast at 2-3 true leaf). Thrips counts were performed on four dates, with the Orthene treatment having the fewest adults on May 23 and 27 and the fewest immatures on June 2 and 9. Thrips injury was rated on a 0-5 scale, where 0 = no injury and 5 = dead plants. The Orthene treatment resulted in significantly less thrips damage than all rates of Radiant tested on all three sample dates. Vigor ratings on June 13 indicated that the plots receiving the Orthene treatment had the most vigorous plants. Cotton was harvested on October 14 from two rows of each plot using a commercial John Deere cotton picker. Four representative one-pound sub-samples were ginned to determine the lint:seed/trash ratio for determining yield. The Orthene treatment resulted in a yield increase of 310 lb lint/acre over the highest rate of Radiant tested. There were no significant differences between Radiant treatments and the control **(Ames Hebert).**