2005 Beltwide Cotton Conferences, New Orleans, Louisiana - January 4 - 7, 2005

58TH ANNUAL CONFERENCE REPORT ON COTTON INSECT RESEARCH AND CONTROL

John J. Adamczyk
USDA, ARS
Stoneville, MS
Eugene Burris
LSU Agricultural Center, Northeast Research Station
St. Joseph, LA

Abstract

There were 12,058,000 acres of U.S. Cotton (Upland and Pima) harvested with an average of 831 pounds of lint per acre (USDA –January 2005 report) in 2004.

Arthropod pests of cotton reduced yield by 4.18% in 2004. The bollworm/budworm complex reduced yields by 1.23%. The bollworm was the predominant species to attack cotton in 2004. Bollworms were estimated to make up 94% of the population *Lygus* (1.06%) were 2nd in losses. Stink bugs (0.588%) were 3rd and Thrips (0.559%) were 4th. Cotton fleahoppers (0.192%) rounded out the top five cotton insect pests for the year. Beltwide, direct insect management costs amounted to $54.54 per acre. Cost plus loss is estimated at $1.1183 billion. (see M.R. Williams, this proceedings).

Crop and Arthropod Pest Conditions:

Alabama

2004 could be summed up statewide as a light insect year. Most scouts and consultants spent the summer just looking but never finding an economic insect infestation. However, one area of the state, the southeastern three or four counties were overwhelmed by all species of caterpillars that are known to occur on cotton. This area was similar to adjacent areas of Georgia and Florida. Worm control required high input by the growers and decisions concerning the choice of chemicals were stressful for consultants. Species that occurred at damaging levels were the bollworm, tobacco budworm, fall armyworm, beet armyworm, southern armyworm and soybean loopers. Most fields had an economic level of mixtures of these species from about July 1 through Labor Day in September. In many instances, especially for fall armyworms, no insecticide choice did an acceptable job.

Plant bugs occurred in high numbers on wild host plants in May and June due to the abundant rainfall. However, with the exception of the Tennessee Valley, few plant bug treatments were required or made. Plant bug adults migrated to cotton throughout the month of June but the in-field offspring never materialized in July. Very few clouded plant bugs were observed which was distinctly different than the 2003 season.

In the southern areas of the state growers were ready to treat for stink bugs at their first sight, based on the damage stink bugs caused in 2003. Many growers in this area made scheduled preventative applications for stink bugs in 2004. As a result, stink bugs were very limited in most fields until migration began in late season. Fields that did receive multiple phosphate sprays for stink bugs were some of the ones where worm pressure was the greatest.

Other pests should be mentioned – these being thrips, grasshoppers, aphids and whiteflies. Thrips injury was significant on cotton that had any or all types of seed treatment or at-planting insecticides applied. However, the actual numbers of thrips found in surveys of seedling plants were not that great. Aphids were sporadic in occurrence but not an economic problem in most fields. Grasshoppers were abundant in many reduced tillage fields, especially in central Alabama. The threat of stand loss resulted in treatments to m any fields. Whiteflies were a problem on late maturing fields in the Gulf Coast region.

Miscellaneous insects reported during the season were: white fringe beetle larvae, three cornered alfalfa hoppers and Japanese beetles.

Crop conditions in 2004 were good to excellent over most of the state. Some areas were adversely affected by a three week dry period in mid-late July. However, when all was said and done, statewide yields in 2004 would have been some of the highest ever recorded had it not been for hurricane Ivan which came ashore near Gulf Shores, Alabama on September 15-16. Many fields in southwest Alabama incurred significant yield loss and some earlier maturing fields suffered 100% yield reduction. Fields in all areas of the state were affected to some degree. Many fields that would have produced 1000-1200 lbs. lint only yielded about 500 lbs. The statewide yield will still be 600-650 lbs.

In North Alabama cotton emerged and grew off under near ideal conditions in 2004. Minor problems were encountered with cutworms. Thrips populations were above average, but the favorable growing conditions minimized damage. Most of the thrips control problems were associated with aldicarb use. Virtually no thrips control was achieved in a few aldicarb treated fields and control was abbreviated, 3-4 weeks, in a number of others. These problems are assumed to be associated with enhanced microbial degradation of aldicarb.

Cotton aphids were a problem on a minimal acreage in late June and early July and for the most part these were induced problems. Two-spotted spider mites were again widespread and required a limited number of applications during June and July.

With some variation tarnished plant bug populations for the year averaged a little above normal. The migration to cotton began in the June 20's, after a number of controls had already been applied, and ended abruptly in early to mid July. Two, and occasionally three, insecticide applications were required to minimize plant bug injury. Stinkbug problems were reported throughout midseason, but after vigorous investigations nothing approaching a problem was identified. A number of early August insecticide applications were wasted on residual bug damage.

Caterpillar populations were very low during 2004, with hardly detectable numbers of corn earworms occurring in late June and in early August. A few fall armyworm and European corn borer larvae were found damaging bolls in late season.

Cotton yields on the 250,000 acres in north Alabama were excellent and should average above 800 pounds of lint per acre. Approximately 70% of the acreage was Bt cotton.

Arkansas

The season began with moderate infestations of tobacco thrips across the state. In-furrow insecticides (predominantly Temik) and seed treatments gave satisfactory control. The only foliar applications that were made were on fields that had no seed treatment or in-furrow insecticide at planting.

Tarnished plant bug pressure was across the board with a few areas experiencing light pressure, but many experienced moderate to heavy pressure. The tarnished plant bug was by far the number one pest throughout the state in 2004. Pressure was heavier as the season progressed. Some areas did experience early season problems from plant bugs, but the majority of plant bug sprays were applied post bloom. Acephate, Bidrin, Vydate, Centric and Trimax were the predominant products used for control and did give good control. However, some areas experienced constant pressure with a few growers making as many as 12 applications to control this pest. The average number of applications was more near 3-4 sprays for the season.

Tobacco budworm pressure was extremely light this year all across the state. Very few fields required treatment for this pest alone. Bollworm pressure light to moderate as well this year. Pyrethroids performed well in controlling this pest.

Spider mites were common in fields across the northeast part of the state, but very few reached treatment level. Predators were observed in many of these fields and appeared to keep mite numbers in check. The same was true for cotton aphid across the state.

Other pests such as stink bugs, saltmarsh caterpillar and loopers were observed in some areas. However, pressure was generally light from these pests with very few fields requiring control measures.

Boll weevil eradication is progressing with the southwest area of the state being basically eradicated at this time. Areas in the southeast are nearing eradication. The Delta zone in the northeast just completed its first full year of eradication.

California

There were 779,365 acres of cotton planted in CA in 2004. The San Joaquin Valley planted 95% of the total acres with the remainder being cultivated in the Southern Desert Valleys (32,215 acres) and Sacramento Valley (8,240 acres). Within the San Joaquin Valley, 522,925 acres were planted to upland varieties (*Gossipium hirsutum*) and 215,635 acres planted to Pima varieties (*G. barbardense*). There were 29,015 acres of Bt cotton plants, primarily in the Southern Desert Valleys.

Yield was predicted to be 1,508 lbs/acre for upland and 1,425 lbs/acre for Pima. Planting conditions in March and April were excellent. Conditions were excellent for early emergence plant development. Between March 10 and May 1 2004, 87% five-day emergence forecasts were in the ideal planting zone, 5% in the adequate, 4% in the marginal and 4% in the poor planting zones. The average five day accumulate heat units during this period were 31.

Conditions for growth and development were excellent through the remainder of the year. Seedling disease was minimal and the plants developed deep root systems. Warm early conditions allowed the crop to vigorously develop and cool nighttime temperatures allowed excellent retention of fruit and bolls. The crop was reported to be 7 to 14 days ahead of normal during the mid-season. Potential for early cutout required careful management to take advantage of the growing season. Harvest went well until early fall rains limited access to fields during October and November.

Insect pressure in general was generally light. Spider mites were low in 2004 but reports from several locations indicated a late season population buildup. Lygus were problematic in scattered areas in July as populations moved from senescing crops and into cotton. Aphids were widely scattered in mid-season but did not develop into large widespread problems, however some treatments were required in locations. Worm pests were not evident in 2004. Silverleaf whitefly was the major concern between July and September. This pest has continued to extend its distribution over a wider area to include most of Fresno County. Widespread, multiple applications were made for whitefly.

Florida

Florida growers planted approximately 94,000 acres of cotton in 2004. Statewide, approximately 87% of the crop was planted to transgenic Bollgard varieties, with Deltapine 555 BR being the most commonly-planted variety.

Sufficient soil moisture and rainfall in late April and early May was favorable for planting and stand establishment in most fields. Adequate rainfall and good growing conditions through the summer resulted in an excellent yield potential. However, several tropical storms and hurricanes brought heavy rain and wind to the eastern portion of the cotton-producing area in early September slightly reducing yield. Hurricane Ivan struck the western panhandle on September 16 resulting in loss of more than one-third of the crop in the area.

Thrips injury was minimal due to rapid crop emergence and growth with adequate uptake of soil applied insecticides. There was a notable increase in the use of insecticide-treated seed compared to previous years.

Although present, grasshoppers caused minor damage in 2004.

Aphids infested most fields at low to moderate levels during late June and early July. The beneficial fungus disease, Neozygites spp began reducing populations the second week of July and they did not rebound the remainder of the season.

The tarnished plant bug populations were generally low all season. Early season square set was high and more than 5 percent of the acreage received an application for plant bugs.

Parasites and predators were generally abundant all season where insecticides were not used. They developed on the early aphid population and helped provide control of worm pests. Fire ants were abundant all season in fields grown under strip-tillage. (Approximately 75% of fields were grown using this method of conservation tillage.)

Bollworm and budworm moth trap catches were higher this year than in several previous years. However, widespread infestations failed to develop and only scattered fields required treatment during early August. Most of the treated fields were planted to conventional varieties while Bollgard varieties generally held up well.

Beet armyworm infestations were rare and fall armyworm infestations were low throughout the season. Southern armyworms were found at low to moderate levels in scattered fields during late July to mid August. Only a few fields required treatment specifically for these pests.

Once again stink bugs posed problems for Florida cotton farmers and an estimated 54,500 acres were infested statewide. Some fields experienced damaging levels following migration from peanuts during late August - early September. Highest infestations occurred in field borders adjacent to peanuts and corn. Some growers obtained adequate control by treating peanut fields or field borders next to peanuts. Approximately 53% of the cotton acreage in the state received at least one application for stink bugs.

State yield is projected to be 650 pounds of lint per acre.

Georgia

Approximately 1.26 million acres of cotton were harvested in Georgia during 2003. Although growing conditions were not ideal, growers had expectations of an above average crop until three hurricanes reduced yield prospects. Insect populations ranged from relatively light to heavy depending on location.

Thrips populations were moderate to heavy and at plant insecticides typically performed well. Isolated reports of grasshoppers reducing plant stands were observed in a few reduced tillage fields. Spider mites were present at low numbers in many fields during June and July but populations rarely reached economic levels. Aphids built to moderate populations during June before crashing due to the naturally occurring fungus in late June and early July.

Tarnished plant bugs continued to be a minor pest in most areas, however high populations and economic damage were observed in some fields in the western side of the state. Beet armyworms were observed in sporadic fields during July. Fall armyworm was also a sporadic pest in southwest and east Georgia.

Tobacco budworm populations were light to moderate during June and July, except in southwest Georgia where sustained pressure occurred during most of July and August. Tobacco budworm infestations were heavy in west Georgia during August, especially on late planted cotton. Tobacco budworms were also more prominent than normal in east Georgia during August. Corn earworm populations were moderate and required treatment on a portion of Bt cotton acres. Sporadic populations of southern armyworm and soybean loopers occurred during August and September.

Stink bug populations were much lower compared with 2003. Stink bug populations were moderate during July but declined as the season progressed into August and September. However, most fields required treatment with insecticide.

Two boll weevils were captured in Georgia during 2004. A single boll weevil was caught in Appling County and a single boll weevil was captured in Wilcox County. Fields in the vicinity of each capture were intensively trapped but no additional boll weevils were captured.

Louisianna

Louisiana planted approximately 495,000 acres of cotton in 2004 with an estimated average yield of 780 lbs of lint per acre. Planting conditions during April and May were excessively wet. Most fields were planted in intervals between showers. Planting dates ranged from April 1 to June 1, with an equal distribution across all dates. Approximately 92% of the acreage was planted to a Bt-cotton variety, with DP 555 BR being planted on greater than 50% of the acreage.

Growing conditions during 2004 were dominated by wet weather during April and May. Conditions during June further deteriorated with the wettest June on record. June rainfall totals ranged from 15 to 33 inches. These conditions dominated much of the production decisions during 2004 and likely influenced insect densities.

Insect densities were low to moderate in 2004, with the exception of tarnished plant bugs. Thrips populations were light in most fields, which could be attributed to frequent rain events causing high thrips mortality during the seedling stage. Additionally, a seed treatment for thrips control was used on greater than 80% of the acreage.

Slug injury was observed in many fields during 2004. Fields with significant slug injury could be characterized as those practicing reduced tillage and having significant quantities of plant residue on the soil surface. Despite a significant number of acres being infested with slugs, economic injury was only caused on approximately 500 acres. Replanting was required in these areas of heavy infestation, with as much as 300 acres having to be replanted twice.

Tarnished plant bug population densities ranged from moderate to high and were persistent during August and September. Population densities were highest in fields planted adjacent to corn and in fields within close proximity to the Mississippi River. Control with insecticides during August and September was marginal. As a result, multiple applications of acephate and dicrotophos were required, which increased the probability of developing resistant populations. The average number of applications for tarnished plant bug control was expected to be six. However, some fields received as many as twelve insecticide applications.

Bollworm and tobacco budworm densities were low to non-existent during the 2004 growing season. The low densities could be attributed to excessive rainfall in June, which resulted in drowned pupae. The majority of insecticide treatments for bollworms and tobacco budworms were applied in conjunction with tarnished plant bug treatments (pyrethroid added) when there were approximately 10% egg-lays.

Looper populations varied from low to moderate during the 2004 growing season. Approximately 20% of all cotton fields were treated for loopers.

Mississippi

Cotton producers in Mississippi planted approximately 1.1 million acres of cotton in 2004. Approximately 85% of cotton in MS was planted to transgenic single gene Bt varieties. Approximately 0.55% or about 6500 acres was planted to dual toxin transgenic Bt varieties. The most popular varieties planted in 2004 was Deltapine 555BG/RR, Stoneville 5599BG/RR, and Deltapine 444BG/RR. These three varieties made up approximately 70% of the total acres planted in 2004.

Positive referenda to continue the Mississippi Boll Weevil Eradication Program have passed in each of the five operational regions authorizing the program for an additional 10-year period at a maximum grower assessment rate of $12.00 per acre per year. In 2004 there were 17,482 weevils captured in the state compared to 78,657 captured in 2003. This represents a statewide reduction in total weevils captured of 77.7 percent. The Bluff Area of Region 3 had the highest number of weevils captured with 92.3 percent of the total weevils captured in Region 3 and 85.6 percent of the total weevils captured in the state coming from this area. The percentage of fields capturing zero boll weevils in each region in 2004 is as follows: Region 1A, 91.9%; Region 1B, 97.3%; Region 2, 92.8%; Region 3, 74.8%; and Region 4, 99.6%. An increase in the percentage of fields capturing zero boll weevils occurred in all regions except Region 4 which remained the same, however, only 20 boll weevils were captured in this region.

Total insect losses in MS were lower than usual in 2004. Overall losses from insect pests in 2004 were 3.79% compared to 5.86% in 2003. Mississippi averaged 5.85 foliar applications to control pests in 2004 for an average foliar insect control cost of $45.79 per acre. 2004 marked another record cotton yield for the state with final estimates of 1034 pounds per acre. Cotton yields in the delta averaged approximately 1100 pounds per acre while the hill region of the state averaged approximately 800 pounds per acre.

Thrips pressure across the state ranged from light to moderate depending on location. Seed treatments continue to gain popularity in MS for control of thrips due to convenience and ease of use. Less than 50% of the cotton acreage received a foliar application for thrips averaging 0.4 foliar applications for this pest.

Tarnished plant bug was the most notable pest in 2004. The delta region of the state averaged 5.3 spray applications for plant bugs while the hill region of the state averaged only 1.3 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 2004 with “standards” such as Orthene, Bidrin, and Vydate getting more use in post-bloom cotton. Widespread rainfall during the month of June caused application delays and “wash offs” throughout much of the delta region of the state allowing immature plant bugs to become established requiring multiple applications throughout much of the delta to get populations under control with some fields averaging 8-9 applications for tarnished plant bugs.

Bollworm/Budworm pressure was one of the lightest on record for 2004 with average number of foliar sprays at 0.3 for the delta region of the state and 0.26 foliar sprays for the hill region of the state. There were a significant number of non-refuge non-Bt acres in the state that required zero applications for this pest. The armyworm complex was also extremely light in the state in 2004. In the extreme southern part of the state southern armyworm and fall armyworm reached levels requiring treatment on several occasions but infestations were generally light throughout the rest of the state.

In summary, with the exception of tarnished plant bug in the delta region of the state, insect pressure was extremely light throughout the state. Total insect control cost for the state in 2004 was $93.95 per acre up approximately $3.5 per acre compared to 2003 but adequate rainfall and cool August temperatures led to another record yield of 1034 pounds per acre up 103 pounds over 2003.

Missouri

In southeast Missouri cotton planting was extended over several weeks from the later part of April into the first week of June. In 2004, Missouri cotton growers planted approximately 390,000 acres of cotton. Approximately 65% and 90% of Missouri's cotton acreage was planted to Bt-transgenic and Roundup Ready varieties, respectively. Early-season crop growth was slowed because of cool, wet soil conditions. Seedling disease pressure was light but thrips infestation levels were above average in most fields; therefore, approximately 19,000 to 38,000 acres of cotton were either replanted or converted to other crops. Despite a slower accumulation DD60's during August, the crop gradually accumulated a substantial fruit load. Rainfall was regular throughout most of the growing season, and nighttime temperatures were not excessive. Because of above average temperatures in October, the crop's heavy fruit load (>85% fruit retention) was generally able to mature prior to harvest. Low use rates of harvest aid products were only required to prepare the crop for harvest. Heavy, frequent rainfall slowed harvesting of the crop during November, thus several thousand acres of cotton remained to be harvested by mid-December. For 2004, the average USDA estimated yield of 960 pounds was 17.3% above the 5-year (2000-2004) average (818 pounds) for Missouri. For the second consecutive year Missouri cotton producers harvested a record crop in spite of heavy pest pressure from the plant bug complex and fair weather conditions at harvest.

Thrips infestations were persistently high in many Missouri cotton fields. Cool, wet conditions during and after planting were a major factor in prolonging seedling exposure to thrips feeding damage and slowing the plants' uptake of soil- and seed-applied insecticide treatments. Approximately 54% of Missouri's cotton acreage was treated with foliar insecticide sprays to combat these thrips infestations. Overall, the second highest percent yield decrease in Missouri can be attributed to thrips.

Missouri Boll Weevil Eradication Program personnel reported a further declined in spring pheromone trap captures of overwintering boll weevils for 2004 as compared to those reported in 2003. The Missouri Boll Weevil Eradication Program initiated early-season ULV Malathion applications during the June 10th-15th trapping cycle. An average of 3.6 ULV Malathion sprays were applied per acre within the buffer zone adjacent to the Arkansas state line, but less than one ULV Malathion application was required in the rest of southeast Missouri for the 2004 season.

Aphid infestations were light throughout the season as aphid populations generally were kept in check by abundant populations of various insect predators (particularly ladybird beetles) and parasitoids.

Plant bug infestation levels were above average and persistent throughout the middle and later parts of the growing season. Mild, wet weather during the spring supported a lush growth of weed hosts, and this abundance of alternate hosts in turn supported the rapid buildup of plant bug populations. Cool, wet conditions during planting time further contributed to the plant bug problem by slowing plant growth and allowing plant bugs to damage more fruiting positions. The combination of heavy fruit loading and abnormally high plant bug populations led to some heavily-infested fields being treated as many as six times. The greatest percent yield decrease among cotton pests in Missouri for 2004 was attributable to the plant bug complex.

Cotton bollworm and tobacco budworm infestation levels were below average in most southeast Missouri cotton fields during the 2004 growing season. Bollworm pressure and feeding damage was relatively light in 2004. Initial reports of bollworm infestations requiring insecticide oversprays occurred in early July. Approximately 20% of Missouri cotton acreage (including fields planted to Bollgard varieties) only received one insecticide overspray for bollworms and tobacco budworms. Overall, the third highest percent yield decrease in Missouri can be attributed to the bollworm / tobacco budworm complex.

In summary, pressure from the plant bug complex was very high in 2004. Thrips infestations were moderate with localized, persistent, hot spots. Aphid, bollworm, boll weevil, European corn borer, fall armyworm, spider mite, stink bug, and whitefly infestations were light with some isolated hotspots in southeast Missouri.

New Mexico

Overall 2004 was a very good to average year depending primarily on location with the southernmost areas having the highest yields. Projected mean yield for the state is 821 lb/A. Pest populations were light throughout the state

Spring conditions were good for planting. Summer temperatures were somewhat low. This did not cause problems in southern New Mexico which had record yields until fall rains delayed picking. However low HU from the cool summer did reduce yields in more northern areas such as Roosevelt Co.

A pink bollworm eradication program is in ongoing in the Mesilla Valley (Dona Ana Co) in south-central New Mexico in conjunction with nearby Texas counties. Pink bollworm numbers were higher in the Pecos Valley (Eddy, Chaves Co) than they have been in a number of years. Some fields were high enough to justify treatment to prevent yield losses. A number of untreated fields did have top crop losses. Boll weevil eradication programs are in place throughout the state.

Total cotton acreage has remained steady but has shifted geographically. Acreage has increased on the east side of the state replacing corn in Roosevelt and Curry counties. This area now has over 30% of the cotton acres in the state. Next year acreage will go up in Quay county replacing alfalfa. Acreage has gone down in Pecos Valley which has a high boll weevil assessment.

North Carolina

Thrips levels were typical for this area of generally high pressure, with approximately 60% of our state's cotton acreage receiving a foliar application. Temik was used on about 75% of the cotton acreage; seed treatments on the remainder. Western flower thrips appeared to be a minor issue in 2004.

Early tobacco budworms were on the light side during the pre-bloom period, although this species came on strong during July and August on conventional cotton. With over 80% of our cotton acreage now planted to Bt cotton in, tobacco budworms have only the remaining 20% to potentially infest.

Cotton aphids were generally a minor problem on most farms in 2004, but caused some treatable headaches on approximately 9% of our cotton crop. Growers appear to be showing increasing confidence in the effectiveness of beneficial insects and in the fungus *Neozygite fresenii* in reducing cotton aphids to subeconomic levels.

Plant bugs were about average during the pre-bloom period, with just over 7% of our acreage treated. However, *Lygus* levels increased substantially in many areas of the state during much of the boll production period, adding to our producers' stink bug woes (see below).

Stink bugs were a major, and unprecedented, threat for many cotton producers in both Bollgard and in conventional cotton fields. In some cases, bolls were damaged well in advance of our mid- to late-July major bollworm moth flight (somewhat unusual for us). Throughout much of the boll production period, the harder-to-control brown stink bug, *Euschistus servus*, constituted over 50% of the brown vs. green (mostly *Acrosternum hilare*) complex. On Bollgard cotton, stink bug (and to a lesser degree plant bug) damage to bolls, at 15.3% averaged across the state, was 5-fold higher than the average of the previous 8 years of Bollgard availability and more than 3-fold higher than our previously highest year for boll damage (4.8% in 2000). In conventional cotton, stink bug damage to bolls across the state was almost 6-fold higher than the average of the 8 previous years (7.0% vs. 1.2%). In a stink bug threshold test in east-central NC, the untreated check reached a damaged boll level of just over 80%. Heavy late season rainfall from the remnants of 3 hurricanes probably substantially impacted the timely opening, defoliation and harvest of the cotton crop in many areas of the state.

The major late season bollworm moth flights from corn were somewhat earlier and higher than average, but still generally lagged behind the state's advanced cotton crop. Underappreciated tobacco budworms appear to have contributed significantly to overall bollworm/budworm complex bolls losses (7.2%), the second highest in conventional cotton since our annual damaged boll survey began in 1985. Bollworm damage to Bollgard cotton, at 1.2% was about average.

Other caterpillars were generally on the light side, although fall armyworms persisted, occasionally at treatable levels a few of our eastern counties. Beet armyworms and cabbage loopers, although detected, were little more than curiosities in 2004. European corn borers in untreated field corn reached what appeared to be moderate to high levels, but this was not manifested as a late-season boll-damaging problem on cotton, perhaps the result higher levels of the monocot-feeding race (e.g., field corn) and lower levels of the dicot-feeding race (e.g., cotton).

As of this mid-December writing, North Carolina cotton producers are expected to harvest approximately 750+ pounds of lint per acre on 722,000 acres.

Oklahoma

A total of 200,387 acres (Oklahoma Boll Weevil Eradication Organization figures) were planted and harvested in 2004. Poor growing conditions throughout June slowed plant development and jeopardized stands across the state. A cooler than normal summer reduced heat unit accumulations by 277 units (May 1st to October 1st). However, sufficient heat units occurred to produce a full crop. The state's production average is projected at 700 lbs. of lint per acre.

Despite widespread use of at-planting insecticides, thrips infestations built to damaging levels across the state. Cotton fleahopper infestations were non-existent in mid-to-late June. However, tremendous numbers inundated fields in late June as weed hosts dried up. Many fields received two insecticide applications to prevent significant yield loss.

Bt cotton continues to be very popular in Oklahoma. Bt cotton represented 51% of the cotton acreage (or approximately 102,752 acres) in 2004. Bollworm pressure was spotty emphasizing the importance of scouting. Conventional cotton received 1 or 2 insecticide applications to prevent worm damage. Populations spilled over into Bt cotton requiring over-sprays in approximately 22% of the fields.

South Carolina

South Carolina farmers are expected to harvest 218,000 acres (State Statistician's estimate), which is unchanged from the harvested acreage of 2003. Cotton production is forecast at 370,000 bales – 44,000 bales more than last year. The average yield is expected to reach 815 lbs lint per acre – up 97 lbs from 2003. Moisture was abundant; and temperatures were somewhat cooler than average.

Thrips annually rank in the top three or four insect pests on cotton. Temik is used at planting to control thrips on 90% of the cotton acreage. Since nematodes are also a common concern, Temik 15G is often applied at rates of 5 lbs or more per acre for nematode suppression and thrips control. Foliar insecticides were utilized on less than 20% of the acreage when soil insecticides failed to provide adequate control. Failures occurred where soil moisture was inadequate, and where western flower thrips were the predominate species. At the Pee Dee REC at Florence, tobacco thrips were the predominate species in late May, but by early June the western flower thrips was more abundant on cotton seedlings. Soil insecticides performed reasonably well. Thrips infestations started showing up in Coastal-Plain cotton fields around the middle of May. By the end of the first week of June, cotton was growing rapidly and thrips were no longer causing problems.

With the increase in strip-tillage, some new insect pests have been observed. For the past few years, false chinch bugs, cutworms, grasshoppers and other insect pests have occasionally shown up in seedling cotton where there was an abundant surface residue and/or green plants, such as winter annuals. No serious infestations of false chinch bugs or cutworms were reported in 2004. However, grasshopper infestations were reported in a few areas between the middle of June and late July – generally in strip-tilled fields. This marks about the fourth year in a row that grasshopper problems have been reported in the Pee Dee area.

As in 2003, tobacco budworms were present in non-Bt cotton fields in fairly high proportions. A few non-Bt fields had economic infestations of tobacco budworms in June, and in late July in some fields, close to 50% of the heliothines were budworms. Bollworm numbers were moderate statewide, with a few areas showing high numbers in July and August. Growers planted about 75% of their cotton to Bt varieties. Bollworm infestations occurred somewhat earlier than usual as heat units accumulated at a higher than average rate in May and June. At Florence, bollworm and budworm moths began laying F_3 generation eggs by 14 July which was nearly a week earlier than usual. Egg numbers began to increase as early as 7 July in the Savannah Valley area. For the sixth consecutive year, there were no reported failures with pyrethroids in controlling bollworms. Growers were generally able to control worms with two to four pyrethroid applications in conventional cotton varieties. About 60% of the Bt-cotton acreage was treated an average of 1.5 times, while 25% was not treated at all.

Since the boll weevil was eliminated as an economic pest in 1985, stink bugs have become a problem in all areas of South Carolina. Problems won't occur in every cotton field, but virtually every cotton field has the potential to suffer damage, therefore, every field must be scouted for stink bugs and their damage symptoms. Clemson University recommends treating with insecticides on a boll-injury threshold of 15%, emphasizing the importance of examining quarter-sized bolls. Injury symptoms include: warty growths on the carpal walls, discolored lint and shrunken seeds. Since we have begun using a injured boll threshold, less emphasis has been placed on estimating actual stink bug numbers.

In 2004, brown stink bugs and green stink bugs were the predominate species in cotton. Numbers in cotton fields appeared to spike prior to boll formation and then tapered off somewhat after bolls became available. Soybeans were setting pods somewhat earlier than usual and they may have attracted a higher proportion of stink bugs than the cotton fields. Nevertheless, damage caused by stink bugs was just slightly less than that caused by heliothines. Lygus bugs and the red plant bug also appear to be damaging cotton bolls in the Savannah Valley area. During early boll set and development (July-early August) lygus bugs were present in moderate numbers in the Savannah Valley area. There were no reports of red plant bugs being observed in cotton in 2004.

Moderate to high infestations of aphids were observed in many fields. Few farmers applied insecticides. By 20 July, the fungus *Neozygites fresenii* had infected aphids in the Savannah Valley; within a two-week period, aphid populations had crashed in most cotton fields.

Beet armyworm, fall armyworm and looper infestations were unusually scarce.

<u>Tennessee</u>

Tennessee planted and harvested about 510,000 acres of cotton in 2004. About 93% of the crop was *Bt* cotton, with PM 1218 BG/RR, DP 444 BG/RR and DPL 451 B/RR being the dominant varieties. Early season rainfall often prevented planting or forced replanting during early May. In most areas, subsequent rainfall patterns were excellent. The final yield average in 2004 (≈ 840 lb/acre) will exceed the state record of 806 lb set in 2003 and the previous record of 762 lb in 2001.

The 2004 season was characterized by unusually few insect problems. Statewide insect-induced yield losses were among the lowest on record, estimated at 3.26%. The estimated average cost of insect control was $68/acre, including the cost of boll weevil eradication (≈ $12/acre) and Bt technology fees (≈ $24/acre).

Boll weevil eradication efforts continued throughout West Tennessee, and no yield losses caused by boll weevils have been reported for three consecutive years. Growers passed a 10-year referendum in the spring of 2004 merging all of West Tennessee into a single eradication zone with an annual assessment fee of $12.25 per acre. A total of 507,838 boll weevils were captured during 2004 in West Tennessee. This is a 5% increase in the number of weevils captured compared with 2003. Over 98% of all boll weevils were captured in counties bordering the Mississippi River. Middle Tennessee, representing about 22,000 acres of cotton, is in a maintenance phase of eradication and continues to be free of boll weevils.

Cutworms were slightly more prevalent in 2004 than in recent years. Most growers are using preventative pyrethroid applications, but some additional applications of insecticide for cutworm control were made to a small percentage of fields. Thrips infestations were generally light to moderate. At-planting insecticide applications, including seed treatments, are used in over 90% of cotton fields in Tennessee. However, some foliar, post-emergent applications were necessary to control thrips infestations.

Prior to bloom, light to moderate populations of tarnished plant bugs were treated in many fields. A high percentage of growers are making scheduled applications of Centric, Trimax or other insecticides during this time frame. High populations of tarnished plant bug were found in isolated areas, particularly in the Mississippi River bottoms. Spider mite infestations developed and persisted at treatable levels in some fields beginning in late June and early July. Approximately 10% of fields were treated for mites.

Tobacco budworm infestations were nearly non-existent in 2004, and bollworm populations were also unusually low. A limited, late-season survey found an average of 2.04% boll damage caused by caterpillar pests in non-*Bt* fields. This was one-fourth of the damaged observed in 2003. On average, 0.30% of bolls in *Bt* cotton fields were damaged by caterpillar pests (only 1/10th of that observed in 2003). This injury was caused almost exclusively by bollworm. Many *Bt* fields were not sprayed for bollworms or other caterpillars pests.

Stink bugs infestations were fairly common in West Tennessee, and some cotton fields were sprayed specifically for this pest in 2004 during July and early August. In a survey, late-season boll injury caused by stink bugs and plant bugs averaged about 3.4% across the state (about 2.35% less than 2003). This pest continues to be important in the low spray environments resulting from boll weevil eradication and the use of *Bt* cotton. Clouded plant bugs were the dominant "sucking" pest in 2004 and continue to be a concern in West Tennessee. Injury caused by clouded plant bugs was similar to that of tarnished plant bugs, feeding on squares, flowers and bolls. Because applications for bollworms and stink bugs were less frequent than in recent years, many fields were treated for clouded plant bugs during July and early August.

Cotton aphids, armyworms, loopers, whiteflies, European corn borers and other insect pests were of minor importance in 2004. For the second year in the row, slug infestations in seedling cotton caused significant stand loss in some reduced tillage fields, although not to the extent as observed in 2003. No effective slug treatments were identified. One field was observed in Lauderdale County with apparent stand loss resulting from millipedes feeding on cotyledonary plants. Injury was similar to that caused by cutworms or slugs; however, these pests were not present. Stand loss was confined to borders immediately adjacent to a forested area where large numbers of millipedes were observed migrating into fields.

Various insecticide and insect management trials were performed in 2004. The results of these evaluations and other information are available at www.utcrops.com.

Texas

The 2004 harvested acreage was significantly higher than in 2003 when almost 2 million acres were lost to multiple severe weather events. Approximately 8 million bales are projected for harvest from about 6 million acres. Unlike last year's droughty conditions, 2004 could be characterized as having record rainfall amounts in many areas of the state. Most regions had more than enough rainfall to maximize yields and genetic fiber potential. Much of the state has adopted higher yielding, more open boll varieties. Most varieties are Roundup Ready. Bollgard planted acreage was up only slightly at 878,830 acres but the percent planted Bollgard acres remained little changed. A few Bollgard fields were treated for bollworms where initial infestation levels were high. No Bollgard II fields required treatment.

Texas encompasses a large geographical region and hence rainfall and moisture conditions can and were highly variable. But, as a general rule, most regions entered the growing season with a very good soil moisture profile. Much of the dryland acreage in the southern High Plains did have soil moisture issues at planting and emergence was delayed until later in June. This delay did compromise some yield potential. The eastern areas of Texas generally had good harvest weather. Harvest has been delayed in the western areas by constant rain, drizzle and cool, overcast weather. Some "stringing out" of lint from looser boll varieties occurred in response to an early November snow. Heat unit accumulation was generally on par with that observed for the last 7 years with the exception of August and October, when accumulations fell below average. This had the greatest impact on micronaire. West Texas dryland fields hit record highs of 2.5 bales per acre while irrigated fields bumped against the 5 bales per acre level observed last year for the first time.

Insect problems were light for the most part with significant thrips problems in the northern High Plains, boll weevil problems in the non-eradication areas of the Northern Blacklands and Lower Rio Grande Valley and bollworm problems south and east of the High Plains. Budworm numbers were higher this year than observed for many years. There were some pyrethroid resistance issues in the Coastal Bend area and some concern in the College Station area and the pink bollworm infested areas of Gaines County, but generally pyrethroid control of bollworms was still good. Yield losses due to insects varied between a low of 1.76% in Far West Texas to a high of 10.1-12.4 in the Blacklands area. Boll weevils and bollworms were responsible for these losses. Overall, Texas yield losses due to insects averaged 3.8%. Reduced problems with cotton fleahoppers and plant bugs was probably due to their reduced movement into cotton where abundant rainfall kept their preferred alternate hosts in good condition. Higher rainfall amounts, generally cooler summer temperatures and lower insecticide use patterns inside most of the boll weevil eradication zones resulted in few aphid problems.

Pink bollworm problems increased again this year for the 3rd year in a row. The use of Bollgard on irrigated acreage has helped tremendously but the non-Bt refuge and dryland acreage is a problem. Unless climatic conditions change or producers are able to better manage this pest, pink bollworm eradication in Texas and New Mexico is in jeopardy.

Most of the state is now under some phase of boll weevil eradication. The Panhandle and St. Lawrence zones in western Texas initiated diapause programs this fall. This was none to late for the St. Lawrence zone, which had been contaminating adjacent zones for 3 years, resulting in many additional applications and considerable expense. No weevils have been trapped in the Panhandle zone for two years. Of the 11 zones in west Texas, 2 are now classified as functionally eradicated and the other 9 are classified as suppressed. The Lower Rio Grande Valley will restart their program next year after voting it out following the disastrous startup year of 1995. The only remaining zone outside of eradication is the Northern Blacklands, which will vote on a referendum next January for the 3rd time. The South Texas/Wintergarden zone remains a hot spot with the Uvalde are the heaviest infested. No real progress has been made in that zone since 2000. There is hope that the startup of the LRGV will solve much of this problem. Otherwise, the eradication program has and is making excellent progress.

Lower Rio Grande Valley (LRGV). The crop weather was near perfect for most of the Lower Rio Grande Valley (LRGV) dryland and irrigated cotton farms in 2004. Fall, 2003 rains were frequent and heavy across most of the LRGV, which provided more than adequate subsoil moisture into the early spring of 2004. Rain, in 2004, fell in February and March set the surface soil moisture to excellent levels for seed germination and early plant development. Additional rains occurred in April, May and June that further improved the crop production situation. Some fields were provided supplemental irrigation water, but the number of irrigations was low compared to the years between 1989 and 2002. Unlike late season, 2003, rainfall amounts were lower and allowed for improved crop harvest. The pattern of adequate to slightly more than adequate rainfall distributed over the primary cotton production period and only light amounts during the harvest period led to excellent results. Heat units were lower overall in 2004 than in recent years due to more cloud cover associated with increased rain events. However, the crop continued to produce a quality crop of above average proportions. Overall, the LRGV farmers produced a record yield of 793 lint pounds per acre. The total bale count was 328,571 on 207,171 planted acres. The previous record of 772 pounds lint per acre was set in 1985, another good seasonal, rainfall- distribution year.

Insect activity was worse in 2004 than in recent years. Boll weevils, the traditional number one pest of cotton in the LRGV was again a serious threat to much of the areas crop. Dryland farms, particularly in Willacy and eastern Cameron county suffered much less damage from weevils than did irrigated areas of the LRGV. Many dryland farms did not have to for boll weevils at all or only trimmed field margins a few times during the season to prevent weevil incursions. Irrigated farms, on the other hand, had much more weevil activity. Many irrigated farmers reported spending in excess of $80 per acre for boll weevil alone and still experienced yield reductions due to weevils. The Valley held a new referendum for boll weevil eradication and it passed to start at 10% cracked boll stage in 2005, This will be its second attempt at eradication, having voted it out after disastrous start in 1995.

Bollworms and tobacco budworms caused some damage in scattered fields, primarily in Cameron County. Tobacco budworms were noted in area fields for the first time as a serious threat since 1992. Treatments for worms ranged from 0 in most fields to 2 applications in a few fields. Cotton fleahoppers were slightly lower in number and frequency in 2004 than in recent years. Overall, fleahoppers were treated less than one time when all acres were calculated into the sprayed and unsprayed categories. Beet armyworms were very sporadic and no reports were received that indicated beet armyworms were sprayed in 2004. Silverleaf whiteflies were reportedly sprayed in one field south of Weslaco. Adult whiteflies were observed in most fields across the LRGV during the production season, but no other reports of treatments were received. Cabbage loopers were reported in many fields, but only a few required any insecticide applications. Most of the looper infestations occurred late in the season (late June and July). No significant impact on overall yield was indicated. Spidermites were reported in scattered fields, but no reports of insecticide applications were received this year. Frequent rainfall, no doubt, had a debilitating effect on spidermite populations.

Coastal Bend (CB). Most of the season was characterized by excessive rainfall that adversely affected yields in fields with poor drainage. Fields with good drainage produced an outstanding crop, and the harvest period was generally favorable. With the excellent yields obtained in well drained fields, Gulf Coast cotton averaged 808 lb/acre.

Thrips and cutworm numbers were at all time low numbers along the lower Gulf Coast, but more thrips were encountered along the upper Gulf Coast. Aphid and spider mites were at very low levels throughout the season except in isolated situations. Bollworm infestations in lower Gulf Coast cotton were high and sustained for a several week period. About mid-June pyrethroids were not providing a high level of control even at high rates, and alternate chemistry was utilized. Evaluation of male bollworm moths in vial tests showed them to have a higher tolerance to cypermethrin than at any of the other Texas locations tested; by late season the tolerance level decreased. The tobacco budworm became a concern in the late-planted cotton, but generally only one treatment was required where infestations reached treatment threshold. The percentage of Bt cotton nearly doubled in the lower Gulf Coast (23%) and increased slightly on the upper Gulf Coast (55%). Moths were sent to USDA at Stoneville, MS for Cry1Ac monitoring. The need to treat for stinkbugs continues to increase each year where the brown stinkbug is the major pest but several other species are also present. The upper Gulf Coast boll weevil eradication continues to make progress. However, in the South Texas/Winter Garden Boll Weevil Eradication Zone, boll weevil numbers have increased to alarming levels especially in the south part of the zone and at Uvalde.

Northern Blacklands (NBL). The growing season was characterized by above normal rainfall in May and June. Cotton developed slowly due to cool, wet conditions and as a result thrips and aphids were a problem on seedlings. A significant acreage was replanted due to weather related losses. Cotton fleahoppers were less abundant than in previous years. Weedy hosts remained attractive to cotton fleahopper due to earlier rains and cool weather, and limited the number of fleahoppers migrating into cotton. Also, rainfall probably increased mortality of fleahoppers and contributed to overall lower numbers. Aphids were present on squaring plants in June but infestations declined as beneficial insects and the fungal pathogen Neozygites increased. Normal weather conditions (hot and dry) returned in late June and cotton made good progress. However, bollworm/budworm infestations were unusually high in early July and many non-Bt fields required treatment. Only a few fields planted to Bollgard required treatment and the efficacy of Bollgard II was outstanding. Treatments for bollworm/budworm were completed by mid-July but boll weevil infestations had reached treatment levels in many fields by late July and further insecticide treatments were required. Cool weather and closed canopies earlier in the season were favorable to survival of immature boll weevils and resulted in higher numbers of weevils mid-season. Overall, yields were average to above average but increased costs for controlling bollworm/budworm and boll weevils reduced net profits.

Southern Blacklands (SBL). We had periods of excessive moisture (cloudy periods) in May and June that caused some nitrification of some of our N which I think limited our yield potential somewhat. Also, the cloudy weather in June caused sign fruit shed to small bolls and squares. This caused reduced yield potential and delayed crop maturity.

Aphids were fairly light but fleahopper pressure was moderate. We did see a few more spider mites populations build up in fields in July and early August, which mainly followed weevil eradication sprays, and some cases pyrethroid applications for worms.

Bollworm/budworm levels were high as you might imagine with the good rainfall. Just about all non-Bt cotton (I would say 95% of the non Bt) was sprayed at least once for worms, some as much as 3 times. Maybe up to 20% of the Bollgard cotton was sprayed once for worms. Bollgard II however performed excellent.

Boll weevil trap catches and field treatments were greater than I anticipated going into the season, but much has to do with the weather and the Foundation not running traps for 2-3 week periods and applications not going out or not going out on time due to those factors. Yields will probably average about 700 lbs/ac **(Mott, TCE, Georgetown, TX).**

Rolling Plains (RP). This includes both the southern and northern portions of the Rolling Plains. Moisture conditions were good going into planting. Rainfall started the first of March and subsoil moisture was at their highest since 1996. Soil temperatures were adequate by early May and a small percentage was planted the first two weeks of May. The use of Bollgard[7] increased slightly, primarily in dryland acreage, increasing from 20% of the region to 25%. Planting moisture was somewhat limited in the last two weeks of May and the majority of the acreage was planted during the month of June, with approximately 15% of the acreage planted later than the optimum (the second week of June). Once planted, growing conditions were favorable prior to square initiation. Cotton aphids were present early but never built up to large numbers. Thrips populations were highly variable but generally well below threshold in the majority of the fields. Even in fields with high counts, growing conditions favored rapidly growing plants and damage was light across the area. Grasshoppers caused isolated problems in the southern part of the Rolling Plains.

Cotton fleahopper numbers were higher than usual with the favorable wild host situation. Approximately 60% of the fields received an insecticide application for cotton fleahoppers. The neonicotinoids were used almost exclusively. Square sets were generally high but some fields had percent square sets below 70%. Part of the problem was due to cool, cloudy conditions that occurred during the latter part of June and early July.

The area did experience the start of a bollworm egg lay in the second week of July. Although cotton tolerated the early flight, the cool, cloudy conditions seemed to prolong the flight and emergence and the whole area experienced one of the toughest bollworm seasons in eight years. Approximately 40% of the fields were treated once for bollworms and a small percentage (<5%) received two applications in late July and early August. Bollgard[7] technology held up well and less than 1% of these fields received an insecticide for bollworms. Some control failures with pyrethroids were reported north of Abilene and tobacco budworms were suspected. Further investigation revealed that wet conditions and above average plant height on the cotton resulted in less than ideal application conditions.

Spider mites were a problem in cotton surrounded by corn. Overall, yields should be above average. Harvest was delayed with wet, cool conditions in October but early yields of dryland fields were well above average and irrigated fields were averaging close to 1500 lbs lint. Cotton yields may be closer to normal in the central region of the Rolling Plains because planting was later and temperatures were cooler.

High Plains (HP). The season began with excellent soil moisture conditions but turned dry in April and May, which impeded dryland planting and emergence in dryland fields. Rains began in earnest by mid June and continued at a record pace through the season and into harvest. The 2004 season had the second highest rainfall on record, to date (December 4) over 32.5 inches. The late start for some dryland acreage will be detrimental to yields and fiber maturity while other acreage has yielded as much as 2.5 bales. Irrigated acreage will yield up to 5 bales with an average across all acres predicted at about 615 pounds. A record production year is on track with 4.3 million bales projected for 3.35 million acres. The absence of widespread weather damage has kept much of the planted acreage in play as compared to last year's heavy weather losses. The abundant rainfall has maximized the genetic potential for most fiber characteristics but abnormally low temperatures in August will apparently produce generally lower micronaire. Weather probably reduced production from a hypothetical optimal level by 18% this year compared to 48% last year. Cool, foggy, rainy weather during he first part of the harvest season has kept harvest equipment out of the field and will most certainly produce some problems with bark. The prevalence of many looser picker varieties has increased the stringing out of lint in response to an early snowstorm although higher yield potentials may balance this loss. A delayed plant-killing freeze occurred in late November. Ginning of this crop will likely extend into March of next year.

Insects reduced yield by 4%, up from 1.5% last year. But reduced weather losses and record yields ill mask most of this loss. Thrips infestations were prolonged and extremely heavy this year in the northern acreage but surprisingly low to the south of Lubbock. Use of preventative Cruiser seed treatments or Temik still lags behind some previous years and is used on far fewer acres than we would recommend. Many northern fields required a foliar insecticide application on top of the at-planting preventative treatment because of the heavy, long lasting infestations. Square retention was generally exceptionally high with most fields averaging over 95% for the first 4 weeks of squaring.

The absence of area-wide cotton fleahopper or western tarnished plant bug infestations, coupled with good growing conditions contributed to this high square set. Both of these pests were a minor problem in most fields during the early season with some increases in plant bugs later in the season. Above normal rainfall and exception weed host growth probably kept the bugs out of cotton.

Boll weevil numbers were generally very low with the exception of the Permian Basin zone, which continued to be contaminated by the St. Lawrence zone. This one finally voted in eradication and started their diapause program in September. This will bring considerable financial relief to the Permian Basin zone primarily but also secondarily to the Western High Plains, Southern Rolling Plains, Southern High Plains and Rolling Plains Central zones that were also contaminated to a lesser degree. No weevils were caught in the Northwest Plains zone or the new Panhandle zone. Most of the High Plains is in Maintenance Phase I with greatly reduced trapping and an aggressive remedial action plan if weevils are caught. This has significantly reduced staffing and cost. Some zones will experience further reductions next year by entering Phase II.

Bollworm infestations were more widespread compared to last year but mostly around our nominal threshold level of 10,000 larvae per acre, ranging between 2,500 and 25,000). Much of this could be ignored but more time was spent in decision-making and follow-up inspections than needed for more acute infestations. Pyrethroids continued to do good service with several generic pyrethroids appearing on the market. Increased tolerance to cypermethrin was detected in areas where pink bollworm applications of pyrethroids were numerous. Bollgard acreage was up a little, providing excellent control of the infestations we experience this year. Other caterpillar pests were generally absent. Aphids were largely not a problem even were pyrethroids were used sparingly. Natural enemies generally held them in check. Repeated pyrethroid sprays for pink bollworms did necessitate as many as 5 applications for aphids.

Pink bollworm infestations continued to expand in the area southwest of Lubbock near the New Mexico state line, especially in Gaines and Yoakum counties. Bollgard acreage increased accordingly with most producers using the 20% sprayed refuge provision. This acreage often came under heavy pink bollworm attack with as many as 22 applications needed before the end of the season. Otherwise, Bollgard performed flawlessly. Area-wide late season trapping has shown that moths are flying in all counties in the High Plains. The potential for a considerable problem is evident. A High Plains Pink Bollworm Task Force was formed and has met to address this growing pest problem.

Far West Texas (FWT). Cotton producers across the Far West Texas production area generally experienced average spring and early summer temperatures. In areas where dryland cotton is grown precipitation was normal to above average, which resulted in good cotton stands and above average yields. Precipitation across the far West counties; however, were considerably higher than normal, with approximately 36 inches recorded in Pecos county and greater than 20 inches in many areas of El Paso and Hudspeth counties. Although the greater amounts of precipitation reduced irrigation needs, frequent fall rains prolonged harvest.

Generally, insect pests were not a problem for Far West Texas cotton producers. Mid-season bollworms were a minor pest in the dryland production areas (Howard, Midland, Martin, Glasscock, Upton, and Reagan Counties), and *Lygus hesperus* was a minor late season pest for El Paso and Hudspeth county cotton producers.

Virginia

There was about 83,000 acres planted to cotton in the 2004 season. Of that, almost 100% of was planted to transgenic cotton varieties if you include both herbicide and insect resistant lines. An estimated 75% was planted with lines that have insect resistance. Conditions were warmer than normal early in the season, then became more temperate for the remainder. Cumulative DD60s for the period from May 1 to September 1 reached 2,206 compared with the 5-yr average of 2,205 for the same period. Rainfall was adequate and relatively uniform over the season, but more than adequate in some locations. Frequent rains hampered the timeliness of some crop management practices, including insecticide sprays. Yields have been generally high with some growers picking 1,200 to 1,300 lb lint/acre. *The state average is not available at the time of this summary.*

Research Progress and Accomplishments:

Arizona

Sweetpotato Whitefly (SPW).

Ecology. Laboratory and greenhouse studies were conducted to quantify lethal and sub-lethal effects of low temperature on SPW feeding on four different winter host plants. The results suggest that effects were independent of the host plant but influenced in a nonlinear fashion by the interaction between temperature and periods of exposure.

Field studies over the past three years have quantitatively described the year-round population dynamics of SPW in experimental plots of alfalfa, fall and spring cantaloupe, broccoli, cotton, ornamental lantana, and native weeds. Predation and dislodgement from the leaf surface are major sources of mortality for SPW on all host plants and it appears that high survivorship on spring-planted cantaloupes may be crucial for the development of population outbreaks in summer cotton.

Natural Enemies. Laboratory experiments evaluated the direct effects of buprofezin and pyriproxyfen, on survival and reproduction of *Geocoris punctipes*, *Orius insidiosus* and *Collops vittatus*. Buprofezin was benign to all species and stages of exposure in terms of survivorship and reproduction and Pyriproxyfen applied to adults had no effect on survival or reproduction of *G. punctipes* or *O. insidiosus*, but egg viability of *C. vittatus* was affected and applied to last nymphal stages of *G. punctipes* and *O. insidiosus* caused some mortality and adult deformities compared to the control.

Investigations were undertaken under USDA/USIF funded collaborative research of potential natural enemies of SPW. Nine aphelinid parasitoids, thirteen predators and four pathogens were identified as potential biocontrol agents. Their detailed biology, percent SPW parasitism and mass rearing suggest a potential use in biological control programs.

The lethal and sub-lethal impact of insecticides on predators was quantified for predators exposed to: (1) no insecticide, (2) whitefly insect growth regulators, or (3) broad-spectrum (conventional) insecticides. ELISA gut contents showed that very few of the predators collected in the conventional insecticide plots contained SPW prey remains, but the predators collected in the IGR plots and those collected in the untreated control plots had a higher percentage of individuals containing SPW in their guts. Using a SPW-specific ELISA, gut contents of over 33,000 predators were examined for SPW prey remains. Generally, the proportion of predators scoring positive for whitefly remains was lower in the conventional insecticide plots than in the IGR and control plots.

Cotton Varieties. Cotton leaf characteristics and SPW population density relationships were studied on 17 varieties of upland cotton. The results showed that the density of branched stellate trichomes on underleaf surfaces was the primary factor influencing the varietal susceptibility to adult SPW. Increased numbers of eggs and nymphs were found on hairy leaf Stoneville (ST) 474 plants compared with smooth-leaf varieties.

Natural Enemy-Pest Dispersal - Protein Marking. A series of tests were conducted to determine: (a) if the sensitivity and efficiency of an established rabbit IgG-specific marking ELISA could be improved, and (b) if a less expensive protein(s) could be used to mark insects directly in the field using conventional spray equipment. The tests showed that the time needed to conduct an effective assay could be reduced by 50% and that a less expensive marker(s) can be used instead of rabbit IgG.

Monitoring. Light-emitting diodes (LEDs) were attached to plastic cup and sticky card traps to improve SPW catches. Traps equipped with 530 nm lime green LEDs caught more adult greenhouse whitefly (GWF) and SPW compared with plastic cup traps alone; yellow sticky card (YC) and clear plastic sticky card (CS) traps equipped with lime green LEDs caught more adult SPW compared with unlit traps of each type. The lime green LED equipped YC traps have potential for use in greenhouses for SPW detection, monitoring and control. Fewer SPW, greenhouse whiteflies and banded winged whiteflies were attracted to direct current (DC) powered white fluorescent lights compared with alternating current (AC) powered fluorescent lights in a dark room study.

Behavior. We examined SPW crawler dispersal behavior difference on field grown cotton leaves in the laboratory. Three out of five crawlers released on lower leaf surfaces remained at the origin of releases, but all six crawlers released on upper leaf surfaces moved away from the release point origin on lower leaf surfaces, crawlers released stopped 7X more often but spent 70% less time per stop. Work with silverleaf whitefly, *Lygus*, and beet armyworm show increased plant volatile emissions associated with their infestations that may be plant cues mediating plant pest-natural enemy interactions.

Oviposition and Honeydew Production. Studies to determine the effect on oviposition and honeydew production of colonization on one host followed by feeding on a different host were conducted. Numbers of eggs laid per SPW female were significantly affected by colony host plant and oviposition-feeding host, females laid significantly more eggs while feeding on melon and honeydew collected from adult females feeding on any combination of cotton, melon, or tomato colony or feeding host contained more trehalulose than any other measured sugars (glucose, fructose, or sucrose).

Cotton Irrigation and Fertilization Effects. Cotton plots treated with high nitrogen levels have higher SPW densities.

Insecticide Resistance. Resistance remains an important issue in SPW management. Differences in resistance expression among various populations of SPW to four neonicotinoid insecticides was observed in a series of laboratory bioassays. Results suggest the occurrence of different resistance mechanisms among SPW populations.

New Insecticide Chemistry. Knowledge of the activity profiles of two neonicotinoid insecticides, imidacloprid and thiamethoxam, in cantaloupe vines is important in application technology. A sensitive ELISA test was used that helps to identify the temporal and spatial distribution of these materials in plants. The duration that an insecticide residue is active in a crop in terms of lethal and sub-lethal effects on insect populations is a critical concept in pest management that has been poorly developed.

Biology. SPW size and weight were investigated on different field grown cotton and cantaloupe plants. Nymphs on cotton leaves were wider, but not longer compared with those on cantaloupe, during nymphal development from 1st to 4th instar, the average (from the two host species) ventral body half volume increased by nearly 51 times compared with an increase of 28 times for the dorsal body half volume.

<u>Pink bollworm (PBW)</u>.

Bt Cotton. A five year study was conducted in Arizona to examine the comparative effects of *Bt* cotton on non-target organisms. Combined analyses over all years indicate that the abundance of several natural enemy taxa, including some spiders, *Hippodamia convergens*, and *Nabis alternatus* were significantly reduced in *Bt* cotton compared with non-*Bt* cotton, in all cases, population reductions were less than 20%, the overall function of the natural enemy community, measured as rates of predation and parasitism on two key pests (PBW and SPW) of cotton were unaffected.

Eradication. A USDA-Animal Plant Health Inspection Agency (APHIS) administered program attempting to eradicate PBW from southwestern United States and Northern Mexico is being conducted, other cultivated and wild hosts will be factors affecting program success. A wild cotton species, Gossypium thurberi is found in parts of Arizona and Mexico. In the laboratory, numbers of eggs laid and percent hatched on a commercially grown, Delta and Pineland (DPL) 5415 cotton cultivar were not significantly different compared with G. thurberi, more dead early instar PBW larvae were found in G. thurberi bolls compared with DPL5415, PBW larval infestations in the bolls in the field averaged 2.9 larvae per boll compared with no larvae found in G. thurberi bolls.

Bt Interactions. Mated PBW female moths in a choice test laid similar numbers of eggs on 'DPL 5415' and Bt cotton bolls that were 7, 21, or 35 days old, boll age had no effect on average PBW mating percentages, percentages of female moths mated were 72.0, 73.3 and 70.7 in mating oviposition containers with seven-, 21- or 35-day old bolls, respectively, when one boll of each age for DPL5415 or Bt cotton (seven, 21 and 35 days) was placed in each individual container, there were no significant differences in oviposition for cultivar or boll age, and 94.4% and 100.00% of the female moth confined with Bt and DPL 5415 bolls, respectively, mated at least one time.

<u>Lygus Spp.</u>

Lygus hesperus were fed artificial diets containing different concentrations of KCl. Over a 72 hour period, an average of 17.5, 2.6, 4.4, 2.7, and 3.8 *Lygus* were observed feeding each hour on diet packs that contained 0, 3, 6, 9, and 12% KCl, respectively. The feeding deterrent may be effective in the field.

Attraction of *Lygus*/Parasitoids/Predators to Plants. Attractants for population monitoring and detections would be important IPM tools. Substantial progress has been made in identifying the volatile composition of a preferred host plant (alfalfa) of *Lygus hesperus*.

Specific Monoclonal Antibody (MAB). Feasibility studies were conducted to determine if foreign protein markers could be substituted for pest-specific MAbs and DNA probes. The results showed that predator species chicken IgG-specific ELISAs detected the mark in predator for at least 6 hours after feeding; the encouraging data from the lab studies was verified in the field.

Tritrophic Interactions. We examined their response to SPW-infested and *Spodoptera exigua*-infested cotton plants using a Y-tube olfactometer. No clear response was observed for SPW-infested cotton plants; however, male *L. hesperus* did show a preference for *S. exigua*-infested cotton that had been fed upon for 48-72 hr. Enhanced volatile release caused by *S. exigua* feeding was sufficient to cause upwind movement; female *L. hesperus* did not show a significant preference to infested cotton plants.

Feeding Behavior. Evaluation of *Lygus* spp. potential as biological control agents was conducted. Data indicated that both *Lygus* species fed predominately on plant tissue. *L. hesperus* fed more readily on whitefly than *L. lineolaris*. When predation occurred, both species fed predominately on the whitefly nymphs. (**USDA-ARS-Western Cotton Research Laboratory, Phoenix, AZ**)

<u>Arkansas</u>

Over the past three years more than 100 colonies of Helicoverpa zea and Heliothis virescens have been assayed for Cry1Ac susceptibility in diet incorporation assays at the University of Arkansas. Measurable variability in H. zea response has been observed with the least susceptible insects coming from colonies established from Bt crops and colonies established from larvae late in the growing season. Variability among H. virescens colonies is low. Efforts have also been initiated to develop baseline susceptibilities for H. zea and H. virescens to Cry2AB and Vip3a proteins.

Stink bug populations have been monitored since 2002 in replicated small plot studies including cotton, corn, sorghum and different maturity group soybean and in commercial cotton and soybeans fields in Southern Arkansas. Populations build to high densities on early season soybean and disperse to other crops, usually late-season soybean, when the early-season soybeans mature. Cotton may be suitable for infestation early in the season before these early season soybean reach early reproductive stages and late in the season when the early-season soybean mature. Proximity to soybean appears to be an important influence on stink bug densities in cotton. Work is underway to refine trap crop approaches to stink bugs in these diverse cropping environments.

Efforts to understand spatial and temporal patterns of insect infestations across large cotton production units continued in 2004. Historical data for Wildy Farms in Mississippi County, Arkansas serves as a benchmark for this effort and as a management example for other systems. The collective dataset includes pheromone trap captures, insect scouting records for individual fields, COTMAN observations, production inputs, and yield as associated with spatial arrangement of crops across the large farm. Efforts were extended to Tillar and Company and R.A. Pickens and Sons in Desha and Drew Counties, Arkansas in 2002 and 2003, respectively. In 2005, we hope to sophisticate the COTMAN information for the southeastern Arkansas sites and add spatial estimates of insect resistance.

Three years of replicated plot experiments with VipCot cotton as compared to a parent Coker cotton, indicate good activity against heliothines in southeast Arkansas. The newer VipCot cottons, VipCot 202 and VipCot 203, have higher activity than the original VipCot 102 cotton. Reduction of larval numbers and yield increases attributed to VipCot cotton were as high as or higher than those associated with the insecticide sprays made to the Coker parent line.

Insecticide termination studies continue for late-season stink bugs in second-generation Bt cotton.

Extension of ARS research on area-wide early season suppression of tarnished plant bug by controlling broadleaf weeds in late winter-early spring was conducted in 2 areas in Arkansas. Initial data looks promising in both areas with lower inputs for plant bug control inside both areas.

Research continues on defining the interactions of plant bugs and other stresses on the cotton plant such as irrigation timing, etc. and their effects on yield.

A recently developed aphid threshold incorporating beneficial insect counts, specifically coccinelids was verified in several grower fields this season. On average, growers saved one insecticide application with no yield loss with the new threshold.

Synthetic pyrethroid resistance monitoring in bollworm and tobacco budworm utilizing treated scintillation vials was conducted in 2004. Tobacco budworm numbers were extremely low making it difficult to collect sufficient data.

Insecticide efficacy trials were conducted targeting thrips, plant bugs, stink bugs, bollworm, tobacco budworm, fall armyworm and cotton aphids at several locations across the state.
(University of Arkansas Cooperative Extension Service, Little Rock, AR)

<u>California</u>
Populations of late-season sucking insects continue to be problematic in California. Silverleaf whitefly infestations have intensified and expanded in range the last 2-3 years and cotton aphid remains an important pest. The most critical period for these insects is often from near the time of defoliation to harvest. A defoliation/insecticide study was conducted at two locations to address some of these questions. The Tulare County location was primarily infested with whiteflies and the Kern County location had an aphid infestation. The infestations at both locations were near the treatment threshold level for silverleaf whitefly or cotton aphid. Various combinations of harvest aids with and without an insecticide was evaluated. Pest levels, honeydew production, defoliation success, regrowth amount, lint sugars, and lint stickiness were evaluated in this team effort of entomologists and agronomists. (Kern and Tulare County, UC Cooperative Extension; UC Davis)

Efficacy studies were conducted on lygus bugs, spider mites, and cotton aphids. On lygus bugs, 17 different treatments were compared; populations of natural enemies as well as the secondary pests cotton aphids and spider mites were evaluated. On spider mites, 14 different treatments were compared; these included six standard materials and four experimental compounds, which are nearing registration. Silverleaf whitefly evaluations were conducted with 16 treatments, including 4 experimental materials. Finally, on late-season cotton aphids, the efficacy of 20 treatments was compared – 11 standards and 3 experimentals. (UC Davis)

Research continued on validating a late-season threshold for cotton aphids on acala cotton for the presentation of sticky cotton. Insecticide treatments to manipulate naturally-occurring aphid populations were applied at weekly intervals from boll opening to defoliation. Whitefly populations, occurring at low levels, were controlled in all but three treatments; this allowed us to evaluate the possible confounding effects of this pest.

Cotton spectral response, following damage from cotton aphids and/or spider mites, was quantified. Naturally occurring populations of these arthropods were altered using selective pesticides. Hand-held spectrometer and satellite data were utilized as the response variables. (UC Davis)

Mark-recapture studies were performed to measure dispersal *Lygus hesperus*. Males were found to move greater distance per day than females. A strong directional bias was found with greater east-west movement than distances along the north-south axis. Greater movement distances were found in fields of cotton than alfalfa or black-eyed bean, which concurs with known host preferences. Similarly, absolute abundance estimates in alfalfa were five times those in cotton. Greater recaptures to the north and west suggested a predilection to upwind movement, as prevailing winds are out of the northwest. (USDA-ARS Shafter)

Isolates of *Beauveria bassiana* from California populations of *Lygus hesperus* and Mississippi populations of *Lygus lineolaris*, were evaluated for control of Lygus hesperus on alfalfa. High levels of infection were obtained suggesting the isolates may be well adapted for hot weather. (USDA-ARS Shafter)

<u>Louisiana</u>
In field trials, novaluron (Diamond 0.83EC, 0.039-0.058 lb AI/acre), thiomethoxam (Centric 40WP, 0.047 lb AI/acre), acephate (Orthene 90SP, lb AI/acre), dicrotophos (Bidrin 8EC, 0.25-0.4 lb AI/acre), bifenthrin (Discipline

2 EC and Capture 2EC, 0.04 lb AI/acre), oxamyl (Vydate 3.77L, 0.5 lb AI/acre), and indoxacarb (Steward 1.25SC, 0.09 lb AI/acre) were tested against the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois) and stink bug complex. Cotton bolls were removed from plants and infested with adults and nymphs of these pests. Novaluron demonstrated poor activity (<25% mortality) against adults of all species. However, novaluron at the higher rates ($\geq$0.058 lb AI/acre) demonstrated significant toxicity to Southern green stink bug, *Nezara viridula* (L.), nymphs (40%), brown stink bug, *Euschistus servus* (Say), nymphs (40%), and tarnished plant bug nymphs (70%). Thiomethoxam demonstrated 30 to 70% mortality of Southern green stink bug adults and nymphs. The recommended organophosphates, acephate and dicrotophos, were effective against Southern green stink bug adults and nymphs (65 to 90% mortality), brown stink bug adults and nymphs (55-70% mortality) and tarnished plant bug adults and nymphs (55-75% mortality). The pyrethroid, bifenthrin, was also effective (75% mortality) and provided mortality of Southern green stink bug adults similar to that of organophosphates. Oxamyl also demonstrated 60% and 45% mortality of Southern green stink bug adults and tarnished plant bug adults, respectively. Indoxacarb, at the rates tested, generally produced lower mortality of these pests (29-35%) compared to other treatments.

A field study determined the influence of Southern green stink bug adults (female and male) and nymphs (fourth-fifth instar) on cotton boll abscission and yield loss. Cotton bolls of several age classes ranging from 0-500 heat units (in aggregates of 50 heat units) were infested with one insect of each gender or life stage of Southern green stink bug for 72 h. Seed cotton yields of bolls infested with adults and late instar nymphs through ca. 500 heat units beyond anthesis were significantly lower compared to non-infested bolls. There were no significant differences in boll abscission and boll weights between adults and nymphs or between adult males and adult females compared to non-infested bolls.

Cotton plants were infested with brown stink bug to define cotton boll age classes (based on heat unit accumulation beyond anthesis) that are most frequently injured during each of the initial 5 wk of flowering. Bolls from each week were grouped into discrete age classes and evaluated for the presence of stink bug injury. Brown stink bug injured significantly more bolls of age class B (165-336 heat units), age class C (330-504 heat units), and age class D (495-672 heat units) during the initial 3 wk in both years and in week 5 in 2002 compared with other boll ages. Generally, the frequency of injured bolls was lowest in age class A (168 heat units) during this period. The preference by brown stink bug for boll age classes B, C, and D within a week was similar when ages were combined across all 5 wk. Based on these data, bolls that have accumulated 165.2 through 672 heat units beyond anthesis (7-27 d old) are more frequently injured by brown stink bug when a range of boll ages are available. The boll ages in our studies corresponded to a boll diameter of 1.161-3.586 cm with a mid-range of 2.375 cm. A general protocol for initiating treatments against stink bugs is to sample bolls for evidence of injury as an indicator of presence of infestations in cotton. Sampling bolls within a defined range, which is most likely to be injured, should improve the precision of this method in detecting stink bug infestations in cotton.

Texas type 75-50 wire cone traps were used to quantify bollworm, *Helicoverpa zea* (Boddie), and tobacco budworm, *Heliothis virescens* (F.), adult dispersal from refuge areas and non-cotton hosts in Bollgard and refuge cotton systems. These surveys were conducted at Panola Plantation near Newellton, LA, in Tensas parish during 2003 and 2004. Pairs of pheromone-baited traps were placed on the border of the refuge and Bollgard fields at pre-determined sites starting in the center of the refuge and continuing at one-half mile intervals for a distance of two miles. One trap for each species was placed at each collection site and the paired traps separated by 50 feet. Traps were sampled weekly between the last week of Jun and mid Oct. Bollworms were the predominate species collected during both years. In 2003, the total number of bollworm moths collected during the entire testing period among sample sites ranged from 2199 to 3821, and averaged 3422 moths per site. In 2004, the total number of bollworm moths collected during the entire testing period among sample sites ranged from 271 to1429, and averaged 754 moths per site. Total bollworm numbers generally were higher at site 2 and at sample sites adjacent to Bollgard cotton compared to numbers collected at the sample sites in the refuges. Insecticide applications may have reduced the number of bollworms emerging in the refuge. In 2003, the total number of tobacco budworm moths ranged from 136 to 818 among sample sites. The average number collected for each site was 426 moths. In 2004, the total number of tobacco budworm moths ranged from 62 to 306 among test sites. The average number collected for each site was 165 moths. The highest number of tobacco budworms was collected at the sample site in the refuges and at the sites one-half mile from the refuge. Beyond sites 1 and 2, the number of tobacco budworm generally declined. These data illustrate the local distance that adults will migrate in this environment and the contribution of the refuge to the heliothine population in Bollgard fields.

In 2004, pheromone baited wire cone traps were used to survey species composition of tobacco budworm and bollworm in five parishes. These parishes represented the northwestern, central, and northeastern portions of Louisiana. The AVT was used to monitor pyrethroid resistance levels in these species. Approximately 110 tobacco budworm moths were assayed for pyrethroid susceptibility from Jun to Aug 2004 using a discriminating concentration of 10 μg in the adult vial assay. Percent survival observed during Jun, Jul, and Aug, was 74%, 54%, and 96%, respectively. Over 830 bollworm moths were assayed using a 5 μg /vial concentration of cypermethrin. Percent survival observed for May, Jun, Jul, and Aug, was 9%, 16%, 39%, and 21%, respectively. No field control failures of bollworm infestations associated with pyrethroid usage were reported in Louisiana during 2004. Field populations of bollworm and tobacco budworm were also monitored for susceptibility to spinosad using the AVT. From May to Jul, bollworm survival ranged from 8.7-24.4% for the 5 μg/vial concentration of spinosad and from 2.3-9.1% for the 15 μg/vial concentration of spinosad. During Jun and Jul, tobacco budworm survival to the 5 μg/vial concentration ranged from 33.3-44.4% and 0-14.8% for the 15 μg/vial concentration of spinosad.

Laboratory studies evaluated the susceptibility of bollworm larvae fed various plant structures from conventional cotton plants and transgenic plants expressing c*ry1Ac*, *cry1F*, and both c*ry1Ac* and c*ry1F* (Widestrike) insecticidal proteins. Neonate larvae were provided white flowers, squares, and terminal leaves at two, four, and six weeks after flower initiation. Additionally, second instars were supplied with leaf tissue (discs) from five and eight nodes below the plant terminal and quarter size bolls. Mortality was assessed at 48, 72, and 96 hours after plant structures were infested. Mortality was consistently higher for neonates than second instars. Mortality (75-84%) of neonates on plants expressing single or multiple toxins was generally similar, regardless of the plant structure, except for that on white flowers (*cry 1F*, 45% mortality). Mortality of neonates on transgenic plant tissue expressing c*ry1Ac* or Widestrike proteins was significantly greater than that of neonates on conventional plant tissues. Mortality of second instars on Widestrike tissue was significantly greater (30%) than that on any other treatment. Mortality of second instars on Widestrike structures was 16-26% greater than those on plants expressing a single protein and 64% greater than those on conventional cotton. Mortality on bolls and leaf discs eight nodes below the terminal was 19% and 23% greater, respectively, than the mortality observed on leaf discs five nodes below the terminal.

A USDA-IFAFS and NASA-AG2020 sponsored project was continued during 2004 to adapt precision agricultural technologies for use in Mid-South cotton production strategies. Insect sampling was done randomly in cotton fields, as well by sampling specific sites in fields based on NDVI maps. There were 13 successful aerial spatially variable insecticide applications made at the test site using two aircraft and two different computer systems. These prescription pesticide applications were based on images (NDVI) obtained from aircraft or satellite-based platforms and yield maps. Field tests evaluating insect pest management between site-specific insecticide applications and conventional broadcast treatments once again yielded promising results. Several demonstrations were conducted in 2004 for consultants, growers, and aerial applicators to demonstrate variable rate aerial application equipment. **(LSU AgCenter's Northeast Research Station, St Joseph and Winnsboro, LA; Louisiana Cooperative Extension Service, Winnsboro, LA; and Department of Entomology, Baton Rouge, LA)**

<u>Mississippi</u>

A three-year sampling study to evaluate the presence of stink bugs and tarnished plant bugs in cotton, corn and soybeans has been completed in the field. Data are being analyzed to help determine the role of the alternate hosts in contributing the pest insects to cotton. **(MSU Department of Entomology and Plant Pathology, Mississippi State, MS)**

Research on Transgenic Crops: Corn/Cotton Interactions. Certain transgenic Bt (*Bacillus thuringiensis*) corn (YieldGard, Monsanto Co.) and cotton varieties (Bollgard, Monsanto Co.) have been genetically engineered to express the Cry1A (subclass b & c for corn and cotton, respectively) δ-endotoxin to control certain noctuid pests. In addition to the Cry1Ac protein, Bollgard II contains a second protein (Cry2Ab). These technologies provide superior control of the tobacco budworm, *Heliothis virescens* F., in cotton, and the European corn borer, *Ostrinia nubilalis* (Hübner), in corn and cotton. However, other pests such as the bollworm, *Helicoverpa zea* (Boddie), is less than adequately controlled in both Bollgard and Bt corn. Although there are numerous reports on the sublethal effects of the Cry proteins on the larval stage of the bollworm, few studies have examined the effects on the moth and subsequent progeny. The purpose of this study was to determine the effects of Bt corn has on bollworm development, especially during the adult stage, and the ability of progeny to survive and damage transgenic Bt cotton.

In one experiment, plots of either conventional corn (Terral 3130) or transgenic Bt corn (YieldGard: Terral 3160) were grown in a 0.125 acre field cages located in Stoneville, MS. Corn types were planted on May 22nd, 2004. A natural population of bollworms was observed on both corn types once plants began to silk. Once the vast majority of bollworms had pupated and corn was no longer attractive to the pest, netting was placed over the entire field cage. Light traps were placed inside the cages to catch emerging bollworm moths. Traps were checked at dawn for 17 consecutive days, and the number of emerged moths was recorded daily. All live moths were transported within 30 min. to the laboratory. The moths were chilled at 4°C for approximately 15 min. and then promptly weighed. Moths were captured in the Bt corn cage nearly one week after emergence ceased in the conventional corn cage. Furthermore, moths were smaller when completing development on Bt corn versus conventional corn. A 3-fold reduction in moths emerging from Bt corn (n=55) was observed when compared to moths emerging from conventional corn (n=170). Smaller than anticipated numbers of moths that were collected was probably due to an epizootic that occurred in late-instars in both conventional and Bt corn.

In another experiment, strip plots (6 rows) of either conventional corn (Terral 3130) or transgenic Bt corn (YieldGard: Terral 3160) were grown in a 0.125 acre field cage located in Stoneville, MS. In addition, transgenic Bt cotton containing the Cry1Ac protein (Bollgard: SG215BRR) and Bt cotton containing both Cry1Ac and Cry2Ab proteins (Bollgard II: DP 424BGIIRR) were planted simultaneously in a randomized complete block design within the cages. Cotton plots were 4 rows (40 inch centers) by 15 ft. Cotton and corn were planted on May 22nd, 2004. A natural population of bollworms was observed on both corn types once plants began to silk. Once the vast majority of bollworms had pupated and corn was no longer attractive to the pest, netting was placed over the entire field cage. For both corn types, emerging bollworm moths successfully mating and deposited eggs in both Bollgard and Bollgard II. Plants (5) per cotton plot were examined for the presence of bollworm larvae. Furthermore, all bolls present on the 5 plants/plot were examined for bollworm damage. Bollworm larvae completed development on both conventional corn and Bt corn (YieldGard). Moths successfully mated and deposited viable eggs that developed into larvae on all cotton types. As anticipated, the majority of larvae were found on conventional cotton followed by Bollgard and Bollgard II. As in the above experiment, fewer total larvae were found in the cage containing Bt corn, suggesting that the Cry1Ab had a negative impact on the previous bollworm population. However, bollworm larvae whose parents completed on Bt corn caused boll damage on all cotton types. These data suggest that fitness costs and selection pressure associated with larvae completing development on Bt corn (YieldGard) are small, although further experiments are needed to corroborate these conclusions. Ultimately, these data may affect the 50% cap on plantings of Bt corn in the southern states.

Genetic Basis for Variability among Bt Cotton Cultivars. The amount of Cry1Ac in transgenic *Bacillus thuringiensis* Berliner (Bt) or Bollgard® cotton varies among commercial cultivars. These expression differences have been correlated to survival levels in Lepidoptera, indicating that all Bollgard® cultivars do not provide the same level of control. The objective of this study was to determine if differences in overall expression among commercial cultivars of Bollgard® cotton were under simple genetic control. If so, these findings could influence the way breeders select cultivars by selecting for efficacy in addition to agronomic traits.

Two sets of crosses were made in the greenhouse with a high expressing and a low expressing cultivar. The parents, F_1, and F_2 generations were planted in the field. The amount of Cry1Ac was quantified using a commercial ELISA kit. Highly significant variances within the two F_2 breeding populations were due to genetic segregation for Cry1Ac expression. Using the modified Castle-Wright formula, estimation of the number of contributing genes in both breeding populations was small. These data show that genetic background has a major effect on Cry1Ac expression. Because backcrossing is the primary method used by commercial cotton breeders, the selection and use of donor and/or recurrent parents that will result in a high level of Cry1Ac expression is crucial.

In order to study Cry1Ac mRNA levels in transgenic cotton lines using real time quantitative PCR, TaqMan primer/probe sets were developed for engineered Cry1Ac gene and single copy RAC1 gene. Reaction conditions were optimized and relative gene expression levels in 4 cotton lines (8 replicates) were carried out. Further optimization is needed in order to verify preliminary findings.

Bt Resistance Monitoring Program. In 2004 19 strains of *Heliothis virescens* and 47 strains of *H. zea* were tested with *Bacillus thuringiensis* Cry1Ac toxin. Ten and 19 of those strains were tested also with Cry2Ab toxin respectively. Although there was a significant reduction in the number of tested strains (47.5% for tobacco budworm and 48.4% for bollworm), the total number of bioassays performed in 2004 increased as compared with 2003. This was due to the fact that Cry2Ab toxin was incorporated to the monitoring program. However, it is more important to note that in 2004 the incorporation of F2 screen took place. This method of segregating recessive alleles in the second generation of the tested strains allows making more accurate determinations of the frequency of resistant genes. In 2004 more than 1,230 *H. virescens* and 3,200 *H. zea* moths were tested resulting in more than 110 and 246 bioassays respectively without any signs of elevated tolerance to the Bt toxins (see a detailed report in these proceedings: Blanco et al. 2005).

Alternative Host Plants to Increase the Effectiveness of Heliothine Production. In its third year of field evaluations, the important legume chickpea (*Cicer arietinum*) demonstrated much higher (≥8X) production of *H. virescens* per area than cotton. Since this is the third most important legume of the world, its potential adoption as alternative refuge for tobacco budworm (and other Lepidoptera) is feasible. This plant provides researchers with a tool for obtaining necessary *H. virescens* larvae to conduct different types of research.

An important aspect of this research is actual moth production assessment per area in different geographies (Texas, Tamaulipas [Mexico] and Mississippi) which in turn might help re-defining Bt cotton refuge strategies. Moth production per area information might help re-designing Bt cotton refuges. Also, the establishment of small *C. arietinum* plots is a reliable method for obtaining necessary numbers of larvae utilized in Bt-monitoring programs.

Toxicity of Avidin, a Potential Bio-Insecticide. Artificial diet was supplemented with avidin at 10 and 100 ppm to determine its effects on growth and mortality of five lepidopteran insects: *Helicoverpa zea, Heliothis virescens, Spodoptera frugiperda, Spodoptera exigua,* and *Anticarsia gemmatalis.* All insects were placed on diet immediately after hatching and observed until death or pupation occurred. At a concentration of 10 ppm, avidin had little or no effect on growth and mortality as compared with the control. However, at a concentration of 100 ppm, mortality of all tested insects was approximate 100%. *H. zea* was further tested by adding a sub-lethal concentration of Bt (*Bacillus thuringiensis*) with 10 ppm avidin in diet. The synergistic effect was significant, and the mortality rate was increased by up to 57% on the Bt+avidin diet.

Investigate Interaction of Bt and Proteinase Inhibitors. Gut proteinases may be responsible for breaking down of Bt toxins and Bt resistance development in insects. Potential resistance development to Bt cotton and shift of pest status in plant bugs prompt research for seeking strategies to preserve environmental-friendly Bt cotton. Proteinase inhibitors are potential candidates in Bt cotton system for enhancing Bt toxicity against lepidopteran pests and for expanding spectra of target insects. Interactions of Bt and proteinase inhibitors were investigated by monitoring growth and gut proteinase activities of the bollworm, *Helicoverpa zea*. Several proteinase inhibitors were combined with Bt protoxin, *Bacillus thuringiensis*, in artificial diet and fed to newly molted 3rd-instar bollworm larvae to determine effects on growth and proteinase activity. A concentration of Bt at a level causing minimal mortality (<10%), was mixed with the following proteinase inhibitors: benzamidine, phenylmethylsulfonyl fluoride (PMSF), and Ṇ--tosyl-L-lysine chloromethyl ketone (TLCK). When compared with controls, the synergistic effect of *Bacillus thuringiensis* and proteinase inhibitors caused significant decreases in mean larval weight and length over time. Midgut samples tested against the substrates azocasein, . -benzoyl-DL-arginine-*p*-nitroanilide (BApNA), and N-succinyl-alanine-alanine-proline-phenylalanine-*p*-nitroanilide (SAAPFpNA) showed significant decreases in the protease activity of larvae fed Bt plus inhibitor versus control.

Rhodamine Incorporation into *H. virescens* Moths. A team of ARS researchers (Hagler and Jackson [Phoenix, AZ]) recently (2001) published a review paper on insect markers. This team wrote that successful marking should have certain characteristics: “insects should retain the marker for a sufficient period of time and not be adversely affected by it. An ideal marking material should be durable, inexpensive, nontoxic, easily applied, and clearly identifiable. Furthermore, the marker should not hinder the insect or its behavior, growth, reproduction, or life span”. All these characteristics have been assessed on this work in collaboration with Drs. O. Perera, L. Williams, J. Ray and E. Taliercio (all of ARS-Stoneville). This technique that only costs $0.25 to mark ≥2000 tobacco budworm moths, can be incorporated into insect bodies after only one day of feeding 0.1% Rhodamine in 10% sugar solution. This dye is clearly identifiable in bodies with the naked eye and Rhodamine-fed male spermatophores can be detected in untreated females with simple UV-light and a microscope. This technique can potentially mark hundreds of field-collected tobacco budworm moths after only one day with unparallel ease, which can be used as an economical mark-release-recapture technique. But more importantly, the detection of this dye in spermatophores will aid this research team (and others) with mating behavior and sperm precedence studies, key aspects for the study of insect resistance management.

Selection for Cry1Ac Resistance in a *H. virescens* Colony. After eight years of intensive selection pressure of Bt crops (corn and cotton) grown in a cumulative area of more than 80 million hectares worldwide, resistance to Bt crops has not yet been documented. This lack of resistance at field level has important consequences for resistance management research, because there are not accessible colonies of Lepidoptera cotton pests that can be used for genetic studies.
ARS-Stoneville *H. virescens* colony was exposed for 10 generations in 2004 to sub-lethal concentrations (0.1-0.2 µg / mL of diet) of Cry1Ac obtaining a ≈7X resistance level and only ≈6.0% larval weight reduction. Interestingly, it appeared in F9 and F10 that the increased tolerance to Cry1Ac ***might*** be controlled by males, a finding that potentially can show that opposite of recently published studies that describe a tolerance mechanism named "female induction". The first F2 reciprocal crosses of the 10th generation, performed in Dec04 indicated that neither sex was responsible for this shift. Further work is expected to follow in $\geq$2005.

Tarnished Plant Bug Research. Holding conditions that produced high mating percentages in control and irradiated tarnished plant bugs were developed. When one male and one virgin female were paired, both untreated males and those given 10 krad of gamma irradiation inseminated an average of 65% of females. In preliminary tests, males irradiated with 20 krad inseminated similar numbers of virgin females as untreated males, indicating that the bugs are able to withstand high dosages with out impairing their mating ability.

The dynamic nature of photoperiod may produce an effect on diapause initiation or termination not seen using static photoperiods. Both increasing and decreasing light regimes had greater effect on the incidence of diapause than similar amounts of light presented in static regimes. Tarnished plant bug nymphs are sensitive to diapause inducing stimuli, but the tendency of nymphs reared in a diapause averting environment to enter diapause quickly (within 10 d) after receiving diapause inducing stimuli as adults is greater than the tendency of bugs reared in a diapause inducing environment to become reproductive quickly upon receiving diapause averting stimuli.

Twenty new isolates of the entomopathogenic fungus, *Beauveria bassiana*, collected during 2002-2003 from *Lygus lineolaris* in MS and one from AR, three from *L. hesperus* in CA, and the commercial isolate GHA were characterized for *in vitro* spore production, pathogenicity to tarnished plant bug, southern green stink bug, bollworms, and tobacco budworms, tolerance to artificial sunlight, and germination rate at high temperatures. The following characterstics were described for GHA, four MS isolates, one AR isolate, and three CA isolates: 1) pathogenicity to honeybees and alfalfa leafcutter bees in collaboration with Rosalind James (ARS, Logan, UT); 2) genetic relatedness in collaboration with Mauricio Ulloa (ARS, Shafter, CA) and Young-Hoon Park (UC-Davis); and 3) mycotoxin (beauvericin) production in collaboration with Ron Plattner (ARS, Peoria, IL). Work on pathogenicity of these isolates to *L. lineolaris* and *L. hesperus*, tolerance to artificial sunlight, and temperature growth optima initiated in the previous year was completed. All work with isolates from *L. hesperus* (CA) was conducted in collaboration with Michael McGuire (ARS, Shafter, CA). Two isolates each from MS and CA were compared to GHA for production under simulated industrial scale conditions in collaboration with Stefan Jaronski and Julie Grace (ARS, Sydney, MT). One isolate each from MS and CA, and GHA were selected for two field trials each in wild host plants (MS), cotton (MS – J. Gore, collaborator), and alfalfa (CA). Data collected from these wild host plant and alfalfa field trials included levels of infection and population change for both the target Lygus spp. and beneficial insects. Data collected from wild host plant and cotton field trials also provided a comparison of direct spray, uptake from treated plant surfaces, and persistence of conidia on plant surfaces using caged insects.

Characterization of this large collection of isolates has demonstrated that a number of these when compared to the commercial isolate GHA have the following characteristics of a good mycoinsecticide: 1) prolific spore production, 2) higher pathogenicity to target *Lygus* spp. and low pathogenicty to beneficial insects, 3) low mycotoxin production, and 4) higher tolerance high temperatures and solar radiation. Field trials demonstrated high infection levels in both Lygus spp. and little infection in beneficial insects. Additional production scale-up and field trials are planned for 2005. These results indicate promising potential for commercialization of a new isolate for Lygus control, which could be a significant contributor to IPM strategies. Patents for these isolates are currently being reviewed by the PWA patent advisor.

Formulation strategies for protecting spores from solar radiation initiated in 2002 and 2003 were completed, which improved spore survival under artificial sunlight by up to 10 times. Pending mass production scale-up at NBCL, spore product will be formulated in collaboration with Robert Behle (ARS, Peoria, IL) for evaluation of these formulations in field trials during 2005. These formulations have potential to greatly improve the efficacy of mycoinsecticides described above and have application to a with range of microbial biopesticides.

A field trial was conducted to evaluate the interaction of cotton development and field inoculation with the incidence of cotton aphid fungus (*Neozygites fresenii*) epizootics in collaboration with Don Steinkraus (U of AR). Samples from this experiment are currently being evaluated to the interaction of cotton development and presence of inocula on cotton aphid infection levels. Understanding the interaction of cotton development and epizootic initiation contributes to our basic understanding of this important fungus and may aid in predicting and augmenting epizootics. Successful initiation of epizootics could reduce the need for chemical insecticides by speeding the onset and ensuring the occurrence of epizootics. Infected cotton aphids were collected during these field trials, dried and stored to be used for future inoculation experiments. These inocula will also be used in experiments to evaluate the potential for infecting soybean aphid in 2005, since *N. fresenii* has recently been described as infecting these aphids in the field. Inoculation experiments being conducted on cotton aphid may have application for inoculating soybean aphid populations to reduce there spread into uninfested and control populations in infested areas.

The tarnished plant bug has become a serious pest in the Bt cotton system. More than eleven-fold resistance level to malathion was detected in a natural population collected in Mississippi. It is very likely that TPB had developed metabolic resistance to malathion, because several synergists, metabolic enzyme inhibitors, could dramatically enhance toxicity of the malathion. Previously, we compared esterase enzyme activity, cDNA structure, and gene expression levels between susceptible and resistant strains. In 2004, we further examined another important metabolic enzyme, glutathione S-transferase (GST). Full GST cDNAs were sequenced from both strains. GST gene expression levels will be compared. Enhanced GST activity was fund in the resistant strain. More than 90% enzyme activity could be suppressed by GST inhibitors. Two inhibitors were selected for bioassay. Mortality was increased by 3-3.5 fold.

Molecular Genetics of Heliothines. A microsatellite library and a gut-specific expressed sequence tag (EST) library for *Heliothis virescens*, and development of an assay for detection of Cry1Ac gene expression in transgenic cotton has been developed. Microsatellite libraries of *H. virescens* have been constructed, each enriched with a combination of 4 to 8 non-complementary oligonucleotide sequences. Twenty five oligonucleotides used in this process represented all possible combinations di-, tri- and tetra-nucleotide microsatalite repeats. Sequencing of 48 clones from each library (a total of 192 clones) revealed over 130 potential microsatellite sequences. These sequences will be evaluated for suitability in population genetic studies.

A gut-specific EST library of H. virescens was constructed by suppressive PCR mediated enrichment of gut specific genes. mRNA isolated from dissected guts were enriched using mRNA isolated from other tissues. Nucleotide sequences of cloned EST fragments were analyzed using database search methods (BLAST) to identify homologies to genes identified from other organisms. Sequences of 73 clones did not match any sequence in repositories. Lack of database matches indicate that these sequences are either new sequences that are not identified yet or *H. virescens*-specific DNA regions of already identified genes. Because the library construction was carried out by digesting cDNA into small (approximately 200 bp) fragments, it is highly likely that many of these clones represent highly divergent, *H. virescens*-specific regions of already known genes.

Of the DNA sequences that matched database entries, several gut specific genes including serine proteases, carboxypeptidases, aminopeptidases, trypsins, and chymotrypsins were identified. In addition, 2 clones with sequence similarities to rat/human X-Prolyl Aminopeptidase P were also identified. Approximately 1 kb fragment from the 3' end was cloned using rt-PCR. Determination of full length sequence and expression of the gene in different tissues and life stages of *H. virescens* is in progress.
(**Southern Insect Management Research Unit, USDA-ARS, Stoneville, MS**)

<u>Missouri</u>
Both experimental and registered cotton insecticides plus WideStrike Bt cotton were evaluated in several field trials. Only test results from two plant bug / fleahopper trials are reported as follows:

Plant Bugs
Trial 1: Pretreatment counts indicated moderate plant bug [predominantly tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois)] and beneficial (ladybird beetles, lacewings, and big-eyed bugs were most common) populations were present in a trial conducted at the MU Delta Center Lee Farm. The trial was conducted on DP 451BR cotton planted on May 21, 2004. Plots were oversprayed once on August the 10th with a 4-row sprayer calibrated to deliver insecticide treatments at 44 psi and 15 GPA through two TSX-12 hollow cone nozzles per row. Plots were sampled using a 15-inch diameter sweep net as a beat net. The net was held at a 45-degree angle to plants, which were then beaten three times over the net, and this was repeated 15 times per plot. Plots were later harvested on November the 22nd.

At 2 and 6 DAT, there were significant differences in total plant bug infestations [adults and nymphs of the cloudy plant bug, *Neurocolpus leucopterus* (Say); the cotton fleahopper, *Pseudatomoscelis seriatus* (Reuter); and the tarnished plant bug] among the insecticide-treated and untreated plots. At 2 DAT, the top three treatments with the lowest total plant bug / cotton fleahopper populations were: Centric (0.047 lbs. AI/A), Discipline (0.04 lbs. AI/A) + Bidrin (0.25 lbs. AI/A), and Discipline (0.04 lbs. AI/A) + Bidrin (0.25 lbs. AI/A). At 6 DAT, the top three treatments with the lowest plant bug populations were: Capture (0.08 lbs. AI/A), Discipline (0.02 lbs. AI/A) + Bidrin (0.25 lbs. AI/A), Discipline (0.03 lbs. AI/A) + Bidrin (0.25 lbs. AI/A), and Discipline (0.05 lbs. AI/A) + Bidrin (0.25 lbs. AI/A). Overall, insecticide-treated plots had 12% higher yields than in the untreated plots, and the top three treatments with respect to yield (lbs. seed cotton/A) were: Discipline (0.05 lbs. AI/A) + Bidrin (0.25 lbs. AI/A), Orthene (0.5 lbs. AI/A), and Centric (0.047 lbs. AI/A).

Trial 2: Pretreatment counts indicated moderate plant bug [predominantly tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois)] and beneficial (ladybird beetles, lacewings, and big-eyed bugs were most common) populations were present in a trial conducted at the MU Delta Center Lee Farm. The trial was conducted on DP 451BR cotton planted on May 21, 2004. Plots were oversprayed once on August the 13th with a 4-row sprayer calibrated to deliver insecticide treatments at 44 psi and 15 GPA through two TSX-12 hollow cone nozzles per row. Plots were sampled using a 15-inch diameter sweep net as a beat net. The net was held at a 45-degree angle to plants, which were beaten three times over the net, and this was repeated 15 times per plot. Plots were later harvested on November the 22nd.

Only at 3 DAT, were significant differences in total plant bug infestations [adults and nymphs of the cloudy plant bug, *Neurocolpus leucopterus* (Say); the cotton fleahopper, *Pseudatomoscelis seriatus* (Reuter); and the tarnished plant bug] observed among the insecticide-treated and untreated plots. At 3 DAT, the top three treatments with the lowest total plant bug / cotton fleahopper populations were: Mustang Max (0.0225 lbs. AI/A), Mustang Max (0.018 lbs. AI/A), and Mustang Max (0.025 lbs. AI/A). At 10 DAT, the top three treatments with the lowest total plant bug / cotton fleahopper populations were: Mustang Max (0.025 lbs. AI/A) + Bidrin (0.5 lbs. AI/A), Karate Z (0.028 lbs. AI/A), and Mustang Max (0.0225 lbs. AI/A). Overall, insecticide-treated plots had 4.2% higher yields than in the untreated plots, and the top three treatments with respect to yield (lbs. seed cotton/A) were: Karate Z, Mustang Max (0.025 lbs. AI/A), and Baythroid (0.028 lbs. AI/A). **(University of Missouri, Agricultural Experiment Station, Delta Research Center, Portageville)**

New Mexico
Yield compensation field trials in Artesia and Las Cruces continued in 2004. Trials were also initiated to examine the impact of low water use on insect pest and beneficial populations. Testing to evaluate the impact of management on crop microclimate and insect populations is ongoing including evaluations of okra leaf cotton.
A variety of biological control projects are also currently underway. These include the development of a key for parasitic Hymenoptera in the Mesilla Valley. Software development for sampling and automatic classification of insects continues. A survey of the spiders of cotton in New Mexico was completed. Work on the bionomics of *Mecidea* is in progress.

North Carolina
Several insecticide screening tests were conducted in 2004. These and other test results may be found at the Cotton Insect Corner web site: http://ipm.ncsu.edu/cotton/insectcorner/research.htm In an at-planting and foliar insecticide thrips test, few statistical differences were found between Temik at 0.75 lb. ai/acre, 2 rates of KC791230, and Gaucho and Cruiser seed treatments plus a first true leaf foliar spray, in adult or immature thrips levels, plant stands, plant heights, plant dry weights, various maturity parameters (node of first fruit, nodes above cracked boll and

percent open bolls), yields, and HVI fiber quality parameters. In a test of Trimax's possible growth regulator effects, two rates of Trimax (0.0312 & 0.05 lb. ai/acre), Baythroid (0.028), Centric (0.05) and Vydate were applied at square initiation. Except for Vydate, the other treatments were sprayed 2 additional times at weekly intervals. All treatments significantly reduced lady bird beetles compared to the check; all treatments showed significantly higher square retention than the check; all treatments except Vydate showed significantly fewer dirty blooms than the check; and no significant differences in either percent open bolls or yield were noted. In a single application, 13-treatment stink bug (approx. 50:50 green: brown) insecticide efficacy test, Orthene at 0.75 ai/acre and treatments combined with Bidrin appeared to provide lower boll damage (< 10%) that pyrethroids alone (~15%). In a second, single application stink bug insecticide efficacy test against primarily (87%) green stink bugs, compared to the check (40% boll damage), boll damage with Orthene (0.75 ai/acre) was 34%, Vydate (0.5) was 29%, Discipline (0.1) was 25%, Bidrin (0.5) was 13%, Karate (0.04) was 12%, Mustang Max (0.025) was 10%. A large-scale, 400 acre replicated test on soybean was utilized to evaluate 2 standard cotton stink bug insecticides (Orthene and Bidrin) and 2 pyrethroids (Mustang Max and Karate) on a population of almost 100% brown stink bugs in eastern NC. Compared to the untreated check plots, Bidrin (0.5) showed 97.8% control, Orthene (0.5) 82.4%, Karate (0.025) 70.0% and Mustang Max (0.025) 66.7% control at 5 DAT. Intruder continued to show superior cotton aphid control compared with Centric and Trimax, although the latter 2 compounds have controlled field populations of cotton aphids adequately in NC. This year, Bidrin provided good cotton aphid control, although this product is not recommended in NC due to the common presence of OP-resistant cotton aphid populations. F1785 (0.063) continues to be competitive with the better choronicotinoids.
In whole field and small plot comparisons, both no-till and strip till cotton culture continued to show a strong trend toward lower thrips levels than in conventional cotton. Although we have quantified a trend toward higher fire ant and cotton aphid levels in reduced tillage cotton (2002-2004), differences between tillage systems are only occasionally significant, probably due to the limited soil disturbance in our widely-adopted (90%) Roundup Ready "conventional tillage" systems.

In our annual late-season insect (bollworms, European corn borers, fall armyworms and stink bugs/plant bugs) boll damage comparison of Bt (Bollgard) vs. conventional fields under producer conditions, 75 Bollgard fields were compared with 75 conventionally treated paired fields, either managed by the same producer and/or in close proximity. This 'real world' evaluation of the efficacy of Bollgard cotton has now been undertaken for 9 years, 1996 through 2004 (2,032 total fields). This year's survey confirmed the high, unprecedented levels of stink bug damage to both conventional and Bollgard cotton, 15.3% and 6.9%, respectively- both figures more than 5-fold higher that the average of the previous 8 years. Bollworm/budworm damage was also high in conventional cotton in 2004, in part due to relatively high budworm pressure during much of early to middle part of our major bollworm moth flight.

An annual survey of North Carolina's licensed independent crop consultants working on cotton was continued in 2004 to gather data on how second generation (June and early July) tobacco budworms, late-season bollworms, thrips, cotton aphids, and plant bugs were managed by these individuals inconventional and in Bollgard cotton. 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 the 720,000 acres of Bollgard cotton planted in NC in 2004, 10.1% was not treated, 58.2% was treated one time, 29.1% was treated 2 times, and 2.5% was treated three times. This year, stink bug damage to bolls was often the primary treatment trigger for Bollgard cotton.

Research into the development of a phenologically-based, dynamic stink bug threshold was expanded in 2004. One aspect of the study involved the creation of different levels of stink protection and the regression of the resulting graduated levels of boll damage (9 to 81%) against yields (in this test 6.9 lb. lint lost per each 1% increase in boll damage). At the onset of anthesis, the maximum diameters of the 25 consecutive bolls x 4 replicates in 3 different sites (a small-bolled variety, DP 555 BR, a large-bolled variety, FM 989 BR, and FM 960 BII R) were measured weekly throughout the growing season from permanently-marked points in the field. In this way, the diameters of both individual bolls and the overall boll population were available to create curves of the "boll safe" population, as indicated by the proportion of bolls over a defined diameter. This "boll safe" diameter (defined as the point at which the diameter of a variety reaches an age of approximately 3.5 weeks) varied somewhat between varieties, plant position (typically 1st or 2nd), moisture availability, and time of anthesis. The end result of this research effort may lead to more realistic, boll development-based thresholds that reflect the increasing resistance of the developing boll population to bug pests. **(Cotton Extension IPM Project, Department of Entomology, NCSU, Raleigh, NC)**

Oklahoma

Several Bt cotton trials were conducted in 2004 to further evaluate the value of this technology under Oklahoma conditions. Since 1996, Bt cotton provided sufficient bollworm control and increased yields to compensate for rental fees under irrigation. . During this 8-year period relying on the Bt technology enhanced profits by $ 62.95 per acre annually. For the time in five years one of the Bt varieties' yield compensated for its rental fees under dryland conditions. SV 4646 returned $2.08/acre over the rental fee. However the slight profit coupled with the poor performance in past years does not warrant planting Bollgard™ varieties under upland dryland conditions that exist across the Rolling Plains of Oklahoma.

This was the ninth year that Heliothine infestations failed to reach levels in economic threshold trials to activate insecticide applications. Heliothine pressure remained below 5 larvae (> 3/8 inch long) per 100 terminals. Insecticide protection was planned if infestations approached 10 larvae (> 3/8 inch long) per 100 terminals. Biweekly tagging of eggs and newly hatched larvae revealed no Heliothine survival on tagged plants. All newly hatched larvae died before any of the larvae reached ½ inch long.

Research continued in 2004 to determine the impact of planting date. Previous research before boll weevil eradication started indicated that years with high boll weevil survival planting date is critical regardless of management scheme to raise profitable cotton. Early May planted cotton produced the highest yields compared to June planted cotton that sustained significant weevil damage. In 2004 slightly higher yields occurred in the June 4th planting. However no significant difference occurred in either planting or insecticide treatments.

An insecticide comparison trial to control thrips on seedling cotton revealed no significant differences in yields between treatments. All treatments except Temik .5lb a.i./acre out-performed the untreated check and compensated for their cost. Cruiser treated seed showed the greatest monetary gain $18.00 / acre while Temik .5lb a.i./acre lost $25.41 /acre. (**Oklahoma Cooperative Extension Service, Altus, OK**)

South Carolina

Neonicotinoids were further evaluated for their effects on beneficial arthropods found in cotton.

For the second consecutive year, Assail had the least effect on major beneficials (geocorids, ants,
Spiders, orius) followed by Trimax, with Centric having the most effect. All of these compounds controlled aphids, but Assail and Centric were the most effective. In small plots, three early-season applications of Trimax (beginning at square set) did not significantly increase yields compared to one application of Assail or Centric or an early-season untreated check.

With cotton bollworm, a new pyrethroid from Dow AgroSciences gave control and final yields similar to Karate/Warrior. A new insect growth regulator from Crompton-Uniroyal, did not provide the same numerical bollworm control as pyrethroids; however, final lint yields were not different from one another.

Extensive studies with piercing/sucking pests (three stink bug species, lygus bug, and red plant bug) indicated applications applied based on current boll-damage thresholds increased lint yields in each of three studies conducted. In additional studies, plots treated weekly beginning soon after boll initiation (5-6 applications of Bidrin) provided the top lint yields; this was compared to 2 applications determined by boll damage thresholds and an untreated check. These studies indicate further research is needed to determine 1) damage potential of the three bugs listed above, and possibly other species, and 2) possible revision of the current damage thresholds.

In a thrips control study we compared the benefits of controlling thrips with seed treatments and foliar sprays with a Temik treatment at planting in both early and late planted cotton. Seed treatments with Gaucho and Cruiser and foliar Orthene sprays were less effective in controlling thrips than 5 lb Temik 15 G at planting, in early planted cotton (8 May). In late planted cotton (30 May), thrips control with seed treatments were as good as the Temik treatment. None of the thrips controls produced significantly higher yields than the untreated when applied to either early or late planted cotton. (**Edisto Research and Education Center, Blackville, and Pee Dee Research and Education Center, Florence, SC**)

Tennessee

A granular experimental insecticide from Bayer (KC791230) was evaluated for thrips control on seedling cotton. Thrips control was only slightly better than that observed in the Temik plots and did not differ from the Cruiser plot. The plants had significantly less thrips feeding injury than other treatments. There were no significant differences in yield in treated and untreated plots. Gaucho Grande was compared to the standard Gaucho treatment and some experimental combination seed treatments. Gaucho Grande did perform slightly better than the other treatments, providing improved control to 27 DAP. Yields did not differ among treatments. An experimental nematicide was evaluated as a seed treatment combination with Cruiser. There was no negative effect concerning thrips control. There were no nematodes present in this test location. Yield was not affected by the combination treatment. Tank mixes of systemic insecticides and glyphosate were evaluated for efficacy and interaction. Thrips counts and yield data are being analyzed. Twelve treatments were evaluated for control of plant bugs. Two applications were made 15 June and 21 June and two on 27 July and 4 August. Significant differences were noted among treatments on 3 August with the best control obtained with Bidrin, Centric and Orthene. Lint yield at first harvest was highest with Bidrin and Centric, but these were not different from eight other treatments. Tarnished and clouded plant bugs and green stink bugs were caged on squares and bolls of known ages for 3.5 and 7 days. The effects of these infestations on fruit set, boll and lint damage are presently being measured in the laboratory. A single bollworm spray to conventional cotton reduced boll damage. Boll damage in Bollgard and Bollgard II cottons was not reduced with sprays. Yields did not differ among the three varieties, sprayed or not. **(University of Tennessee, Department of Entomology & Plant Pathology, West Tennessee Experiment Station, Jackson, TN)**

Texas

The Southeastern Boll Weevil Eradication Program has recently emphasized the importance of reducing maintenance program costs within eradication zones. One suggested cost-reduction measure is the use of an extended-life "superlure" in the pheromone traps. However, no field study has adequately evaluated superlure effectiveness relative to a standard lure. We compared captures of boll weevils (*Anthonomus grandis* Boheman) in traps baited with a standard lure (10 mg grandlure) to those of traps baited with the superlure (30 mg eugenol plus 25 mg grandlure) in a study near San Benito, TX. Four treatments (standard and superlure, replaced bi-weekly or not replaced) were included in three month-long experiments conducted during distinct seasonal periods (February-March, June-July, and October-November) of 2004. Meaningful differences among the lure treatments were observed only in the final week of the first trapping period, when weevil captures (mean ± SE) were highest for the superlure replaced after 2 wks (45.0 ± 4.33 weevils/trap), intermediate for the superlure not replaced (29.0 ± 4.19) and the standard lure replaced after 2 wks (27.7 ± 4.08), and lowest for the standard lure not replaced (11.7 ± 4.48 weevils/trap). Captures during other trapping periods may have been too low to detect differences among lure treatments, but numerical trends were similar to those observed during the first period. Our preliminary results do not suggest trapping effectiveness of the superlure replaced monthly would be different from that of the standard lure replaced bi-weekly.

Population detection by pheromone traps is the core monitoring technology used by active boll weevil eradication and post-eradication maintenance programs. Additional insights into the dynamics of boll weevil chemical communication and its implications for trapping systems may be used to improve the efficiency of trap-based monitoring systems. Studies that examined the effects of diet substitution on pheromone production indicated that weevils stimulated to produce pheromone on a diet of cotton squares continued or increased pheromone production when small (12-15 mm diameter) or medium (20-23 mm diameter) bolls were substituted for the squares. Additional studies indicated that weevils that previously ceased pheromone production in response to starvation resumed pheromone production rapidly (2-3 days) when access to squares was reestablished. These observations may be useful in understanding the role of the pheromone in late-season mate and host finding. Ongoing studies of the influence of pheromone trap surroundings on captures of boll weevils indicated trap captures were reduced (about 50%) when traps were separated from prominent brush lines by as little as 10 m. Extensive evaluations of kill strips in boll weevil traps did not indicate benefits of the kill strip in terms of either increased trap captures or decreased trap handling time. These studies currently continue and may provide improved guidelines for trap monitoring systems in eradication maintenance programs.

Predation of boll weevils (Coleoptera: Curculionidae) by jumping spiders (Aranea: Salticidae) inhabiting grandlure baited pheromone traps was confirmed by using three genomic DNA based microsatellites developed in previous research. The jumping spiders interfere with the trap capture of boll weevils which are used to determine when eradication treatments are applied. The technique worked well and can be used for many other predation studies of the boll weevil.

Cotton stalk destruction is a prime tool in management of several species of cotton pests in the Lower Rio Grande Valley of Texas, particularly the boll weevil. Mechanical methods of stalk destruction are generally successful, but some stalks may survive these operations. Moreover, adverse weather conditions and conservation tillage often impede immediate and complete stalk destruction using typical tool implements. These studies provide an examination of different herbicides (thidiazuron [Harmony Extra]; dicamba diglycolamine salt [Clarity]; 2,4-D Amine [Savage]; flumioxazin [Valor]; and Aim), rates, spray volumes, and application timings on shredded or standing cotton stalks after stripper or picker harvest. The herbicide 2,4-D Amine applied twice at one pound of formulated product per acre in 10.0 gallons of water per acre on shredded or standing cotton stalks at 0 and 14 (or 21) days after cotton was harvested, was 100% effective in killing stalks. These findings will aid in the identification of opportunities for improved effectiveness and economics of control of overwintered boll weevils, and the successful expansion of the boll weevil eradication program into subtropical and tropical environments.

Research was conducted to determine the effects of weevil body weight on feeding and reproductive activity. Heavier male and female weevils produced more punctures than did lighter weevils. Female weevils that weighed more than 10 mg lived longer, laid more eggs, and produced more offspring than lighter females. Even the smallest weevils produced offspring. Because light body weight reduces weevil reproduction and survival, crop management that promotes production of small adults weevils may be used to limit weevil population growth. Better knowledge of the biological relationships between boll weevils and cotton plants will lead to the development of environmentally-safe and efficient pest management strategies.

Effects of temperatures on development, viability, and fecundity of boll weevil were assessed at 10, 15, 20, 25, 30, 35, 45ºC, 65% humidity, and a photoperiod 13:11 (L:D) h. The mortality of boll weevil immature stages was 100% at 12ºC and decreased as the temperature increased to 25ºC (to 36.4%), then at 30-45ºC increased from 50.1 to 100%. Between 15ºC and 35ºC, the boll weevil preimaginal development rate was linearly related to temperature. The average development time decreased 3.6-fold and the preovipositional period by 3.3-fold when the temperature was increased from 15ºC to 30ºC. The lower threshold for developmental was estimated at 10.9, 6.6, 7.0, and 9.0ºC for eggs, larval, pupal, and total immature stages, respectively, with total thermal time requirement to complete immature stages of 283.2 DD (15ºC) and 309.4 DD (35ºC). At 11ºC and 46ºC weevil females did not oviposit. Longevity of adult females decreased 4.6-fold with increasing temperatures from 15ºC to 35ºC. Fecundity increased with increasing temperatures up to 30ºC and significantly decreased thereafter. These findings will be useful in creating a temperature-based degree-day model for predicting the occurrence of key life stages in the field. An accurate predictor of pest development can be very important in determining sampling protocols, timing insecticide applications, or implementing an IPM control strategy targeting susceptible life stages.

A laboratory spray chamber was used to determine effects of the insecticides dimethoate, fenpropathrin, lambda-cyhalothrin, azinphosmethyl, and the defoliant tribufos, and combination thereof in direct and indirect treatments on boll weevil. In addition, we tested the effects of the biological insecticide Novodor (*Bacillus thuringiensis* subsp. *tenebrionis*) applied to cotton buds on feeding, egg laying, infestation, and mortality of boll weevil. While Novodor has specific action toward coleopteran pests, such as the Colorado potato beetle, we found no significant effect of Novodor on control of the boll weevil. Dimethoate, at a reduced field rate, and azinphosmethyl, at a typical field rate, caused 100% mortality to the boll weevil. Lambda-cyhalothrin and fenpropathrin were slightly less effective. Dimethoate plus fenpropathrin, both at greatly reduced field rates, caused 100% mortality to the boll weevil and acted synergistically. Tribufos alone had little effect on the boll weevil, but tribufos plus dimethoate also acted synergistically to cause 100% mortality of boll weevils in direct sprays. The data show that fenpropathrin plus dimethoate, and tribufos plus dimethoate could be effective treatments for the boll weevil and could be used at reduced rates and therefore reduced cost.

Current methods for estimating cotton fleahopper, *Pseudatomoscelis seriatus*, infestations in cotton are generally viewed as too laborious and time-consuming for practical use, so treatment decisions are often based on factors other than fleahopper population size. Because the timing and intensity of fleahopper movement into cotton varies, corresponding insecticide applications are often mistimed. Development of a practical trapping system could improve cotton fleahopper management efforts by alerting producers of fleahopper movement into cotton. Earlier field studies to examine the potential of using sticky traps to monitor fleahopper movement into cotton were continued. Two colors (yellow, white) of sticky traps were positioned at different heights along the field border, and just above the plant canopy in the field interior. Although fleahopper population levels were unusually low, results were similar to those from previous years. Based on the numbers of fleahoppers captured, yellow sticky traps placed immediately above plants within the field offer the greatest potential for monitoring fleahopper movement into cotton, followed by yellow sticky traps placed at ground-level on the field margin. These results will be used to focus efforts to evaluate relationships between trap captures and field populations of fleahoppers.

Cotton fleahoppers continue to pose an early-season threat to young, fruiting cotton, and these infestations typically occur because of movement from early-season wild hosts. A second-year of data collection during the spring of 2004 confirmed the occurrence of cotton fleahoppers in *Rapistrum rugosum* (turnipweed). This wild mustard had not been previously identified as an early-season host in Central Texas. These results indicate turnipweed may be a critical host, in addition to other previously reported wild hosts, for developing cotton fleahopper populations.

A field study was conducted in the Brazos Valley, Texas, to determine patterns of fleahopper dispersal from fields with substantial growth of turnipweed and other known or suspected wild hosts. Fleahopper dispersal was monitored using sticky traps placed around the perimeter of three plots with significant growth of turnipweed. Despite low captures, traps captured significantly more fleahoppers on the southern side of plots. Differences between captures on the outside and inside of traps were significant only at one site, which indicated immigration to, rather than emigration from, the site. The findings will lead to more effective prediction and more timely management of fleahoppers in cotton.

Additional suppression/control technologies for lepidopteran insect pest that are compatible with existing approaches of integrated pest management on cotton are needed to decrease dependence on broad spectrum insecticides. An adult noctuid attracticide containing a feeding attractant and stimulant was formulated by a Cooperative Research and Development Agreement (CRADA) partner; mixed with thiodicarb (Larvin®) at labeled field rates; and evaluated in 3 producer cotton plots adjacent to corn with an emergent population of corn earworms *Helicoverpa (=Heliothis) zea (Boddie)* near Plainview on the Texas High Plains. One-row strips spaced 50 meters apart were applied to treated plots and numbers of moths killed, eggs per row-meter, and moths flushed were compared to those in adjacent untreated plots. The number of moths killed was much higher in the treated than untreated plots with only an occasional dead moth found in the untreated plots. More moths were killed in the treated strips closest to corn. The number of eggs collected per row-meter and moths flushed were not sufficient to differentiate between treated and untreated plots; however, cotton in the plots was approaching cutout. Additional evaluations are needed to determine if increased moth kill in treated areas leads to reduced egglay.

Droplet size and concentration of deposits on aerially-sprayed cotton plants and effect on insecticide efficacy are important because of efforts to reduce drift by application of larger sized droplets. Progress was made in the calibration of a spray table using different spray nozzles to apply deposits on cotton plants of varying droplet sizes and concentrations. When calibration of the spray table is complete, the effect of droplet size and concentration of the different insecticides used in cotton for control of different pests will be determined. Optimum spray deposits will be verified under field conditions for more efficacious aerial application of insecticides.

An economic evaluation was conducted on near isolines of cotton cultivars that did or did not contain Bollgard® technology for their usefulness in the defense of cotton bollworms H. zea, tobacco budworms Heliothis virescens (F.) and other insect pests at a northern and southern location of the Texas High Plains. The most intense insect pressure came from beet armyworms Spodoptera exigua (Hübner), an insect not targeted for Bollgard® control, in the southern location. Conventional insecticide applications saved an average 178 lb/a of lint cotton, but were not economically feasible because of the cost and number of the insecticide applications. The northern location did not result in any insect pest surpassing the economic threshold, especially those targeted for Bollgard® control. The benefits of preventing secondary pest outbreaks from cotton aphids and other pests did not present itself in the two years and for the two locations of this study.

A field project was conducted to quantify seasonal production of cotton insect pests in the Texas Winter Garden and the availability of insects as a food source for Mexican free-tailed bats. Seasonal surveys of major cotton insect pests (bollworms, tobacco budworms, fall armyworms *Spodoptera frugiperda* (F.), and beet armyworms) were conducted twice weekly in conventional and Bt-transgenic corn and cotton at 4 locations (Batesville, Castroville, Knippa, and Uvalde). Fields were scouted for insect eggs and larvae; emergence cages were inspected for moth emergence from corn fields; and pheromone traps were inspected for moths. Frequent, heavy precipitation throughout the first half of 2005 had a significant impact on crop production, insect population dynamics, and insect and bat flight activity. Bollworm and beet armyworm moths were the most prevalent of the 4 insect pests that were trapped. Tobacco budworm moths were trapped in late-July and late-August at Batesville, TX, but very few fall armyworm moths were captured at any location. Peak capture of bollworm moths occurred on approximately May 1, June 1, and July 1, which would have coincided with immigration and oviposition on whorl stage corn, oviposition on silking corn, and emergence from mature corn, respectively. Peak insect infestation occurred on approximately June 6 in corn and July 10 in cotton, and infestations were generally higher in conventional crops than in Bt-transgenic crops. From approximately 9:00 – 11:00 p.m. CDT during the 2-week period of peak moth emergence in late-June and early-July, there was a nightly average of 83.0 moths and 8.9 bats flying within a 1.86-m^2 viewing area about 3 m above the cotton canopy illuminated by infrared strobe light. Significant peak flight activity of moths and bats occurred on July 3-5 when a maximum of 373 moths and 23 bats were observed within a 2-h period.

There are presently no tactics for beet armyworm control on cotton other than conventional pesticides, and the beet armyworm is known to become a serious pest of cotton particularly after insecticides suppress natural enemies. This study demonstrated that several formulations of neem, a botanical extract containing azadirachtin and other possibly insecticidal components, are effective at deterring beet armyworm oviposition, reducing feeding by larvae, and causing mortality among eggs. Alternative tactics to conventional insecticides, such as neem-based products, can provide protection of cotton after conventional insecticide applications, and this might be particularly important once the boll weevil eradication program is underway in the Lower Rio Grande Valley of Texas.

An important aspect of determining insecticidal efficacy relative to droplet size and concentration is that field-collected or derived insect pests at the different stages are needed to provide more realistic evaluations. Considerable research was conducted to determine how these insects could be made available. Blacklight traps were found to be good sources of adult green stink bug, southern green stink bug, and brown stink bugs at various times during the growing season. Successive plantings of a combination of seed and forage millet were also found to provide good sources of adult and nymphal southern green stink bugs and leaffooted bugs. Techniques were also developed for rearing cotton fleahoppers collected as diapausing eggs in croton stems. Using the approaches mentioned allows for the planning of spray table evaluations with the different pest species during the growing season as well as the winter.

Feeding injury and abscission of 6th, 9th and 11th node, first-position cotton *Gossypium hirsutum* squares exposed to *Lygus hesperus* Knight and *L. elisus* Van Duzee for 24 h were investigated in field and laboratory studies in 2001 and 2002. Square abscission was not significantly different for *L. elisus* or *L. hesperus* in six separate field trials across the 2 yrs.; however, the control was significantly lower in abscission in two of the six trials. Final square abscission averaged across the 2 yrs was 82.5% for the control, 90.0% for *L. hesperus* and 86.3% for *L. elisus*. Square injury as measured by estimating the surface area affected by *Lygus* feeding was significantly higher for *L. elisus* compared with *L. hesperus* in three of the six of trials (6th node in 2002, 11th node for 2001 and 2002), indicating that in some cases, *L. elisus* damage is higher than *L. hesperus*. However, when seed-cotton yield was obtained from squares that did not abcise, there was no significant difference for the control or the two *Lygus* species. This result was similar to other published studies of infesting cotton with *L. lineolaris* (Palisot de Beauvois) where yield compensation negated any differences in yield when infested cotton was compared to the control. *Lygus elisus*, a little known and often misidentified plant bug pest of Texas High Plains cotton, should be considered as damaging as *L. hesperus*.

Plant bugs have become problematic in many areas of the Cotton Belt. Identification of plant bug species and associated native hosts is crucial for identifying plant species contributing to the development of plant bug populations in Central Texas. The tarnished plant bug, *L. lineolaris,* was the only lygus species identified in the Brazos River Bottom. Adults and nymphs of the tarnished plant bug were collected from 21 host plants, 10 of which were previously unreported hosts in the region, during this second year survey. In wild host sampling, tarnished plant bug adults and nymphs were most abundant on horseweed (*Conyza canadensis*) and turnipweed, respectively. Temporal occurrence of these two hosts indicates they may play a role in sustaining tarnished plant bug populations. **(Areawide Pest Management Research Unit, USDA, ARS, SPARC, College Station and Weslaco, TX)**

Statewide pyrethroids resistance monitoring of bollworms. A statewide monitoring program for resistance to pyrethroids in males of bollworm (*Helicoverpa zea*) was conducted from April to September of 2004, surveying nine Texas counties. Moths were trapped near cotton fields using pheromone, Hercon Luretape® with Zealure. Moths were collected early in the morning and assays were performed the same day. Vials were prepared in the Toxicology Laboratory, Department of Entomology at Texas A&M University, College Station, Texas, and shipped

as needed to Extension personnel. Vials were prepared using acetone only for controls, and cypermethrin (technical grade, 95.2% purity) at 0.3, 1, 3, 5, 10 and 30 µg/vial. Moths from Burleson, Nueces, and Uvalde Counties, which had survivors at the highest dose of 30 µg/vial in 2003, were tested at additional doses of 60 and 100 µg/vial in 2004. One moth was placed in each vial and bioassays were evaluated after 24 h. Moths were classified as alive, dead, or "knocked-down". From Burleson County 2,070 moths were tested. Other counties in Texas participating in the monitoring program were: Hale, Hockley and Gaines Counties in the High Plains production region; Tom Green County in the Southern Rolling Plains region; Ellis and Williamson Counties in the Blacklands region; Uvalde County in the Winter Garden region; and Nueces County in the Coastal Bend region. A total of 3,377 moths were tested for all areas outside Burleson County. Data from all areas in Texas was sent to Texas A&M University Toxicology laboratory and analyzed using Probit-PC, Probit and Logit Analysis and results were graphed using SigmaPlot. A baseline for susceptibility to cypermethrin in 2003 was established from two areas in Texas with low LC50 values, Hockley County and Wharton County, these values were pooled to obtain a baseline LC50 of 0.283 µg/vial. In addition to this, in 2004 the LC50 value of 0.44 µg/vial previously obtained by studies directed by Drs. L. Kanga and W. Plapp in Burleson County in 1988, 1989, and 1993 was used to calculate resistance ratios (*J. Econ. Entomol. 89: 583-589, 1996*). Levels of resistance in Nueces County were nine times the LC50 value calculated in June for susceptible field populations studied by Kanga et al. mentioned above. Moths in Ellis County in July were seven times more resistant. Uvalde County had resistance ratios of six in September, and in Burleson (September), Ellis (July), and Williamson (June/July) moths were five times more resistant. Bollworm populations from Hockley County were susceptible to pyrethroids in 2004, having similar susceptibility as populations tested by Kanga et al. (*J. Econ. Entomol. 89: 583-589, 1996*).
(Pietrantonio, Junek , TAMU, College Station, TX).

Development of a web-based climatic database. As part of a cotton site-specific management project, Yubin Yang, Ted Wilson, and Robert Lascano have been involved with developing a web-based climatic database for six cotton and rice states. The database is up and running for Texas and Arkansas, and currently contains temperature and rainfall records. By April 1, 2005, the database will be expanded to include Missouri, Louisiana, Mississippi, and California. By September 1, 2005, we expect to add daily estimates of solar radiation and relative humidity for all stations. We anticipate providing climatic data for approximately 2000 stations in near real-time when the database is fully functional in September 2005. The climatic data will serve as a foundation database for future crop, pest, fertilizer, and irrigation scheduling and management programs. To date, we have developed two web-based applications for rice (three if you include the climatic database) and are working on one for cotton/corn, which we hope to release in late

2005. The climatic database for Texas and Arkansas can be accessed through this address:
http://beaumont.tamu.edu/WeatherDatanew/WeatherData.aspx. **(Wilson, TAES, Beamont, TX).**

Leaf nitrogen-aphid abundance studies using a chlorophyll meter. Percent leaf nitrogen content has been shown to be significantly correlated with cotton aphid abundance. However, determination of percent leaf nitrogen using Kjeldahl analysis is time consuming, and information would rarely be available in a timely manner. Leaf chloropyll content is easily obtained with a hand-held meter and values are available immediately. Therefore, a study was designed to determine if there were significant correlations between leaf nitrogen content and chlorophyll readings. A Minolta Chlorophyll Meter SPAD-502 was used. The chlorophyll meter was used to determine chlorophyll content on 10 leaves located on the fifth mainstem node, and then ten, fifth mainstem node leaves were picked and oven dried and leaf nitrogen content was determined using Kjeldahl analysis. Additionally, chlorophyll content was determined on five leaves located on the top-half of the plant and from five leaves located on the bottom half of the plant. Chlorophyll content was the average value of these ten leaves. Leaf nitrogen content was also determined from five leaves picked from the top-half and from five leaves picked from the bottom halves of the plants (top and bottom leaves pooled together). Samples were taken at six weekly intervals, from July 22 to August 26, in plots that were grown dryland and in plots that were furrow irrigated throughout the season. Dryland plots were fertilized pre-plant with 0, 30, and 60 lb nitrogen per acre. Irrigated plots were fertilized pre-plant with 0, 60, and 120 lb nitrogen per acre. All treatments were replicated three times at the Texas Agricultural Experiment Station at Chillicothe. No significant correlations were found between chlorophyll readings and percentage leaf nitrogen in any of the treatment combinations (dryland fertility treatments, irrigated fertility treatments, fifth mainstem node leaves, and top plus bottom leaves). Nearly all correlations were negative, indicating that high leaf nitrogen content tended to be associated with low chlorophyll values. These results indicate that the chloropyll meter readings will not provide useful indications of percentage leaf nitrogen. **(Slosser, TAES, Vernon, TX)**

Cotton aphid population dynamics modeling. Year 3 of the 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. Leaf samples will be processed for nitrogen analyses during winter months. Cotton aphid populations were <1 aphid per leaf throughout August, but increased to 51 aphids per leaf on September 23, and the populations declined to 12 aphids per leaf on October 1. Overall, cotton aphids were highest at 150 lbs per acre treatment followed by 200, 100, 0, and 50 lbs per acre treatments, with only 150 and 50 lbs per acre treatments being significantly different. This test will be repeated in 2005, but we will also monitor the effect of nitrogen fertility on thrips and fleahoppers as well. Data are being summarized and will be incorporated into the model. **(Parajulee, TAES, Lubbock, TX).**

Quantifying natural enemy profile and developing a decision-rule system. Laboratory studies were conducted to quantify the predation efficiency of key cotton arthropod predators. The predation rates of *Hippodamia convergens* (adult and larva) and *Chrysoperla carnea* were quantified at fixed prey density (100 aphids/leaf) in the laboratory. *Hippodamia convergens* adult showed the highest rate of consumption (91 aphids/12 h) followed by *C. carnea* (75 aphids/12 h), *H. convergens* medium larva (56 aphids/12 h), and *H. convergens* small larva (13 aphids/12 h). Predation rates were also examined temporally for variable prey densities. Laboratory prey suppression trial and field cage study showed that *H. convergens* adult can suppress *Aphis gossypii* populations more efficiently at lower prey density and the suppression rate decreased when prey populations exceeded 100 aphids per leaf. In a field cage study, one *H. convergens* adult per plant released at the prey density of one aphid per leaf kept the aphid population below economic threshold for the entire growing season. Three *H. convergens* adults per plant released at 25 aphids per leaf or six adults per plant released at 50 aphids per leaf could not prevent aphid populations from exceeding the economic threshold. Field experiments showed strongly positive temporal and spatial distributions of *H. convergens* with that of *A. gossypii*, suggesting a significant potential of *H. convergens* for *A. gossypii* suppression in cotton. A two-year study is funded (2004-2006) to conduct field cage studies to develop a decision-rule system. **(Parajulee, TAES, Lubbock, TX).**

Lygus damage potential of cotton fruit. Experiments were conducted to quantify the age of the boll (degree-days from boll formation) that is safe from *Lygus hesperus* damage in 2003-2004. 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. **(Parajulee, TAES, Lubbock, TX).**

Investigating host source of Lygus bugs in the Texas High Plains. A survey for *Lygus* bugs was conducted in the Texas High Plains in 2004. Non-cotton hosts and cotton were surveyed using a standard sweep net (100-150 sweeps/habitat/site) in three counties representing the northern (Hale), central (Lubbock), and southern (Dawson) areas of the region. Numerically dominant wild hosts found in roadside ditches and in and around cultivated fields were surveyed throughout the study period. Sampling was conducted on a weekly basis beginning in early February for wild hosts and in early July for cotton. Sampling is still ongoing. As of late August, totals of 64,834 and 8,500 sweeps were taken in non-cotton hosts and cotton, respectively. *Lygus* were present on one or more non-cotton hosts on almost all sample dates, and in several cases survey means (by survey and location and across host) exceeded 100 *Lygus* per 100 sweeps. By host plant (across season and location), London rocket (early season) had the highest number of *Lygus* (137 per 100 sweeps), followed by flixweed, alfalfa, blue mustard, tumble mustard and yellow sweetclover, in that order. Due to its extended seasonal presence and observed *Lygus* activity, alfalfa was the most sampled non-cotton host, with 15,150 sweeps taken during the survey duration. In cotton, *Lygus* numbers were much lower, with a high of 5.3 *Lygus* per 100 sweeps in a Lubbock County field in mid- to late August. No *Lygus* were detected in Dawson County cotton. This comprehensive survey supports reports in the literature that *Lygus* are strongly polyphagous, based on the detection of *Lygus* throughout the season on available non-cotton hosts. The ability to utilize a succession of common non-cotton hosts allows *Lygus* to build large populations in wild hosts and invade cotton if conditions are favorable. In 2004, the species complex observed in non-cotton hosts consisted of 95.0, 4.4, and 0.6% *L. hesperus*, *L. elisus*, and *L. lineolaris*, respectively while in cotton the complex consisted of nearly all

L. hesperus with one specimen each of *L. elisus* and *L. lineolaris* from cotton samples. Host-plant sequencing of *Lygus* throughout the year is being established. **(Parajulee, TAES, Lubbock, TX).**

Investigating cotton aphid abundance patterns as affected by precision application of nitrogen and irrigation water. This study was conducted at the AG-CARES farm in Lamesa (Dawson County) to characterize the effect of irrigation level and nitrogen application on leaf moisture and leaf nitrogen content in cotton and the resulting influence on cotton aphid population dynamics. The treatments consisted of three irrigation levels and three nitrogen fertility levels within each irrigation level. Treatments were deployed in a randomized complete block design with nine replications, with a total of 81 experimental units (or grid points) for the entire test. Each grid point was approximately 0.4 acre. Three nitrogen fertility treatments included blanket-rate-N, variable-rate-N, and no nitrogen augmentation. The three water levels (high, medium, and low) were targeted at 85, 75, and 65% ET replacement. Cotton aphid abundance, percentage leaf moisture, and percentage leaf nitrogen were measured per week from each plot during the entire growing season. Higher rate of irrigation resulted in significantly higher leaf water content, but the leaf water content did not vary among nitrogen treatments. Leaf nitrogen content did not vary with nitrogen application method (variable-N versus blanket-N), but both the blanket application and variable rate application resulted in significantly higher leaf nitrogen content than in plots without nitrogen augmentation. Leaf nitrogen content correlated positively with the rate of irrigation water, indicating the increased nitrogen uptake by plants at higher rates of irrigation. Spatial and temporal distribution of cotton aphids in relation to variable water and nitrogen are being analyzed. **(Parajulee, TAES, Lubbock, TX).**

Seasonal abundance patterns of bollworm, tobacco budworm, and beet armyworm moths in the Texas High Plains. Pheromone trapping of three major moth species was conducted in Hale, Lubbock, and Dawson counties throughout the 2004 growing season. Three traps per species per county were deployed and traps were serviced weekly. Average seasonal bollworm moth captures (early July to mid-September) in Hale, Lubbock, and Dawson counties were 32, 47, and 40 moths per trap per day, respectively. Tobacco budworm moth captures were 1 moth each per trap per day while beet armyworm moth captures were 14, 12, and 14 moths per trap per day in Hale, Lubbock, and Dawson counties, respectively. **(Parajulee, TAES, Lubbock, TX).**

Evaluating the merits of sub-threshold effects of the Bollgard technology on the economics of bollworm management. This project was designed to measure the damage potential of sub-threshold infestations of bollworms (less than 10,000 larvae per acre) on a Roundup Ready cotton cultivar grown in an irrigated production system. A comparison was made with a stacked gene Roundup Ready-Bollgard cultivar and with a stacked gene Roundup Ready-Bollgard II cultivar from the same recurrent parent line. The study was conducted in Lubbock and Halfway. In Lubbock, one bollworm activity period was recorded which started on July 7 and peaked on July 27. Numbers reached about 12,000 per acre in the heaviest infested plots. We did initiate the insecticide sub-treatment overlays of the variety plots. In Halfway, a bollworm infestation finally developed in early September that permitted us to apply the insecticide sub-treatment overlays to the variety plots. Infestations reached about 18,000 per acre in the heaviest infested plots. Even at such a low bollworm activity, bollworm larval abundance was highest in Roundup Ready cotton plots followed by Bollgard and the Bollgard II plots had the lowest larval activity. The percentage fruit damage by bollworms was lowest on Bollgard II plots followed by Bollgard and the highest fruit damage was found in Roundup-Ready plots. The degree of fruit damage was also measured to separate the superficial versus the damage that would impact the yield. **(Leser, Parajulee, TCE, TAES, Lubbock, TX).**

Early season square loss compensation studies. Validation of the compensation value used in the COTMAN model continued into the 4th year. Manual removal of squares was replaced with field cage studies using cotton fleahoppers and later western tarnished plant bugs. The goal of these studies is to validate the manual removal results and eventually develop a research-based threshold for these two bugs for the Texas High Plains and hopefully more of the Texas cotton producing areas. **(Leser, Parajulee, TCE, TAES, Lubbock, TX).**

Pink bollworm overwintering studies. We initiated overwintering studies for pink bollworms in the High Plains, an emerging pest. One study was designed to determine how many larvae cut out of bolls to overwinter as free cocoons in the soil. Over 300 infested bolls were evaluated with slightly more than 80% of the pink bollworms staying in the bolls. Additionally, emergence cage studies were initiated to determine overwintering mortality and spring emergence profiles of pink bollworms in each of five treatments:1) bolls on soil surface, 2) bolls buried 2 inches deep in November, 3) bolls buried over 6 inches deep in November, 4) bolls on surface till February and then buried 2 inches deep, 5) bolls on surface until February and then buried over 6 inches deep. **(Leser, Parajulee, TCE, TAES, Lubbock, TX).**

Temik soil microbial biodegradation studies. A two-year study was initiated this fall to determine if soil microbial biodegradation was a factor in declining efficacy of Temik for both western flower thrips and root knot nematode control. Greenhouse experiments have been initiated planting cotton into containers with soil obtained from cotton fields that have either never had Temik applied or that consistently had Temik applied for a number of years. The soil was either used untreated or after soil microbes had been eliminated through autoclaving. We then replicated several rates of Temik and infested seedlings with adult thrips. We are measuring reproduction and residual activity. This coming summer we will initiate the field component of the study, evaluating various cropping systems as a means to minimize this suspected problem. **(Wheeler, Leser, TAES, TCE, Lubbock, TX).**

Boll weevil trap evaluations. Precision Plastics is replacing their metal screen trap top with a plastic one. Plato Industries has produced a new plastic top trap. The director of field operations and the chair of the Texas Boll Weevil Eradication Foundation Technical Advisory Committee evaluated these new designs as suitable replacements for the standard metal screen top Precision Plastics trap in 10 replicated trials in 5 geographical locations. A simple ANOVA demonstrated that the Precision Plastics wire screen top trap was slightly more effective in capturing boll weevils than their plastic top trap replacement but these differences were not significant. The Plato plastic top trap captured significantly fewer weevils than the Precision Plastics plastic top trap in 5 of the 10 tests and was numerically better in 9 of 10 tests. **(Allen, Leser, TBWEF, TCE, Abilene, Lubbock, TX).**

Insecticide screening studies. Bayer's KC791230 15G was compared to Temik 15G for efficacy against western flower thrips. Syngenta's Cruiser seed treatment for thrips control and their A14006 seed treatment for nematode control were evaluated for both pests as single treatments and as a combination to evaluate interaction effects. **(Leser, Vandiver, Nino, TCE, Lubbock, Farwell, Dimmitt, TX).**

COTMAN irrigated compensation and termination studies. Through previous trials, we have documented the ability of LEPA irrigated Paymaster 2326 to compensate for pre-bloom square loss. The objective of this study is to determine if an open boll cotton variety of can compensate for pre-bloom square loss in a high yielding, intensively managed environment. The experimental was a randomized block design with four replications. First position squares were removed on the first nine fruiting nodes creating the following treatments: 1)100 percent removal of first position squares on the first nine fruiting nodes, 2) 50 percent removal of first position squares on the first nine fruiting nodes and 3) zero percent removal. Another study was initiated to determine the optimum time to discontinue subsurface irrigation by utilizing the number of heat units accumulated after cutout (nodes above first position white flower is equal to five). The experimental design was a randomized block design with four replications. The treatments consisted of constricting the drip tape at 450, 650, and 850 heat units after cutout. **(Baugh, TCE, Lubbock, TX).**

Evaluation of Bollgard technology. Comparisons were made between Round-up Ready, Bollgard and Bollgard II cotton in Fibermax 800 and 991 variety series. The 800 series plots were in an area that had little lepidopteran activity this season and seed cotton yields were equal among all varieties.
The 991 series plots had heavier bollworm activity in July & August requiring treatments in the Round-up plots with Tracer at 2.5 oz per acre in July and Asana XL at 9 oz per acre in August. Neither the Bollgard nor Bollgard II plots required treatment. Yields again were equal in all plots. **(Multer, TCE, Stanton, TX).**

Studies of arthropod populations in conventional and reduced tillage fields. These studies indicate that reduced tillage fields should not experience significant insect problems and that reduced tillage fields may actually be more favorable for retaining predators (ground beetles and spiders). **(Sansone, Minzenmayer, TCE, San Angelo, TX).**

Host plant resistance studies. The goal of this project is to identify cotton germplasm with resistance to cotton fleahopper and develop cotton genotypes with high levels of resistance to this pest. During 2004, 116 converted race stocks were evaluated for resistance to cotton fleahopper using choice and no-choice tests. These race stocks are expected to have a wide variety of genetic material not previously available to cotton breeders and may represent previously unknown sources of resistance to insect pests. Studies are also underway to determine the damage potential of adult and immature fleahoppers and males and females. These evaluations were conducted in cooperation with Dr. Wayne Smith, Texas A&M Cotton Improvement Laboratory, and are a part of a larger project on introgressing new germplasm into cotton breeding lines. Field studies were also conducted to determine species composition and damage potential of stinkbugs in cotton in the Upper Gulf Coastal region of Texas. These studies were conducted by Mr. Bradley Hopkins, MS candidate in the Entomology Department and Dr. Julio Bernal, Entomology Department, Texas A&M. **(Knutson, TCE/TAES, Dallas, TX).**

Insecticide screening studies. Significant field studies included (1) comparison of Temik to Bayer KC791230 15G at 5.8 and 4.0 oz/acre on thrips, aphids, and fleahoppers, (2) testing of the seed treatments Cruiser, Gaucho, and Orthene all at standard rates on thrips and aphids, (3) evaluation of Intruder 70WP [0.41, 0.59, and 0.90 oz/acre, Centric 40WG [2.0 oz/acre], and Diamond 0.83EC [6.0 and 9.0 oz/acre] on fleahopper and aphid, and (4) evaluation of VipCot and Widestrike cotton varieties on Heliothines. Both Bt cottons reduced significantly bollworm damage on cotton. Generally, other tests did not have high levels of the target pest insects. Diamond, Centric, and Intruder did reduce fleahopper numbers. Diamond did not affect aphid numbers, but even the low rate of Intruder significantly reduced cotton aphids. **(Parker, TCE, Corpus Christi, TX).**

Insecticide screening trials. Conducted insecticide evaluations against cotton fleahoppers and western tarnished plant bugs. Insecticides evaluated included: Intruder, Orthene, Diamond, Centric and Trimax. Insect numbers were generally too low to achieve statistical separation of treatment. Intruder was a poor choice for WTPB though. **(Muegge, Downing, Elrod, TCE, Fort Stockton, El Paso, TX).**

Continued a Texas Department of Agriculture supported project in the El Paso Valley on sticky cotton management due to whitefly and aphid feeding late in the season on pima cotton. This project was in cooperation with Eric Hequit of the Texas Tech University International Textile Center. For the second year in a row, a late season rain event eliminated honeydew deposits and terminated the study. **(Downing, Leser, TCE, El Paso, Lubbock, TX).**

Virginia

Thrips – Thrips pressure was considered moderate-to-high with substantial seedling injury, stunting and plant death occurring in untreated cotton. Most growers managed the problem well with insecticide in-furrow or seed treatments and seedling broadcast applications. Adults were collected weekly from May 19 to June 1 from both cotton and peanut trials and a representative sample (758 total) were identified to species. Tobacco thrips comprised 96% of the total population. We completed 9 field trials evaluating 60 different treatment options. Trails were evaluated weekly for 4 weeks beginning May 18 when first true leaves began to emerge by visually rating seedling injury using a 0-5 visual injury scale, where 0 = no injury and 5 = dead plants. Thrips were counted in selected trials by removing 10 seedlings per plot and floating adults and immatures using mildly soapy water. Results showed that untreated plots reached an average of about 3.8 on the seedling injury rating scale. Treatment ratings averaged over the 4-wk period ranged from 0.31 to 0.38 for the most effective treatments to 2.66 to 3.5 for the least effective. Yields are not available, yet.

Plant bug/stink bug – Eighteen growers' fields in 3 counties were surveyed weekly from pin head square to when growers made bollworm applications. Monitoring included square retention determinations for a 3-week period, a single dirty bloom count, a single boll damage rating of 10 to 14-day old bolls, and weekly insect sampling using both the beat sheet and sweep net methods. Plant bugs were present in fewer fields compared with the previous year, but more exceeded the 8/100 sweep suggested threshold. Stink bug numbers were much higher compared with previous years with 100% of the fields infested and almost 90% reaching the 1/6 row ft. suggested threshold. Square retention never dropped below 80% and ranged from 81-100% (avg. 98% in wk 1; 95% in wk 2; and 94% in wk 3). All fields had at least some damage to bolls with a range from 4-50%. The average over all fields was 22%. Almost 80% reached or exceeded the current suggested treatment threshold of 15%.

Five fields did drop below the suggested 80% square retention threshold and were selected for further study. In each, growers applied replicated strip trails (treated vs. untreated) using Bidrin (the rate varied according to the growers' program). Treatments were applied after the discovery of the square retention problem, but prior to the normal time for applying bollworm treatments. Both pre and post treatment 10 to 14-day old boll damage ratings were made in each treatment. Yields were determined using a weigh-dump boll buggy. Lint quality was determined based on sub-samples (USDA Lab, Florence, SC). Results (to date, 3 of the 5 tests have been harvested) showed that all treated strips had higher yields compared with untreated strips and the difference was significant in two field trials [(trial 1 – Δ = 138 lb; $P<0.01$), (trail 2 – Δ = 46 lb; $P<0.055$)].

Bollworm/budworm – The ratio of the bollworm/budworm complex was monitored using the Agdia *Hel*-ID system. Fifty-two separate 22-egg samples (1144 total) were collected from growers' fields from 12 cotton growing counties from July 22 to September 8. Over all samples, *H. zea* comprised 90% of the population. *H. virescens* peaked around July 23 at 36% and again on August 24 at 40%.

H. zea resistance to pyrethroids was monitored using the standard cypermethrin vial system. Adults were captured in pheromone baited traps located in 5 counties. A total of 2,498 adults were tested over the period from June 18 to September 10. Survival was considered low compared with previous years with 1.9%, 0.4% and 97% surviving the 5ug, 10ug and control treatments, respectively. A total of 467 larvae were collected from field corn in 20 counties, reared to the adult stage in the lab on artificial food media, and tested. 5.6%, 2.5% and 94% survived the 5ug, 10ug and control treatments, respectively.

Four trials were conducted to evaluate 31 different foliar or plant-delivered insecticides for management of bollworm/budworm. Boll damage was assessed weekly for 3 weeks after applications. Percent boll damage in the untreated controls ranged from 36-55%. All treatments had significantly fewer damaged bolls ($P<0.01$) compared with the untreated controls. (**Virginia Tech, Tidewater AREC, Suffolk, VA**)

Additions to Insecticides/Miticides Registered for Cotton Pest Control:

New products registered for use against cotton pests are listed in Table 1 by the reporting state.

Changes in State Recommendations for Arthropod Pest Control in Cotton:

Additions and deletions of recommended pesticides by state extension organizations for the 2004 crop year are listed in Table 2. Included also are changes in thresholds or indications for certain pests.

Insecticides/Miticides Screened in Field Tests:

Pesticides (experimental materials or pesticides not labeled/recommended for use yet on certain pests) tested by state and federal researchers during the 2004 crop year for control of arthropod pests of cotton are listed in Table 3 by the reporting state.

Table 1. New products registered for use against cotton arthropod pests in 2004.

State	Pesticide	Target Pest
Alabama		
Arkansas	Abba (abamectin) Prolex (gamma-cyhalothrin) Discipline (bifenthrin) Widestrike cotton	
California	Fenpyroximate (Fujimite™, Nichino America Inc.) 1-2 pt/acre	
Georgia	Diamond Discipline Prolex	
Louisiana	Diamond 0.83EC Prolex 1.25SC Widestrike gene	
North Carolina	Widestrike cotton	Various caterpillar species
South Carolina		
Tennessee	Discipline 2EC	Bollworms, stink bugs, etc. (identical to Capture)

	Prolex 1.25 EC	Bollworms, cutworms (identical to Karate)
	Diamond 0.83EC	Plant bugs, stink bug suppression
Texas	Lock-On [Texas 24©]	Pink Bollworm
Virginia	Prolex	
	Proaxis	

Table 2. Changes in state recommendations for treatment for arthropod pests of cotton for 2004.

State	Pesticide	Target Pest
Arkansas		
Additions	Widestrike	Bt cotton recommendations
	Gaucho Grande	Thrips
	Discipline	Bollworm, cutworm, stink bugs, spider mite, whitefly
	Prolex	Bollworm, cutworm
	Vydate	Stink bug
	Acephate	Stink bug
Deletions	Fury 1.5E	All recommendations
Georgia	Diamond	Beet Armyworm, Fall Armyworm, Plant Bugs,
Additions		Loopers, Stink Bugs
	Prolex	Bollworm/Budworm, Cutworm, Stink Bugs
	Discipline	Bollworm/Budworm, Cutworm, Stink Bugs
	Comite II	Spider Mites
	Comite	Spider mites
Deletions		
Louisiana		
Additions	Diamond 0.83EC	Tarnished Plant Bugs
	Prolex 1.25SC	All pests that Karate 2.08SC is currently recommended to control, with the exception of brown stinkbug
	Widestrike	Insects similar to Bollgard and Bollgard II
Missouri		
Additions	Prolex 1.5CS	bollworm, cutworms, European corn borer, green stink bugs
	WideStrike	bollworm, European corn borer, fall armyworm, loopers, tobacco budworm
	Zephyr 0.15E	spider mites
N. Carolina		
Additions	Widestrike cotton	Various caterpillar species
	Discipline 2E @ 3.2 to 6.4 oz./acre	Bollworms/budworms, spider mites
	Prolex 1.25 E @ 1.3 to 2.05 oz./acre	Bollworms and Budworms
	Vydate 3.77 SL @ 11.2 to 17.0 oz./acre	Stink Bugs
	Denim @ 6.0 to 12.0 oz./acre	Soybean and Cabbage Loopers
Tennessee		
Additions	bifenthrin 2EC	Stink bugs
	Vydate C-LV 3.77	Stink bugs
	Denim 0.16EC	Spider mites (suppression)
Texas		

Additions	Proaxis	Bollworm
Virginia		
Additions	Mustang Max	1.28 – 1.92 oz/acre for control of thrips
	Proaxis	1.92 – 2.56 oz/acre for control of thrips
		3.2 – 5.12 oz/acre for control of bollworm/budworm
		3.2 – 5.12 oz/acre for control of ECB
		1.92 – 2.56 oz/acre for control of cutworm
		2.56 – 3.84 oz/acre for control of plant bug
	Prolex	0.77- 1.02 oz/acre for control of thrips
		1.28 – 2.05 oz/acre for control of bollworm/budworm
		1.28 – 2.05 oz/acre for control of ECB
		0.77- 1.02 oz/acre for control of cutworm
		1.02 – 1.54 oz/acre for control of plant bug
	Karate Z	1.28 – 1.92 oz/acre for control of plant bug
	Warrior T	2.56 – 3.84 oz/acre for control of plant bug
	Baythroid 2	1.6 – 2.6 oz/acre for control of plant bug
	Mustang Max	2.64 – 3.6 oz/acre for control of plant bug
	Asana XL	5.8 – 9.6 oz/acre for control of plant bug
	Zeal	0.66 – 1.0 oz/acre for control of spider mites
Rate Changes	Orthene 97	from 12.0 oz/acre for stink bug control, to 8.0 – 12.0 oz/acre

Table 3. Promising pesticides screened in 2004 for control of cotton arthropod pests.

State/Pesticide (lb AI/A)	Target Pest(s)
Arkansas	
KC7911230 0.5, 0.6, 0.75	Thrips
L0112 12.8 oz/cwt seed	Thrips
L0112 + L0263 9 oz + 3.84 oz/cwt	Thrips
KN-128 0.09, 0.104	Plant bugs
Diamond 0.039	Plant bugs
S1812 0.15	Heliothis
V-10132 6 oz/acre	Heliothis
Diamond 0.058, 0.078	Heliothis
Prolex 0.014	Heliothis
Widestrike	Heliothis
Widestrike	Armyworm
Louisianna	
Discipline 2EC	Southern green stink bug, Brown stink bug, Tarnished plant bug, Bollworm and Tobacco budworm
Vydate 3.77L	Southern green stink bug, Tarnished plant bug
Centric 25WG/40WG	Southern green stink bug, Brown stink bug
Trimax 4F	Southern green stink bug, Brown stink bug
Steward 1.25SC	Brown stink bug
Intruder 70WP	Tarnished plant bug
S-1812 35WP	Bollworm, Tobacco budworm
Flonicamid	Cotton aphid, Tarnished plant bug
BAS 320I	Southern green stink bug, Brown stink bug, Tarnished plant bug, Bollworm and Tobacco budworm
Diamond 0.83EC	Bollworm, Tobacco budworm, Tarnished plant bug, Southern green stink bug, Brown stink bug

Mustang Max 0.8EC	Thrips, cotton aphid
Zephyr 0.15EC	Brown stink bug, Tarnished plant bug
Prolex 1.25SC	Brown stink bug, Bollworm
Missouri	
Diamond 0.83E 0.039, 0.058	plant bugs / cotton fleahoppers
Discipline 2E 0.02, 0.03, 0.04, 0.05, 0.08	plant bugs / cotton fleahoppers
Prolex 1.25CS 0.015	plant bugs / cotton fleahoppers
WideStrike Bt-transgenic cotton	bollworm, European corn borer, fall armyworm, loopers, tobacco budworm
North Carolina	
F1785 50 DF @ 0.063 lb. ai/acre	Various caterpillar species
Tennessee	
Imidacloprid 12.8 oz/cwt	Thrips
Clothianidin 3.8 oz/cw	Thrips
KC791230(Bayer) 3.5-5.0 lb/A	Thrips
Texas	
Cruiser 5 FS (7.6 oz/cwt seed)	Thrips
A14006 FS (15 gm/100,000 seed)	Thrips
KC791230 15G (3.5-5.0 lbs/acre)	Thrips
F1785 50DF (0.063 lbs ai/acre)	Aphid
Intruder 70 WP (0.41-0.9 oz/acre	Aphid
KC791230 15G (4.0-5.8 oz/acre)	Aphid
Centric 40 WG (2.0 oz/acre)	Aphid
Diamond 0.83EC (6.0-9.0 oz/acre	Aphid
Intruder 70 WP (0.41-0.9 oz/acre)	Cotton Fleahopper
KC791230 15G (4.0-5.8 oz/acre)	Cotton Fleahopper
Centric 40 WG (2.0 oz/acre)	Cotton Fleahopper
Diamond 0.83EC ().026-0.058 lbs ai/acre)	Cotton Fleahopper
Diamond 0.83EC (0.039-0.58 lbs ai/acre)	Western Tarnished Plant Bug
Intruder 70 WP (0.05 lbs ai/acre)	Western Tarnished Plant Bug
Bollgard II	Bollworm/budworm
VipCot	Bollworm/budworm
Widestrike	Bollworm/budworm
Virginia	
L0112 – Gustafson	
L0263 – Gustafson	
0112 20SG – Valent	
S-1812 35WP – Valent	
V-10132 2.58EC – Valent	
Assail 70WP– Cerexagri	
A14006 – Syngenta	
A14483 A, B and C – Syngenta	
DPX-HGW86 – Dupont	
KC791230 15G– Bayer	
PHY 470WR – Dow AgroSciences	