54TH ANNUAL CONFERENCE REPORT ON COTTON INSECT RESEARCH AND CONTROL

D. D. Hardee
Research Leader
Southern Insect Management Research Unit, USDA, ARS
Stoneville, MS
E. Burris
Associate Professor, Northeast Research Station
Louisiana State University
St. Joseph, LA

Foreword

There were 13,097,500 acres of U.S. Cotton(Upland and Pima) harvested in 2000 with an average of 625 pounds of lint per acre (USDA - January, 2000 report). Arthropod pests of cotton reduced yield by 9.26% in 2000. Boll weevil was still a pest on 44% of U.S. acreage, and because of high populations in Texas became the most damaging pest at 2.86% loss. Beet armyworm ranked second causing 2.11% reduction in yields, and the bollworm/budworm complex was third with 1.43%. The bollworm was the predominant species to attack cotton in 2000. Making up 79% of the population. Early-season thrips (0.59%), *Lygus* (0.56%), stink bugs (0.52%), and aphids (0.44%) rounded out the top seven cotton insect pests for the year. Beltwide, direct insect management costs amounted to $62.30 per acre and losses were $55.02. Cost plus loss was estimated at $1.672 billion. **(see M.R. Williams, this proceedings).**

Crop and Arthropod Pest Conditions

Alabama

The 2000 cotton production season in Alabama was characterized by drought, high temperatures, overall low insect pressure, and average or below average yield. Very little input was required for insect control. Caterpillar species were very low over much of the state most of the season requiring few to no insecticide applications on most acres. The exceptions would be bollworm and budworms, primarily budworms, after August 1 in the Gulf Coast and lower coastal plains counties. Soybean loopers were heavy in sporadic fields in the central and southern areas in late August and September. No fall armyworms occurred season long at anything approaching treatable levels. Beet armyworms occurred on one farm in Chilton County where five malathion applications were made following boll weevil detection by traps.

The early season (seedling to bloom) was characterized by some of the heaviest thrips pressure ever recorded. This was during a drought period when plants were growing off very slow. Several other non-traditional insects also occurred during this period. These included grasshoppers, threecornered alfalfa hoppers, cutworms, whitefringed beetle larvae, vegetable weevils and false chinch bugs. Several thousand acres were treated in central Alabama for grasshoppers, primarily in reduced tillage fields.

Aphids added much stress to the already drought-stressed plants in June and July. Populations lingered longer than normal prior to crashing from the natural fungus in mid to late July. Tarnished plant bugs were very low, likely due to the drought effects on wild host plants. However, since many fields had no other insects at damaging levels except aphids, no insecticides were applied season long. In this low spray environment, fleahoppers built to high levels in several geographical areas. Controls would have been necessary if not for the drought conditions.

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Stink bugs were present in many fields from early square to maturity. However, populations did not continue building into late season; therefore only a limited acreage was ever treated. Leaffooted bugs were observed damaging bolls in late season in the Gulf Coast area.

Whiteflies built to high numbers late in the season, especially in the Gulf Coast and southeastern (Wiregrass) areas. Both the bandedwinged and the silver leaf species were involved. Several thousand acres needed controls, but none was applied due to the low yield potential of the cotton and the high cost of effective whitefly IGR insecticides.

The 2000 cotton production season was a challenging one. Only about 25% of the state's acreage came up to a good stand. Another 25% had a marginal stand, while up to 50% of the intended acreage was not planted or did not emerge in the central and southern areas of the state. Approximately 75,000 acres were destroyed for insurance purposes in southeastern Alabama.

Statewide yields will be in the 450 lb range with many farms in central Alabama harvesting 250-350 lb of lint per acre. Insecticide input was very low with the average field statewide receiving 1.2 foliar insecticide sprays in 2000. Approximately 65% of the acreage was planted to Bollgard varieties. However, due to the light worm year, growers do not feel that they recuperated their investment in technology fees.

Cooperative Extension activities for 2000 included the following: 14 multi-county winter cotton production meetings; 15 multi-county in-season field days; 4 regional cotton scouting shortcourses; toll free 800 line with insect updates; 12 newsletters (weekly during season); 5 meetings with consultants; 3 pesticide dealer meetings; pheromone trapping program – 5 species, 8 sites; aphid disease monitoring in cooperation with Arkansas; use of Hel ID tool and network to disperse information. (Central and South Alabama)

Overall, 2000 was one of the lightest cotton insect years in recent memory for North Alabama. A major shift toward various types of minimum tillage occurred in 2000; nevertheless, cutworm populations were normal. Thrips populations were extremely high, but the rapid development of cotton minimized damage. June problems with tarnished plant bugs were slightly less than average, and July populations were well below what they had been over the past few seasons. Twospotted spider mites appeared in scattered fields in June and, by August, infestations were widespread. Cotton aphids caused above average damage in late June and early July. Aphid infestations were notably more common and higher in conservation tillage fields, presumably due to their symbiotic relationship with the fire ant. Caterpillar problems were virtually nonexistent throughout the entire season. Again, a very high percentage of Bollgard cotton was utilized in 2000. Yields will average somewhat less than 600 pounds of lint per acre.

Arizona

Arizona planted 284,000 A of cotton in 2000 (incl. 9,000 A of American Pima). Transgenic varieties dominated the marketplace with over 80% of all acres. Those varieties containing Bt transgenes comprised around 60% of the total acreage. Varieties stacked with both RR and Bt transgenes were planted on about 40% of the state's cotton acreage.

The 2000 season was one of the best in recent years in terms of planting, stand establishment, early crop growth, and in-season development. After an early, but false, start to our unusual monsoon season, the typically disruptive rains and associated moisture were not nearly as limiting to good fruit set as in prior years. Some locally heavy thunderstorms did result in lodging of plants in some limited incidences. Weather, in general, remained quite favorable initially into the fall with record heat in September. However, beginning in October, a typically dry month, most of Arizona experienced unseasonably cool and wet weather conditions. An early frost was also experienced in most locations. Depending on elevation and production goals, some growers were caught with most of their crop left to pick through this period. These conditions complicated defoliation and picking with some areas experiencing yield losses due to these rains and quality losses throughout this period. Yields, in general and in spite of these adverse late conditions, were excellent throughout the state. High micronaire values continue to be a significant challenge with many varieties for some growers and areas.

Insect pressure in 2000 has continued what has been an historic trend for Arizona. The 1999 season represented a 21-year low (as far as organized records go) in foliar insecticide usage and cost. Growers in that year sprayed on average just under 2 times for all arthropod pests, down from an all time high in 1995 of over 12 sprays. The 2000 year will likely track very closely to 1999 in terms of number of sprays.

Arizona's principal pests are pink bollworm, Bemisia whiteflies, and Lygus bugs (mainly *Lygus hesperus*). Whitefly incidence was somewhat earlier to "on-time" in many locations with threshold level infestations during July. However, producer confidence in the IGR (insect growth regulator) tools is high. Thus, sprays are made only when absolutely necessary. In many cases, populations abated on their own either through good biological activity (i.e., predation) or through timely weather events (e.g., dust, wind or rain storms). Most growers averaged less than 1 spray for this pest.

Lygus bugs constitute a larger proportional threat to growers than in year's past when the other primary pests were in abundance. Lygus this year, however, were generally low throughout the state with only very localized incidence of chronic invasions. The preceding dry winter, and locally, the more timely production and management of alternate hosts (i.e., alfalfa) both helped to limit the abundance of Lygus in Arizona. Typically, growers sprayed about once on average for this pest.

Pink bollworms continue to be less problematic with so much Bt cotton planted in the general landscape. With cotton as its sole host, many are observing generalized areawide suppression of this pest even on susceptible acreages (i.e., non-Bt cotton). Few in-season sprays were made against this pest statewide. In spite of this favorable trend, PBWs continue to build to detectable and sometimes treatable levels beginning in September. For those non-Bt acreages that were carried into late September and October production, some loss to this pest was experienced. Including Bt acreage, however, PBW sprays are reduced to, on average, around one third of a spray per acre.

Other pests occasionally reach treatment levels or otherwise cause damage in Arizona. Starting at planting and during stand establishment, thrips are sometimes a concern. However, with the excellent start, most growers did not have to contend with this pest. Instead, some limited areas of Yuma, Pinal and Pima Counties had unusually high levels and especially high survival of beet armyworms on establishing cotton. This generation is not uncommon for Arizona but often disappears on its own due to climatic and other natural factors. In 2000, first generation BAW survived well and mid-stage larvae attacked the growing points in an atypical "boring" behavior. This resulted in high incidences of forked terminals and "crazy cotton" in some fields. In rare instances, stands were reduced. Grower action to control this pest was generally too late to prevent the current damage, but may have prevented future build-up. Damage was less pervasive and less striking on Bt cotton acreages, yet still present.

After several years of ostensible absence from our agricultural landscape, cotton fleahoppers built to unprecedented levels in localized areas of central and western AZ. Economic levels are ill-defined but rarely, if ever, reached in AZ. Under certain conditions, however, where these bugs were abundant and reproducing and small squares in the terminal were blasted, sprays were warranted. Those that sprayed for these pests were able to control them quickly and with relatively low rates of organophosphates or carbamates. Others managed cotton fleahoppers intentionally or incidentally with sprays for either Lygus or whiteflies. Few other pests rose to any significant level of concern for growers, though bollworms were present in some areas. After initial egg-lay, there was generally high egg and early instar mortality with only a few growers electing to take action in non-bt cotton.

Arkansas

The season began with cool, windy conditions which set the crop back some. Much of the cotton in the central and southern parts of the state received very little rainfall after June. This significantly impacted the dryland cotton in these areas. The extreme Northeastern part of the state did receive some timely rains throughout the season.

Thrips were a significant problem in early season. Even though the majority of cotton planted throughout the state received an in-furrow insecticide, many fields sustained some damage from these insects. In many areas the predominant species appeared to be the western flower thrips. Thrips also appeared to be more attracted to already stressed cotton (wind damaged, herbicide drift, etc.), further compounding the damage. Many fields, particularly in NE Arkansas, received 1 to 2 applications of a foliar insecticide to control this pest.

The bollworm and tobacco budworm population in Southeast Arkansas was variable. The majority of cotton was planted in Bollgard varieties which had a significant influence on the Heliothine inputs. Bollgard cotton may have required one application of insecticides to control bollworm. In the conventional or non-Bollgard cotton, the tobacco budworm was the major problem. Populations were high and required several applications of insecticide to manage the pest. The bollworm was the predominant species in Northeast Arkansas where a limited amount of Bollgard varieties planted. Bollgard acreage considerably increased further south. The majority of the cotton in NE Arkansas required 2 to 3 applications to control this complex.

Aphids occurred earlier this year and populations were present in late June. The aphid population peaked around July 1, and at that time the aphid fungus began to occur. The overall population declined significantly after July 1, and the epizootic spread throughout the state within around 10 days. A few applications of insecticide were applied to control aphids in a few situations.

Plant bugs were relatively light this year and not of much concern. A few areas were treated outside the eradication zone. The malathion insecticide applications in the eradication zone significantly reduced the plant bug populations. Stink bugs were also of concern in several areas and appeared to be building in Bt cotton in some places.

Spider mites were more numerous than in previous years and were a common pest throughout the delta, causing some producers concern. The new product, Denim, was shown to have activity in control of the spider mite and was used in several areas for control of the Heliothine complex and spider mites when they occurred in the same field.

Fall armyworm and beet armyworm occurred in several locations but were overall light and spotty in distribution. Beet armyworms were found in a few fields mostly in SE Arkansas, and these sprayed with the newer insecticides Tracer (spinosad), Steward (indoxacarb), and Denim (abamectin benzoate). These products performed very well in control of beet armyworm and fall armyworm.

Boll weevils were light in the eradication zone. In the central area of the state where eradication began in the fall of 2000, the populations were moderate to heavy and required some treatments. In the eradication zone, populations were treated based on observations and trap captures. Eradication is progressing well, but a few bumps have occurred along the road of progress. Boll weevil numbers were very high in the NE part of the state, where many producers reported that they had not seen numbers this high previously. However, the majority of areas requiring multiple treatments were in high habitat areas near the Mississippi and St. Francis Rivers and Crowley's Ridge.

California

The 2000 growing season was very good in California for the total of 919,000 acres of cotton planted. Pima was grown on 144,275 acres (16% of total), down from 32% in 1999. The San Joaquin Valley (SJV) grew 879,680 acres (96% of the total) and 100% of the Pima acreage. The southern deserts had 21,320 acres, and the Sacramento Valley grew 18,000 acres of cotton. The overall yield in California is estimated to be over 1300 lb/acre for Upland and 1200 lb/acre for Pima, both up from 1999. In the SJV, planting conditions were excellent through March and April with 71% of the days being ideal or adequate for cotton planting. Rain and hail in late April required a limited acreage to be replanted. Good growing conditions and light insect pest pressure in 2000 resulted in excellent retention and good early boll set in most fields. Squaring was well underway by late May. Hot temperatures in August may have contributed to limited shedding of fruit in a relatively small portion of fields, which were planted late or suffered early fruit loss. Defoliation was initiated in early September and harvest continued through late November. Weather during harvest was good through most of October, but two or more inches of rain in the northern SJV during late October and early November delayed some harvests.

Insects generally were not a major problem, but localized areas were affected. Thrips were a problem on about one-third of the acres, causing leaf and meristem damage. Specific non-Acala Upland varieties were again noted to be most sensitive to thrips. Spider mites densities were heavier in mid to late season, requiring additional miticide applications in some areas. *Lygus* was not a widespread problem but treatment was required in some areas. Aphids were a limited problem. Silverleaf whitefly was abundant in August and September, and treatments were required in Kern, Tulare, Kings and even Fresno Counties. Cotton bollworm was treated in the southern portion of the SJV for the first time in many years. The cropping pattern has shifted with a large increase of corn and tomatoes being introduced and perhaps providing additional sources of this pest.

Florida

Fields planted before the last week of April generally had enough soil moisture to establish a stand. Rainfall was extremely limited and scattered during May and June. As a result, many fields were planted two or three times. This resulted in delayed crop emergence and skippy stands in many fields. Stand establishment was delayed in some fields until late June, and drought conditions persisted throughout the season. In the eastern panhandle, approximately 25,000 acres of cotton had to be destroyed because of the drought. In the western panhandle, granular insecticides used at planting provided adequate thrips control. In the eastern panhandle where the soils are generally lighter, thrips damage was above average due to inadequate uptake of the granular insecticides. Grasshoppers caused severe stand damage to several hundred acres of seedling cotton during June. Pyrethroids provided control where applied. Plant bug populations were extremely low all season. Less than 3 percent of the acreage received an application for *Lygus,* and early season square set was generally high.

Heavy aphid infestations developed in most fields during late June and early July, but the beneficial fungus disease, *Neozygites* spp., began reducing populations in mid July. In some areas, the fungus was slow to develop due to drought conditions. By the time that the fungus began to suppress aphid populations, many fields had suffered plant damage, resulting in delayed maturity with subsequent yield loss from this pest. Aphids resurged to moderate levels the second week of August but declined again by September 1.

Beneficials were at high levels 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. (More than 50% of fields grown were using this method of conservation tillage.)

Bollworm and tobacco budworm populations were extremely low all season and did not cause problems in either conventional or Bt cotton. Statewide, conventional varieties averaged less than one application for these pests. Many fields did not require any treatments. Beet and fall armyworm infestations were very low season long. Few, if any, fields required treatment for these pests. Soybean looper infestations developed in some fields during late August - early September. Few fields were treated; but controls probably would have been justified in some.

Stink bug populations increased to damaging levels in many fields following migration from peanuts in September. Some growers obtained adequate control by treating peanut fields or field borders next to peanuts. Approximately 50% of fields received an application of insecticide for stink bugs.

This was a very light cotton pest year for the second season in a row. Inadequate soil moisture was the major limiting factor. Many late-planted fields suffered freeze damage during mid-November, further reducing yields. Yields were highly variable, ranging from a few pounds to 1200 lbs of lint per acre under irrigation. Statewide yields are expected to average approximately 500 lbs of lint per acre.

Georgia

Approximately 1.49 million acres of cotton were planted in Georgia during 2000, but harvested acres will be significantly less than planted due to ongoing drought. Thrips populations were moderate to heavy. Some plant injury occurred on early planted cotton where environmental conditions were not conducive for plant uptake of preventive thrips insecticides. False chinch bugs flourished in these dry conditions, actually reducing stands to unacceptable levels in some fields. The heaviest false chinch bug infestations occurred in conservation tillage fields. Grasshoppers were more numerous on seedling cotton than in years past.

Plant bug and cotton fleahopper populations were generally light as a whole, but sporadic fields were infested at economic levels. Aphid populations built to high numbers during late June and early July in southwest Georgia. A higher percentage of the acreage than normal in this area was treated for aphids. Drought conditions compounded aphid injury, and economic loss occurred in some fields due to aphids. A fungal epizootic occurred in early to mid July and finally brought some relief to the stressed cotton.

Tobacco budworm infestations were sporadic and ranged from light to heavy. Treatable populations occurred on non-Bt cotton during early July and continued through August in some areas. Difficulty controlling tobacco budworm with pyrethroids was observed. Bollworm populations were also spotty and ranged from light to heavy depending on location. Pyrethroids generally performed well and some Bt cotton fields required supplemental treatment of corn earworm. Both fall and beet armyworm populations were generally low statewide. However, some late planted fields required treatment for beet armyworm during late June and July. Looper numbers were low but detectable late in the year.

Stink bugs continued to be a primary pest of Georgia cotton and damage ranged from light to moderate. The low use of broad spectrum insecticides is conducive for stink bug establishment. One to two well-timed insecticide applications were necessary where economic populations present.

As in recent years, the silverleaf whitefly infested a localized area around Tifton. However, during the 2000 production season, populations were much more widespread and economic damage was observed over a broader area on late planted cotton. Cotton planted prior to late May avoided economic infestations. Silverleaf whitefly is an unpredictable pest of Georgia cotton, and control of established infestations is both difficult and expensive.

In summary, the 2000 production year was difficult. Yields were limited by an ongoing drought, and it is estimated that approximately 1.3 million acres of cotton will be harvested with a projected yield of 600 lb of lint per acre.

Louisiana

Wet conditions during early April resulted in most of the crop in Louisiana being planted during the last week of April and the first two weeks of May. Below average yields are expected in 2000 due to hot /dry environmental conditions during June, July and August. Louisiana planted approximately 689,913 acres of cotton with an average state yield expected to be 625 to 675 lb lint/A. Of the 689,913 acres planted, approximately 84% were planted to a Bt-cotton variety.

Insect pest populations ranged from extremely low to very high in 2000, primarily depending on the variety planted. The most troublesome insect in 2000 was the tobacco budworm. Statewide applications for budworm control on non-Bt cotton ranged from 2 to 8, with an average of approximately 4.5 applications. Considering only irrigated non-Bt cotton, the number of insecticide applications for budworm control increased to approximately 6.5.

Early-season insect populations were moderate. Initial concerns about a burring bug that was being found in high numbers (up to 100 per plant) in reduced tillage fields turned out to have little observable impact. Thrips populations were also moderate. Many cases of less than acceptable control were attributed to western flower thrips. A seed treatment (imidicloprid or acephate) for seedling pests was used on as much as 50% of the acreage. Aldicarb was used on much of the remaining acreage.

Cutworm populations were low with only a few exceptions. In an isolated area, primarily in Franklin parish, a tunneling cutworm caused significant plant stand density reductions. Insecticides were applied at planting, but because the larvae were not moving on the soil surface, they were not being exposed to the insecticide.

All cotton production in Louisiana was in an active boll weevil eradication program. The Red River zone completed the fourth year, while the Northeast zone completed the second year. Boll weevil populations in the Red River zone were very low, with the exceptions of the Vick and north Caddo regions. Boll weevil populations in the Northeast zone were also low but most still required a considerable number of treatments. An average of over 11 malathion applications was made in the Northeast Eradication zone, with some fields having as many as 24 applications.

Tarnished plant bug populations were almost non-existent early-season and only moderate in late-season with few fields being treated. Low tarnished plant bug numbers were attributed to malathion sprays for boll weevil eradication.

Stink bug populations were moderate to high in late season. Significant boll damage occurred in many fields, especially near field margins. Injury was more apparent in Bt-cotton varieties than in non-Bt varieties. Insecticide treatments for other insect pests were similar between Bt and non-Bt cottons with insecticides that are efficacious against stink bugs. Populations were initially high in corn, then moved to other hosts, notably soybeans, then moved to cotton.

Populations of sucking insect pests were high for much of the season. Aphid populations were high through June until the fungal epizootic occurred in early July. Whitefly populations were the highest observed in some number of years. Fields treated for whiteflies received as many as three insecticide applications for their control. Spidermite populations were also high during July and early August.

Bollworm populations were light during most of the season. Very few insecticide applications were applied to either Bt or non-Bt cotton for bollworm control. Resistance monitoring of bollworm populations indicated little change in susceptibility of bollworm to pyrethroid insecticides.

Mississippi

Mississippi cotton producers planted approximately 1.3 million acres of cotton in 2000. Approximately three of every four of these acres were planted to Bt-transgenic varieties.

Mississippi entered the new millennium with active boll weevil eradication programs (BWEP) underway in all regions of the state. The East and West Hill Regions both began eradication efforts in 1997, so this was the fourth year of BWEP on the 475,000 acres located in the Hill Region of the state. The South Delta Region, approximately 223,000 acres, was in its third year of eradication, and BWEP was initiated on the approximately 590,000 acres in the North Delta Region in the fall of 1999.

Since it began, Mississippi's BWEP has faced some very significant environmental and production changes that have made BWEP much more challenging. These include: a series of unusually mild winters, which resulted in higher overwintering survival; introduction and widespread planting of Bt-cotton, which requires fewer grower applied treatments of products that provide coincidental control of boll weevils; and the introduction of new, more target specific insecticides, which do not have activity against boll weevils. Despite these unprecedented challenges, Mississippi's BWEP has made excellent progress toward the goal of eradicating the boll weevil from the state, and no economic yield loss was attributed to boll weevils in 2000. The average number of BWEP treatments applied to fields in the Eastern Hills, Western Hills, South Delta, and North Delta was 3.1, 5.0, 3.0, and 6.8, respectively. These treatments were applied based on pheromone trap captures and a treatment criterion that triggered treatment on any field in which the total weekly trap capture reached two or more weevils.

Although planting was delayed initially because of unusually cool weather in April, May was warmer and drier than usual, and planting was completed ahead of normal schedule. Unfortunately, this hot, dry weather persisted throughout the remainder of the season. May was also unusually windy, and this combination of weather resulted in unusually heavy thrips pressure throughout most of the state. Fields that did not receive in-furrow insecticide treatments at planting usually required multiple foliar treatments to control thrips, and fields that did have an in-furrow thrips treatment often required a supplemental foliar spray. There were numerous reports of "hard to kill" thrips and some speculation that this was because of an unusually high abundance of western flower thrips. While it is true that thrips collected from treated fields were more likely to be western flower thrips, continuous heavy re-infestation, due to the windy conditions and high thrips populations, seemed to be the primary cause of the thrips control problems encountered in 2000.

There were also a number of unusual pest problems on seedling cotton in 2000. Sugarcane beetle was observed destroying seedling plants in a several fields. This was not an especially severe or widespread problem, and is noted simply because it was unusual. The damage was caused by the adults, which cut the seedlings one to two inches below the soil, resulting in a distinctive ragged or shredded appearance of the cut stem. Usually all plants in a "hill" were affected, and a few fields were so heavily infested as to threaten stand loss. These infestations of sugarcane beetle occurred in both reduced-till and conventionally tilled fields.

A number of no-till fields experienced heavy infestations of false chinch bugs (*Nysius* spp.), which caused death of seedling plants, and in some cases, resulted in severe stand loss. The injury resulted when aggregations of nymphs and adults, up to 50 or more, fed on seedling plants, essentially sucking the small seedlings dry. As soon as a plant or hill of plants began to die, the insects would move to nearby healthy plants. A few fields were treated for false chinch bugs, and there were some reports of control difficulties.

Extremely heavy numbers of negro bugs (Family: Thyreocoridae) were also observed in many reduced tillage fields. Numbers often exceeded 10 to 20 bugs per plant, prompting concern over the potential for this insect to cause damage. Adults and nymphs could be found resting on the foliage, as well as in the seed drill below the soil line, but these insects did not appear to cause damage to seedling cotton plants. However, populations of negro bugs and false chinch bugs often occurred in the same fields, resulting in some confusion over which insect was causing the damage.

Infestations of cutworms were also more common than usual, and a few fields required multiple foliar insecticide applications to control cutworms. In particular, granulate cutworms (*Feltia* spp.) were more abundant in 2000.

Injury to seedling plants caused by the threecornered alfalfa hopper (*Spissistilus festinus*) was also reported from a number of locations in the state. The damage was similar to that caused by this insect in soybeans. Usually, the first symptom observed was a reddening and stunting of individual seedlings. Initially this injury was often mistaken for herbicide injury, but closer examination would reveal a sunken necrotic ring that completely surrounded the main stem. Usually this "girdled" area was located within one to two nodes of the first true leaf. Affected plants were often concentrated along the edges of fields, although field wide infestations were observed in some small, limited tillage fields. Once plants reached the five to six leaf stage, girdling of the main stem usually ceased, but girdling of leaf petioles could often be observed. Depending on the age of plants when first attacked, girdled plants were either killed, severely stunted, or recovered. Overall, this early damage by threecornered alfalfa hopper did not appear to have any significant effects on yield.

Because early season boll weevil eradication treatments of ULV malathion often provided coincidental control of tarnished plant bugs, early season infestations of this pest were somewhat lower than normal. However, much of the Delta experienced mid-season plant bug infestations that required treatment. Plant bug infestations were much lower in the Hill region, and relatively few fields in this region required treatment for plant bugs.

Compared to past years, bollworm and tobacco budworm pressure were both unusually low throughout most of the state. Statewide, approximately 0.9 foliar sprays per acre were applied to control these pests. This is less than the estimated 1.27 sprays per acre required for these pests in 1999, and is approximately one-third of the number of sprays required in the two years before 1999. Only 380,000 acres of corn were harvested in Mississippi this year, and this relatively low corn acreage is thought to be one of the primary reasons for the low bollworm numbers. Heavy use of Bt cotton varieties is of course the reason for the generally low tobacco budworm numbers.

However, it must be noted that extremely heavy tobacco budworm infestations were experienced on some of the non-Bt cotton grown in the North Delta region of the state. Several consultants reported near 100% infestation levels, and some fields required seven or eight applications for control of tobacco budworms. This was the first full season of the BWEP in this portion of the state, and destruction of beneficial insects due to multiple applications of ULV malathion likely contributed to the increased tobacco budworm problems experienced in these non-Bt fields. Fortunately, growers in this region anticipated the flaring of secondary pests, which often occurs during the early years of BWEP, and increased their plantings of Bt varieties in 2000.

In contrast, growers in the Hill region of the state began to experience some of the benefits that boll weevil eradication can provide in terms of secondary pest problems. Although, boll weevil eradication is not yet completed in this region, there were many fields that were boll weevil free in 2000 and did not require treatment for boll weevils. This allowed beneficial insect populations to remain in the field and help control other pests. Although non-Bt fields in the Hill region received an average of approximately 1.7 sprays per acre for control of bollworms and tobacco budworms compared to 3.2 sprays in the Delta, there were a number of fields of non-Bt cotton grown in the Hill region which did not receive any insecticide treatments for control of caterpillar pests. Based on results of an end of season survey, only 5.9% of the Bt fields grown in the Hill Region received insecticide applications to control bollworms. Approximately 47% of the Delta Region Bt fields received one or more bollworm treatments.

Because of concern over the potential for increased problems with beet armyworms, which often occur during the early years of BWEP, Mississippi sought and obtained approval to use Denim (emamectin benzoate), Steward (indoxacarb), and Intrepid (methoxyfenozide) against this pest under Section 18 Emergency Exemptions. The unusually hot dry conditions that persisted throughout the season resulted in increased concern over the potential for beet armyworm problems. Fortunately, only a relatively small amount of acreage required treatment for beet armyworms in 2000. However, it must be observed that Bt cotton does provide some suppression of BAW, and most of the non-Bt fields in those areas of the state that were most prone to beet armyworm outbreaks received multiple applications for control of tobacco budworm. In most cases the insecticides used to control tobacco budworms were products that also have activity against beet armyworms.

Fall armyworm was a more widespread problem than beet armyworm in 2000 but still did not cause excessive amounts of yield loss. However, treatable fall armyworm infestations occurred much farther north in the state than normal, and many consultants had their first experiences with this pest. Interestingly, treatable fall armyworm infestations were more common on Bt cotton than on non-Bt varieties. Presumably, this was because non-Bt fields received more treatments for bollworm and tobacco budworm and the products used to control these pests provided coincidental control of fall armyworms. Treatment decisions were often difficult to make in Bt cotton because some fields had relatively high numbers of small caterpillars that declined without requiring treatment or causing damage, while other Bt fields sustained significant levels of boll damage. It appears that there is considerable variation in the susceptibility of currently available Bt varieties to this pest.

Cotton aphid populations were low in the Hill Region of the state, with very few fields requiring treatment. However, approximately two-thirds of the fields in the Delta Region required treatment for aphids. The portion of treated fields was particularly high in the North Delta, which was involved in the first full season of BWEP. This agrees with observations from past years, in which regions involved in the first full year of BWEP received more treatments for cotton aphids. Furadan (carbofuran) and Centric (Thiamethoxam) were available for use under Section 18 Emergency Exemption. Both of these products are effective against cotton aphids, and their availability helped keep aphid-induced yield losses to a minimum.

Bandedwinged whiteflies required treatment in a few fields in areas that received numerous early and mid-season applications of ULV malathion as part of the BWEP, but overall populations of this pest were relatively low. Treatable populations of silverleaf whitefly (*Bemesia* spp.) were observed in two counties in the extreme southern portion of the state. These counties have a thriving commercial nursery industry, and cotton is often grown in close proximity to commercial nursery crops, resulting in an opportunity for whiteflies to move between these two crops.

The severely dry conditions were favorable to spider mite problems, and a number of fields in the Delta Region of the state and some portions of the Hill Region required treatment for this pest. Although the incidence of spider mites seems to have increased in recent years, spider mites continue to remain a minor pest.

The unusually mild winter combined with the reduction in foliar sprays associated with the progress of BWEP and the planting of Bt cotton resulted in increased populations of stink bugs and an increased awareness of this pest by consultants and producers. A number of fields were treated for stink bugs in 2000, but very little yield loss was attributed to this pest.

In summary, the 2000 growing season was unusually hot and excessively dry. These adverse growing conditions resulted in disappointing yields, and low yields combined with low prices resulted in a generally disappointing year for most producers. Fortunately, overall insect populations were relatively low in 2000. Insect-induced yield losses were estimated at 4.5%, and, excluding BWEP sprays, the estimated number of foliar insecticide treatments per field was 3.5. Still, because of fees associated with boll weevil eradication efforts and use of Bt cotton, the estimated costs of insect control were substantial at $91.07 per acre.

Missouri

In 2000, Missouri cotton growers planted approximately 425,000 acres of cotton. Early-season planting weather was generally good except for cool soil temperatures. In late-May, a weather system dumped several inches of rainfall onto the region. Both the excessive rainfall and blowing sand severely damaged seedling plants and slowed their uptake of at-planting insecticide applications. Weather-induced seedling mortality was high and initial crop growth was poor. Approximately 25,000 acres of cotton were either replanted or converted to other crops. Thereafter, weather conditions were generally favorable with timely rains throughout most of the growing season. Fruit retention was high (>85%) in most fields across the region, and the Missouri crop matured one to three weeks earlier than normal. Harvest conditions were excellent in 2000, and the average USDA yield estimate for 2000 (696 pounds) was 12.6% above the previous 5-year average (608.4 pounds) for Missouri.

Overall, pest pressure in Missouri was moderate in 2000. Thrips infestations set another record high for the second consecutive year and were further supplemented by western flower thrips that migrated into Missouri in late-May. Weather (cool, wet, windy conditions after planting) again was a major factor in slowing seedling growth and prolonging their exposure to thrips feeding damage. This slow growth decreased the plants' uptake of soil- and seed-applied insecticide treatments, and it necessitated the need for one to two foliar insecticide applications before the thrips infestations were finally controlled.

Spring pheromone trap captures of overwintering boll weevils were down in 2000 compared to 1999. This was likely due to a combination of cold, wet weather during December and January that increased overwintering mortality, delayed crop growth in the spring, and increased suicidal weevil emergence. But, in-season populations rapidly recovered and Missouri growers averaged an estimated three insecticide sprays per acre to combat weevil infestations. Two separate but unsuccessful (66.7% majority needed for passage) boll weevil eradication referenda were held in March and August in Missouri; however, a third one held in November finally passed. During the March referendum 1301 people (approximately 46% of the eligible voters) participated in the referendum and 56.1% voted for the program (Table 1). In the August referendum 1935 people (approximately 52.5% of the eligible voters) participated in the referendum and 60.6% voted for the program (Table 2). In the November referendum, 2013 people (approximately 59.0% of the eligible voters) participated in the referendum and 74.2% voted for the program (Table 3).

Table 1. Missouri boll weevil eradication balloting results[A] – March of 2000.

County	Balloting Yes	Balloting No	% Yes Vote
Stoddard	82	11	88.2
Scott	36	6	85.7
Dunklin	339	235	59.1
New Madrid	162	171	48.7
Pemiscot	111	148	42.9
TOTAL	**730**	**571**	**56.1**

[A] Missouri Department of Agriculture.

Table 2. Missouri boll weevil eradication balloting results[A] – August of 2000.

County	Balloting Yes	Balloting No	% Yes Vote
Stoddard	139	15	90.3
Scott	49	11	81.7
Dunklin	509	279	64.6
New Madrid	284	210	57.5
Pemiscot	192	247	43.7
TOTAL	**1173**	**762**	**60.6**

[A] Missouri Department of Agriculture.

Table 3. Missouri boll weevil eradication balloting results[A] – November of 2000.

County	Balloting Yes	Balloting No	% Yes Vote
Stoddard	157	12	92.9
Scott	75	9	89.3
Dunklin	642	190	77.2
New Madrid	354	134	72.5
Pemiscot	266	174	60.5
TOTAL	**1494**	**519**	**74.2**

[A] Missouri Department of Agriculture.

Aphid populations steadily increased throughout May and June. On 02 June the Environmental Protection Agency granted Missouri's request for a Section 18 use label for Furadan 4F. Dunklin County was the first one (The Missouri Department of Agriculture triggers the label on a county-by-county basis.) to receive its Section 18 label on 22 June. Aphid infestations increased steadily until early-July when aphids infected with the fungus, *Neozygites fresenii*, were collected in Dunklin County. Thereafter, aphid populations declined across the Bootheel. There was a slight rebound of aphid infestations in mid-August, but beneficial insects (primarily ladybird beetles) and the aphid fungus generally suppressed these infestations.

Plant bug infestations remained steady throughout the middle and later parts of the season; however, these infestations were generally light to moderate and were kept in check with insecticide sprays for other insect pests (i.e. boll weevil). Spider mite infestations were first reported in early-July, but these infestations were light and sporadic across the region.

Bollworm infestations were above average in southeast Missouri during the 2000 growing season. Initial reports of infested cotton fields occurred in mid-June in the northern areas of the region where corn production is more intense. These and other infestations remained light throughout most of the region during June and most of July; however, egg-laying activity greatly intensified the latter part of July. Fields generally required one insecticide overspray for bollworms, but many fields needed multiple oversprays to control overlapping bollworm moth flights and egg lays.

Armyworm, stink bug, tobacco budworm, and whitefly infestations were light and sporadic in 2000. A few fields (mainly in the northern Bootheel area) required treatment for European corn borer infestations in early August.

In summary, bollworm, boll weevil, and thrips infestations were high in 2000. Aphid and plant bug infestations were moderate with localized hot spots. Armyworm, European corn borer, spider mite, tobacco budworm, and whitefly infestations were light to absent in southeast Missouri.

New Mexico

Spring conditions in 2000 were good with relatively low losses from hail and wind damage. The northernmost growing areas had a particularly good year with temperatures from May-September about 4^{o} F above average. This was fortunate since there was an early frost in late September. On the other hand, a cold and wet fall reduced yields of Pima cotton in the Mesilla valley and quality of late bales of some upland cotton in parts of the Pecos valley. Yields were average for the state with estimated yields of 1.5 bales/acre.

Boll weevil eradication programs were in place or voted in for all but a few thousand acres in NM in 2000. The South Central NM program in the Las Cruces area is well established. The Pecos valley (Eddy/Chaves counties) began an eradication program this fall. Lea County voted in two programs, an eradication program, which covers most of the county and a suppression program, which covers approximately 3000 acres. Roosevelt and Curry County farmers approved an eradication program this fall.

Bollworm populations and losses were average for NM. Boll weevil losses were highest in the Pecos valley and parts of Lea County. The most unusual insect losses were due to *Lygus* which reduced yields in the Mesilla valley. Whiteflies also were an unusual problem, with up to 10% of farms in the Mesilla valley making an application for whiteflies. Aphids were low to moderate, but high numbers in the Mesilla and Pecos valleys are not typical. This year up to 30% of farms in the Mesilla valley treated fields for cotton aphids. Heavy beet armyworm infestations were reported in the eastern High Plains of NM.

In the last two years there has been a dramatic increase in cotton acreage at the northern limits of the cotton growing areas of eastern NM, in Curry, Roosevelt and Quay counties. This parallels a similar increase in nearby Texas where this cotton is ginned. Despite low cotton prices cotton is attractive in this area. Inputs are relatively low and the lower water use is particularly attractive since rainfall is low (16"/year) and irrigation water is increasingly a limiting factor.

North Carolina

Cotton was planted on just over 901,400 acres in 2000, exceeding North Carolina's previous record by approximately 40,000 acres. With yield prospects presently in the record 775 pound per acre range, this state's bale production will exceed previous records by a wide margin. Although much could happen with worldwide cotton prospects between now and planting season, North Carolina cotton acreage could again significantly increase in 2001.

Thrips levels were high throughout much of the state. Foliar treatments for thrips were applied to almost 70% our cotton acreage (very high for this state), and some cotton fields were treated 2 or 3 times. These figures are up considerably from our long term average of 20 to 30% acreage treated with a foliar insecticide for thrips. Dry early weather limited uptake of at-planting systemic insecticides, and also resulted in high levels of migrating adults. For the second consecutive year, western flower thrips accounted for control difficulties at a few locations. Approximately 90% of NC cotton growers used an at-planting insecticide (including seed treatments) in 2000.

Second generation tobacco budworms were again very low throughout the state, and the subsequent generation managed to surface only a few instances along with bollworms in the late July to late August time period. Approximately 1% of the state's cotton acreage was treated for these early budworms, similar to the 0.86% in 1999, and down from our 7-year average of about 4.5%.

Aphids were an early, widespread and persistent problem in 2000, with the mummifying wasp parasites and the fungus *Neozygites fresenii* arriving too late to help some producers avoid apparent economic damage. Much of this damage occurred to late-emerging, stunted cotton in July. Approximately 4% of North Carolina's acreage was treated for aphids, up from our long term average of 1%. Foliar imidacloprid was the main material used on the treated fields. With a few exceptions, biocontrol remains the most effective means of consistently reducing or eliminating local populations of cotton aphids in North Carolina.

Plant bug levels were moderate by North Carolina standards, with about 4% of the acreage being treated for early (pre-bloom) plant bugs. Along with stinkbugs, plant bugs became part of the late season bug complex in a number of Bollgard cotton fields. Approximately 7% of our producers treated their cotton acreage specifically for plant bugs, higher than the previous 4 years of commercial Bt cotton use.

Our major mid-July to early August bollworm moth flight generation averaged about a week early, and flight intensity and egg deposition was up considerably from 1999. Control of bollworms on conventional cotton was complicated by a number of factors, including significant rainfall at the time of egg deposition and hatch, rapid terminal growth of new tissue, a high level of bloom tags stuck to small developing bolls, and significant egg deposition down in the plants. State-wide damage to bolls by bollworms on conventional cotton, at 6.95%, was the highest ever recorded in our damaged boll survey which began in 1985. The average number of treatments required for bollworms and other occasional late-season pests was 3.9, almost identical to our 14-year average of 3.8 applications. Bollworm establishment under bloom tags now appears to be an annual problem in both conventional and Bollgard cotton. Adult vial tests for bollworm resistance/tolerance to pyrethroids revealed that some control problem with bollworms on cotton may be due in part to tolerance or resistance to pyrethroids.

Bollgard cotton was planted on approx. 54% of NC's cotton acreage in 2000, significantly up from 20% in 1999 and 13% in 1998. Bollgard cotton was treated an average of 1.03 times for late season pests, a decrease from 1998 (1.24 times), but greater than in 1996 (0.58 times), 1997 (0.48) and 1999 (0.67). Mean boll damage to Bollgard cotton from bollworms, based on a survey, was less than a fourth of that found in conventional cotton (1.58 % vs. 6.96%), although overall boll damage to Bollgard cotton, primarily due to stink bugs (4.74% in Bollgard vs. 0.1.76% in conventional cotton), was closer (6.34% for Bollgard vs. 9.00% for conventional).

FAW did not account for much overall damage this year. European corn borers were very light across most of the state, continuing a trend begun in 1990. Beet armyworms were also very low in 2000.

Only 1 boll weevil has been captured in North Carolina as of this early December writing (in the Elizabeth City area of Pasquotank County). Deployment of 500 traps in this isolated 102-acre block of cotton have not revealed additional weevils. This represents quite a drop from the 2,000+ boll weevils found just 2 years ago in the Conetoe area of Edgecombe County.

Oklahoma

In 2000, about 216,000 acres were planted. Excellent growing conditions prevailed across the state through June, but a prolonged drought during boll set limited production reducing harvested acres to 190,000 acres. A total of 2,854 heat units accumulated between May 10 and October 1, exceeding the 40-year average. The State production average is projected at 440 lb of lint per acre.

Despite widespread use of at-planting insecticides, thrips infestations built to damaging levels across the State. Lighter-than-normal infestations of cotton fleahoppers coupled with widespread OBWEO sprays limited the number of applications applied solely for cotton fleahopper control throughout Southwest Oklahoma. Heaviest cotton fleahopper infestation occurred in portions of Northern Oklahoma which is not in an active OBWEO spray program.

Light bollworm populations, coupled with the large increase in acres planted to Bollgard cotton, limited spraying in 2000. Conventional cotton received 1-3 insecticide applications to prevent damage. June rains delayed beet armyworm infestations, but infestations surfaced in late July and early August with heaviest infestations occurring in Harmon County in Southwest Oklahoma.

Cotton aphid infestations flared during July. Heaviest infestations were associated with active OBWEO programs in Southwest Oklahoma. Only District 1, comprising 5 Counties (Harmon, Greer, Jackson, Kiowa and Tillman), was cleared for Furadan use to control resistant cotton aphids. Heaviest infestations occurred in cotton intensely managed, and severe yield loss would have occurred if Furadan had not been available for use. This aphid buildup was short lived and did not recur.

South Carolina

South Carolina farmers are expected to harvest 310,000 acres (State Statistician's estimate) in 2000, although acreage certified through the Clemson University Department of Plant Industry was somewhat lower, as boll weevil fees were collected on about 290,000 acres of cotton. We expected to have as much as 340,000 acres, but dry soils in May and June prevented many fields from being planted. Using the 310,000-acre estimate, farmers are expected to harvest 390,000 bales, up 39 percent from last year. The expected yield average is 604 pounds lint/acre, up 176 pounds from last year. Harvested acres will be 5,000 acres lower than in 1999.

As has been the case in previous years, 90% or more of the cotton was treated with Temik at planting. Soil treatments were not enough in many fields, therefore, more foliar insecticides were applied than usual. In research studies at Florence, foliar treatments were considerably less effective than I have observed in previous years. Despite the relatively poor performances of foliar sprays, there were no significant differences in yields between them and the untreated checks.

There was a considerable amount of tobacco budworm pressure in tobacco in May and early June, but few infestations were reported in cotton. Budworm moth captures in pheromone traps placed near cotton fields were generally quite low; however, one farmer in Marion County reported problems in controlling worms in July with pyrethroids. Larvae collected from those fields turned out to be 100% budworms, but the adults were susceptible to cypermethrin. Moths collected in August on the same farm were also susceptible to cypermethrin. An average of less than 2 pyrethroid applications was made in South Carolina, because of low bollworm pressure and the fact that 75% of the acreage was planted to *Bt*-varieties. This was 10% less lower than the acreage of Bt cotton planted in 1999.

It was extremely dry "below the lakes"; corn plants in many fields had barely reached three feet in height when they began tasseling. Needless to say, the yields were poor and the crop was less than attractive to ovipositing corn earworm moths. There were large differences in numbers of moths caught in pheromone below the lakes and above the lakes. For example, a typical pheromone trap located in the Savannah Valley would have typically captured100 moths per night in late July and August, while it was rare to find that many moths in a span of 3 or 4 nights in the Pee Dee area. As in 1998 and 1999, "earworms in corn often failed to show up as moths in cotton (personal communication, Al Hopkins, formerly a USDA entomologist and now a consultant in the Pee Dee area)." From the paucity of moths in nearby cotton fields in July, it appeared that only a small percentage of the earworms in corn had developed into adults.

There were no reported failures with pyrethroids in controlling bollworms for the second consecutive year. Growers were generally able to control worms with 2 to 4 applications in conventional cotton varieties. About 75% of the Bt-cotton acreage was treated an average of 2 times, while 25% was not treated at all.

Stink bugs were a statewide problem in 2000. Clemson University recommended treating with insecticides on a boll-damage threshold, emphasizing the importance of examining quarter-sized bolls. Numbers of stink bugs were de-emphasized in importance because of the difficulties in accurately determining economic infestations with beat-cloth samples. Scouts reported seeing economic damage at or before mid July in some fields. Stink bugs were once thought to be only a late season pest of cotton, but during the last few years they have been observed infesting some cotton fields soon after first bloom.

False chinch bugs infested cotton seedlings throughout the state in minimum-tillage fields. Growers were concerned, and some considered spraying fields where seedlings appears to be suffering from lack of moisture. When damage occurred it was limited to areas where small seedlings were infested with nymphs and adults. The adults did not appear to cause any damage to cotton then, or at later stages of growth. In some cases, adult infestations were sustained well into July.

In July, moderate infestation levels of aphids were observed in many fields. A few farmers were treating with insecticides, but most did not. By the end of July, most aphid infestations had succumbed to the fungus *Neozygites fresenii*. Beet armyworm and fall armyworm infestations were unusually scarce. We received a Section 18 for Steward to control of beet armyworms, but numbers were insufficient to trigger it's use. Few infestations of tarnished plant bugs or cotton fleahoppers were reported. Grasshopper numbers were unusually high. In most cases, damage was only cosmetic, but some fields were treated to prevent economic defoliation.

One boll weevil was captured in a pheromone trap in Aiken County in September. After increasing the numbers of perimeter traps and installing in-field traps, no further captures were made. Roundup-Ready cotton continues to be a problem when plants come up within fields rotated to another crop such as soybeans or corn. These plants are often not apparent until the bolls begin to open. With 95% of the cotton in RR varieties, this poses a potential problem for the boll weevil eradication effort. Randy Lynch, OIC with South Carolina Grower Foundation, reported that in a survey of 2,503 fields, which were rotated from cotton to other crops in 2000, 23 fields harbored volunteer cotton plants.

A malady referred to as "seed rot" was first discovered in South Carolina in 1999. A statewide survey conducted in September 1999 showed that seed rot was present in every county in the state, and in all varieties examined. The highest incidence of seed rot was found in bolls collected in the Savannah Valley. In 2000, the incidence of seed rot was similar to 1999, but symptoms tended to be more prevalent above the lakes.

Tennessee

The season began with slightly cooler than normal temperatures and more than normal rainfall. These conditions resulted in less than optimal uptake of systemic insecticides due to poor plant growth. Thrips populations were the highest of the last two decades, with extensive pressure from the western flower thrips which had not previously been detected on seedling cotton in Tennessee. Producers had to overspray much of the cotton which had been treated at planting. False chinch bug was observed damaging seedling plants in several locations. Plant bug populations were high in early June, but declined late in the month in zone 1 of the BWEP, but were much lower in zones 2 and 3 to the north. Boll weevil populations at the pinhead square stage were quite high in the two north zones, but much reduced in zone 1 where the BWEP began in 1998. Some areas in zone 1 bordering zone 2 had significant boll weevil numbers overwinter. Plant bug numbers increased in early July and bollworm and tobacco budworm levels were spotty. By mid-July, many fields had to be treated for bollworm and tobacco budworm. By this time, most of the cotton in West Tennessee was under drought stress which continued in some areas for the remainder of the season. Late July and early August witnessed major increases in bollworm and tobacco budworm moth numbers, but relatively light damage occurred the remainder of the season. Boll weevil numbers continued to remain high in the two northern zones. Aphid populations were relatively low during the season and the aphid fungus controlled the higher populations.

Texas

The harvested acreage was up somewhat from the approximately 5.2 million acres in 1999 with 5.4 million projected for 2000. Most acreage lost was from the High Plains area due to the drought, with weather losses such as hail and some flooding. Moisture shortages following excellent rains in June had the greatest impact on remaining acreage and yields. Most of this yield reduction was in the drought-strickened west. Heat unit accumulations were again above normal, especially later in the season. This resulted in exceptional yields on those acreages where irrigation water was adequate. Otherwise, yields were cut substantially. Yields ranged between production regions from a high of 1050 pounds per acre in the Southern Blacklands to a low of 175 in the Northern Rolling Plains.

Approximately 970,000 acres of Bollgard type cotton was planted in the state in 2000, a considerable increase over last year. Much of this was in the new boll weevil eradication zones, undergoing their first full season of applications. The expense of the Bollgard gene is still holding back many producers, especially in the dryland production areas. The use of Bollgard varieties did reduce yield losses and the number of applications required for caterpillar pests in general. While control of beet armyworms in west Texas often reached 40%, this was inadequate to prevent some needed applications.

The 2000 pest situation was quite different compared to 1999 when cotton fleahoppers and *Lygus* pushed yield losses high enough to cause the fleahopper to be the number one pest for the entire cotton belt. The absence of early hosts and the indirect effects of ULV malathion on these pests resulted in minimal yield losses this year. In contrast. The beet armyworm, with infestations concentrated primarily in the High Plains and Northern Rolling Plains areas, was a devastating pest. The extensive use of expensive insecticides held yield losses in check but not enough to prevent the beet armyworm from becoming the state's number one yield detractor. The boll weevil was second, followed by the bollworm/budworm complex. Only the presence of 7 active eradication zones prevented the boll weevil from becoming the number one pest.

A dry winter limited boll weevil survival somewhat even though Texas experienced above average winter temperatures for the fifth consecutive year. But abundant May/June rains produced a cotton plant in many areas that shaded the soil and reduced mortality of the F_1 generation, resulting in large infestations later in the season. Where eradication programs were not in place, yield losses attributed to the boll weevil were quite high. Four new boll weevil eradication zones were activated with diapause treatments the fall of 1999 with their first full season of applications in 2000. These zones were the Northern Rolling Plains, Northwest, Permian Basin and Western. Three more zones will start eradication efforts in the fall of 2001, with the passage of their referendums this year. These new zones are the Southern Blacklands, Southern High Plains/Caprock, and Northern High Plains. The acreage encompassed by these three zones is about 2 million. The Southern Rolling Plains Zone was declared functionally eradicated, i.e. no reproduction or damage detected for one year.

Thrips were a problem across much of the area, especially where winter wheat was grown. While numbers were not exceedingly high, infestation pressure was extended for several weeks due to migration and damage was more pronounced where weather factors limited early plant development and systemic insecticides provided less residual control.

Even though there were some good early season rains, these were either inadequate or poorly timed to result in sufficient alternate hosts to cause a cotton fleahopper or *Lygus* problem. Most *Lygus* problems were concentrated in fields adjacent to prime alternate hosts such as peanuts, potatoes, and especially alfalfa.

Unlike last year when caterpillar pest problems were almost nonexistent, the year 2000 was the year of the worm. While the many active boll weevil eradication programs may have had some impact on increasing beet armyworm problems this year, there is no definitive evidence to support this possibility. In fact, in many areas, high boll weevil activity would have necessitated many producer applications (a potential contributing factor as well). Beet armyworms arrived early in pre-squaring cotton in the southern acreage of the High Plains and caused considerable square loss in early infested dryland fields. As the infestation increased, it spread northward into the northern High Plains and Northern Rolling Plains. Late infestations moved into irrigated acreage where numbers ballooned to levels exceeding 300,000 per acre. These July/August infestations caused significant damage to young bolls when left unchecked.

A high percentage of acreage in the involved areas were treated one or more times (usually 2 but as many as 4 applications) for beet armyworms. The aggressive management of the beet armyworm by producers limited somewhat yield losses but drove up control expenses. Denim, Steward and Intrepid were used under Section 18's while Tracer, Lorsban and Confirm were used as fully labeled materials. A Section 18 for Pirate was requested but EPA denied this request after sitting on it for a protracted period. Bollworm and tobacco budworm activity was up from last year but still considerably lower than historical norms. Some control problems were encountered in the High Plains with tobacco budworms.

Cotton aphid infestations appeared earlier than normal in much of the cotton acreage of south Texas and needed treatment. Texas did request and receive a Section 18 for Furadan 4F. Aphid infestations in the rest of the state were sporadic and appeared to be very unstable, often declining before reaching high levels. Lady beetles were very common, even where other pests were requiring multiple treatments. Other natural enemies did not appear so lucky, and their numbers were down. However, the presence of large numbers of beet armyworms in some areas did result in above average levels of the *Cotesia* wasp. Aphids resurged later in the year and caused some apparent honeydew problems, but late season rains eliminated this potential sticky cotton problem. The ULV malathion sprays used for boll weevil eradication programs may have been a contributing factor, but this relationship was not as clear as it was in 1999.

Lower Rio Grande Valley (LRGV)

Weather conditions in the LRGV in 2000 were excellent for most of the cotton producing region. Rain occurred in February, March, April, May, June and August. The more significant rainfall months were March, May and June. The rain in March was good for many area fields, but delayed planting in others until early April. Rain fell during May and early June, in the critical fruit set and early maturation stage of growth. Some areas near the central part of Cameron County received no useful amounts of rain during the same period in contrast to most of the LRGV. Temperatures were much higher than usual in the early season. Higher-than-average Heat Unit accumulations occurred in the months of March (+74%), April (+15%), May (+22%), and July (+5.2%) and lower-than-average in June (-2.93%), and August (-9.2%). Approximately 239,850 bales were ginned from an estimated 244,103 planted acres. Insurance adjustments of cotton was high in 2000, thus, the actual harvested acres likely was much lower than the planted acres. Fiber quality was considered to be good overall. Cotton prices again were low ranging from $0.46 to .062 per pound of lint.

Boll weevil activity in cotton was higher than in the last 10 years or more. Fruit loss and high dollar amounts for insecticides were expended in trying to control weevils in 2000. The other insect pest of concern in some fields was cotton fleahoppers. Some fields were sprayed 1 or 2 times, but most fields when the whole LRGV was considered would have been sprayed less than 1 time for fleahoppers. Worms (bollworms primarily) were very sporadic and did not threaten the area's cotton yield potential in 2000.

Coastal Bend (CB)

Cotton was generally planted during the favorable March period, but there were areas where planting was delayed or replanting was required. Soil moisture for planting and early plant growth was adequate. Timely rain was received where cotton was planted on time. About mid season the rains ended, limiting potential production, especially for the late season crop which included much of the Upper Gulf Coast acreage. More than 50% of the acreage was planted in the following varieties: DPL50, FiberMax 832 and 989, DPL 436RR and DPL 20B. Yields ranged from 300 (severe drought) up to 1,800 lb lint/A and averaged over 700 lb/A.

Thrips numbers increased in seedling cotton and treatments were required, especially on the Upper Gulf Coast. Aphids reached treatment threshold on a high percentage of the acreage between 2 true leaves and bloom. Cotton fleahopper numbers were below or just at treatment threshold during the critical square set period. Bollworm (BW) and tobacco budworm (TBW) infestations were moderate and a substantial amount of the acreage was treated once for these pests. Tobacco budworms were the predominant species on late fruiting cotton. No control problems were experienced as long as pyrethroids were not used for TBW. A low percentage of transgenic B.t. cotton was treated one time for BW. Stink bug, looper, *Lygus*, spider mite and cutworm numbers were low. The southern armyworm was present for the first time on Upper Gulf Coast cotton, but only a small acreage was treated. The Lower Coastal Bend boll weevil eradication program is currently in the third full season and boll weevil numbers were well below economically damaging levels. Outside the eradication area (Upper Gulf Coast), boll weevil damage ranged from moderate to severe. Cotton stalk destruction for boll weevil control was considered good in the lower Coastal Bend and poor in the Upper Gulf Coast. Pheromone trap catch for the year was low in the eradication zone and high outside the zone.

Southern Blacklands (SB)

The 2000 cotton crop was planted three weeks early because of a mild winter and good soil moisture conditions in early spring. The crop grew off well with very little replanting except for a hailstorm in the Mumford area of Robertson County, TX. Early season pests in the dryland areas were of considerable concern. Thrips and fleahopper delayed fruiting until treatments were applied. Boll weevil continues to be the major insect pest. Most cotton fields received two overwintered boll weevil treatments. A major part of the irrigated acreage in the Brazos River area received a third treatment for early season boll weevils. Warm weather and good rains made the cotton grow well in April and May.

Most mid-season treatments to cotton were directed toward boll weevil control. It was June before all boll weevils were out of overwintering sites. The summer was dry and hot. A new "all time high" temperature was set this summer with a high of 112 degrees. Night time temperatures were hot with 16 new records recorded at College Station, TX. Some irrigated cotton fields received 4 to 5 applications of supplemental water. Cotton fruited well with the hot weather and the 2000 cotton crop was harvested about a month early. Many producers had completed harvest by mid September. Yields were better than the 1999 crop but fiber strength was lower for the 2000 crop. Some irrigated cotton was treated 12 to 14 times for boll weevil control. Bt cotton produced well with some treatment for bollworm in mid season. Acreage of transgenic cotton continues to increase in the area.

Northern Blacklands (NB)

The cropping season began with good soil moisture, but yield potential was significantly reduced by hot and dry weather conditions in July and August. Insect activity overall was somewhat less than in previous years. Overwintering numbers of boll weevil were high and most fields received a single application for this pest. However, drought conditions in mid-summer delayed in-field reproduction and very few fields required in-season treatments for boll weevil. Fleahopper numbers were the lowest observed in the past ten years. Only about 30% of the fields required treatment and a single application was sufficient. This is in sharp contrast to the 1999 season when infestations were so high and sustained that multiple treatments often did not provide adequate fruit protection. Cotton aphids were present in most fields, but numbers usually remained below treatment thresholds. Aphid predators were often observed and believed responsible for suppressing aphid numbers. Furadan was available under a Section 18 and was used on the small percent of fields which required treatment. Economic infestations of other mid-season pests, including bollworms, *Lygus*, and spider mites, were uncommon and localized. Where bollworms required treatment, Tracer was commonly used to avoid flaring cotton aphid infestations. Acreage of Bt cotton continued to decline due to consecutive years of low bollworm pressure, lack of yield response, and the higher cost relative to non-Bt varieties.

Northern Rolling Plains (NRP)

The cotton growing season started with hot, dry conditions and inadequate planting moisture. Rain in late May provided needed planting moisture for parts of the area, and there were several good rains in June. However, in mid-June parts of the area remained too dry to plant. July, August and September were dry and hot. Most cotton was planted from May 26 through June 20. Record high temperatures on May 23 and 24 were especially hard on seedling cotton. Cool, cloudy conditions during June resulted in slow stand establishment. In late June, high winds whipped seedling cotton on sun baked soils resulting in plant girdling and poor stands. With seedling cotton growing slowly, thrips continued to migrate into and damage cotton during much of June.

The cotton acreage is estimated at 460,000 acres, up about 10 % from last year. Stand establishment, with the dry spring and cool weather in June, was very difficult, and several producers who failed to establish a viable stand chose not to replant.

Boll weevil eradication programs are underway in the Central and Northern Rolling Plains Zones, which includes the entire area. This was the first full year of ULV malathion applications in the Northern Rolling Plains Boll Weevil Eradication Zone (NRPBWEZ) and was the third full year in the Rolling Plains Central Boll Weevil Eradication Zone (RPCBWEZ). During September and October an average of 0.04 and 3.33 boll weevils per trap week were captured in the RPCBWEZ and the NRPBWEZ. With the drought conditions this summer, heavier boll weevil infestations were in areas where there was some irrigated cotton. Next year should be the clean-up year in the RPCBWEZ with most of the insecticidal applications applied from mid-June through mid-July and from mid-August through September.

In the NRPBWEZ, largest numbers of boll weevils were in the western part of the zone. Heaviest infestations were in the Turkey area of Hall County. About 23,500 of the 27,800 irrigated cotton acres or 85% are in the western part of the zone. From Hardeman and Foard counties east through Wilbarger, Wichita, Archer and Clay counties, boll weevil numbers have been reduced to very low levels. In these counties most of the irrigated cotton is in Hardeman and Wilbarger counties. With good isolation, boll weevil mortality was at a high level due to the drought and reduced treatment thresholds starting in September; boll weevil numbers were well below those in the western part of the zone. With the two active boll weevil eradication zones in the area, boll weevils did not cause economic damage.

Grasshoppers damaged developing cotton stands during late June and early July, and in a few areas were still a problem through late July. Heaviest infestations were on the eastern side of the area. Some fields in the western part of the area were damaged, but most of that damage was limited to field borders.

Cotton fleahoppers increased in fields and were a concern in later planted cotton in mid-July. However, ULV malathion applied for boll weevil control suppressed fleahoppers. They caused little damage, because by the time they increased to damaging levels hot, dry weather was the primary factor limiting square set and boll retention.

Bollworm moth numbers captured weekly in pheromone traps prior to and during the growing season were well below the average established during the 1982 -1999 growing seasons. Tobacco budworm numbers were higher than normal in late April through mid-May, but they were below average during the remainder of the production season. There was little bollworm and tobacco budworm damage in dryland fields. Cotton with the Bollgard® gene was planted on most of the irrigated acres, and only a limited amount of insecticide was used for bollworm control. Even in irrigated cotton without the Bollgard gene, only one or two insecticidal applications were applied for bollworm control.

Beet armyworms began increasing the week of June 22 and continued to increase through July. Infestations were often found in fields where Round-Up Ready® cotton was treated for weed control and beet armyworms moved off the weeds onto cotton. Beet armyworm egg masses were found in cotton by mid-July. By July 19, heavy infestations including all stages were found in drought stressed dryland cotton that was in the first week of squaring. By the following week beet armyworms in populations of up to 20,000 per acre caused extensive foliage loss, destroyed some terminals, and were feeding on squares. Infestations were decreasing, especially in drought-stressed cotton by August 9, but damaging infestations continued to be found in irrigated fields in the northwest part of the area. Some irrigated fields were treated twice for beet armyworm control. By August 1, Steward® and Denim® were no longer available for beet armyworm control, and second beet armyworm applications were with Confirm®, Dimilin® or Tracer®.

Cotton aphid increased during July, and by July 12 aphids were generally distributed throughout the area. Infestations ranged from an occasional winged aphid to developing colonies in plant terminals and on squares with heavy infestations in spots. Infestations continued to increase through the week of August 9 when populations crashed. Furadan7 4F was cleared by the Texas Department of Agriculture under a Section 18 label for cotton aphid control in Extension Districts 1, 2, and 3 on July 27, based on information provided by Ronney Carpenter, Paymaster Gin at Quitaque. Furadan use was limited, and most was used in irrigated fields during the week of August 2. In late August and into September cotton aphids rebuilt in fields that were not severely drought stressed.

What appears to be bandedwinged whiteflies were found the second week in August in several fields in Wilbarger County, and by late August infestations were developing in irrigated cotton in Knox County. Where there were heavier infestations whiteflies produced large amounts of honeydew. Rains of 7 to 10 inches in October and early November thoroughly washed the lint, and the whitefly honeydew should not be a problem.

Primarily because of the dry winter and drought conditions from late June through September, cotton yields are estimated at 175 pounds of lint per acre. Insect damage was light and much of it was masked by extremely dry conditions. Much of the cotton in the area will not be harvested. Yields in irrigated fields where producers were able to keep up with the plants' moisture requirements will be in the 2 to 3 bale range, but in this area, irrigated cotton represents about 6.5 percent of the acreage, and of that adequate water is available to fully irrigate about 30 percent.

Southern Rolling Plains (SRP)

The 2000 cotton production season was set up for failure from the start. The 1999 season was extremely dry and rainfall was 70% below normal for the area during the winter of 1999 and early spring 2000. Producers with irrigation average two pre-watering applications but the planting profile was still marginal. Weather patterns changed briefly in May and early June and most of the region received enough rainfall to plant the crop. The Southern Rolling Plains (Mason, Schleicher, Tom Green, Concho, Runnels, McCulloch, Irion, Coleman and part of Taylor County) planted approximately 400,000 acres of cotton. The region averages about 300,000 acres. The additional acreage was due to failed wheat acreage and a shift from grain sorghum. The Fisher, Jones, Nolan, Scurry and Mitchell County area planted approximately 280,000 acres. The region plants about 25% Bt cotton and most (95%) of the acreage does have some type of herbicide transgenic cotton.

Approximately 50,000 acres of some type of irrigation is present in the region. Much of this acreage was affected by limited water. Early season pests were minimal. Wild hosts were limited, and thrips did not have the typical wheat crop to build up populations. Where seed beds were established early and the moisture profile was adequate, the crop started well. Fruiting rates were maintained well above 85% for the first three weeks of squaring. As with thrips, cotton fleahoppers were not a problem in the Southern Rolling Plains because of a lack of wild hosts. Cotton fleahoppers were a minor problem in the northern area because of greater rainfall and more wild hosts. Unfortunately, rainfall ended by mid-June and the crop rapidly degraded through the month of July. By July 15, 200,000 acres were failed in the Southern Rolling Plains.

Pest problems were concentrated in the northern region (Mitchell, Scurry, Fisher, Jones and Nolan counties), but they were minimal. Bollworms and beet armyworms were a minor problem in the irrigated acreage. Limited spraying occurred on approximately 3,000 acres for lepidopteran pests. The area did see a late build-up of bandedwinged whitefly and western flower thrips, but the crop was not susceptible late into the season.

Approximately 165,000 acres of the 680,000 planted in the region will be harvested. Harvest is delayed due to late season rains that were too late to help yields. Final yields on harvested acreage will range from 100 lb lint per acres on dryland to 1000 lb lint per acre on irrigated acreage.

High Plains (HP)

The 2000 season began with poor soil moisture. With much of the dryland acreage to the south and irrigated to the north, above normal April and May temperatures encouraged producers to the north of Lubbock to plant before the traditional early planters to the south. Good rains in June in some areas allowed the dryland crop to be planted and get off to an excellent start. In fact, some of this dryland acreage looked just the same as irrigated, i.r. large plants with large leaves. Other dryland areas to the south of Lubbock received very little of these June rains, failed to establish a productive stand, and were failed fairly early. While there was a very low acreage lost due to typical spring storms which bring hail, heavy rains and plant-stand-destroying winds, a considerable percentage of the dryland crop was lost or had their yields decreased significantly due to the lack of rains between June and September. Further weather losses occurred at the end of the season when rains and wind prevented timely harvest. Production estimates declined from 3.2 million bales in late August to less than 2.4 million bales the start of December. Weathering losses also reduced fiber quality, bringing discounts as much as $0.10 per pound.

Early season thrips infestations were lighter than in some years, but their movement into cotton was over an extended period. Weather appeared to reduce the residual effectiveness of many planting insecticide treatments, requiring additional foliar sprays to compensate. Some early cold weather slowed the crop initially, resulting in more vulnerability to thrips damage.

Both cotton fleahopper and plant bug (*Lygus hesperus*) infestation levels were far below the record levels observed in 1999. This was probably due to the reduction in alternate wild hosts for both these species because of the drought and the impact of multiple applications of ULV malathion used in the active boll weevil eradication programs. The only area where *Lygus* was a problem was in the Eastern Plains area, where boll weevil eradication is yet to be initiated. It was the number one pest here. Other *Lygus* problem situations were concentrated next to cultivated alternate hosts such as potatoes, alfalfa and peanuts.

Boll weevil winter survival was reduced due to desiccation in their very dry overwintering sites. Winter temperatures were not low enough to cause much mortality. Even with this mortality, boll weevil numbers emerging from overwintering sites in 2000 were high, and survival of the F_1 generation was also high due to the soil shading provided by lush plants resulting from June rains. As a result, multiple overwintered boll weevil applications were needed on much of the acreage in the inactive eradication zones. Boll weevil numbers exploded in late August and into September and October, requiring as many as 4-6 applications. In Spite of these applications, most producers lost their top crop to weevils. This often represented a 13-25% yield reduction. Boll weevil numbers in the three active zones in the High Plains (Northwest, Permian Basin and Western) were greatly reduced by the eradication program applications. However, the Northwest Zone had some difficulty with migration from New Mexico and the inactive zones to the east and south late in the season.

Bollworm numbers were higher than last year but still at record low levels. Most fields treated for this pest were triggered by other pest problems. The severe reduction in corn acreage in the northern area greatly reduced the magnitude of bollworm infestations in August. Control problems developed in a few fields where species identification indicated the presence of pyrethroid-resistant tobacco budworms.

Beet armyworm infestations were the heaviest observed since the crisis of 1980. While levels in 2000 probably equaled or even surpassed levels in 1980 in some instances, the aggressive control strategy adopted by many producers probably limited yield losses somewhat while increasing control costs substantially. These beet armyworms started in pre-squaring cotton in the Western eradication zone southwest of Lubbock and progressed northward in July and August. While their numbers were much lower in the dryland acreage they initially infested, their chronic presence and square feeding resulted in significant yield losses if not controlled. Some decisions in dryland cotton were hard to make because of the likelihood that some of the fruit protected would be lost to moisture stress later on anyway. Mixed in with these beet armyworm infestations were often cabbage loopers and bollworms, and sometimes aphids and boll weevils. This made control decisions and chemical selection more difficult and more expensive. Defoliation in some cases was heavy, exceeding the 35-45% level often used to make control decisions. Late August and September infestations caused considerable defoliation and "boll grazing" damage but this resulted in very little yield loss.

The presence of multiple pests, the extended infestation period, and the expense of beet armyworm control made decisions tough for producers. Some growers treated as many as four times, spending as much as $30.00 an acre for an application. Section 18's were available for Denim, Steward and Intrepid, but only Steward was available at times in sufficient quantities to make a difference. Growers were reluctant to use both Intrepid and Confirm because of their slow activity but those that did liked the level of control and extended residual activity. Most treatments consisted of either Tracer or Lorsban. Lorsban saw considerable use during the week when all the other materials were scarce. Coverage was critical for the performance of these newer materials, especially Tracer.

Cotton aphids were a sporadic pest, causing some concern early during the blooming period. High levels of lady beetles and the apparent inability of drought-stressed plants to carry very many aphids tended to keep many infestations in check. High numbers did develop as cotton opened in some fields, causing some producer concern. Fall rains eventually washed away the potential sticky cotton threat.

Overall, drought had the biggest impact directly or indirectly on production in the High Plains. These dry conditions encouraged the buildup of beet armyworm and looper infestations and limited the management options available to many producers. The boll weevil eradication program was a great success, in spite of the associated beet armyworm problem. The Texas Boll Weevil Eradication Foundation used a sliding trap threshold to insure during times of high risk from beet armyworms that individual work unit acreage treated never exceeded 10-15% per week. While no one can determine for certain that the Foundation was entirely successful in this strategy, there is no definitive evidence to the contrary.

Far West Texas (FWT)

Cotton producers in the Trans-Pecos and El Paso production areas generally experienced average spring and early summer temperatures and rainfall in 2000. Temperatures were above normal and rainfall below normal during spring for the St. Lawrence production area. Unfortunately, this is the region where all of the dryland cotton production occurs. Unless pre-watered, rainfall amounts generally were not high enough for producers to plant dryland cotton during the late April to mid-May planting period. Warm spring temperatures; however, ensured fast growth of seedling cotton where adequate soil moisture was not a limiting factor. Many dryland producers did not start planting until mid-June when adequate rainfall provided good soil moisture. Rainfall amounts exceeded 5 inches in some areas, causing local flooding and reduced cotton stands. Summer temperatures were good for cotton growth, but rainfall through July and August was generally light and sporadic, resulting in highly variable yield potentials for the dryland production area. Most dryland cotton cutout by late August and harvesting was initiated by mid-September. Overall dryland and irrigated yields were average for the area.

Insect pest populations across the Far West Texas region were sporadic and generally treated on a local basis. Most of the insect pest problems occurred in the irrigated cotton production (Trans-Pecos and El Paso) region. Insect pests were generally not a problem for dryland cotton producers. Cotton fleahopper was the only widespread pest that received pesticide treatments. Greater than half the planted cotton acres received pesticide treatments for bollworm, pink bollworm, and cotton aphid in the Trans-Pecos and El Paso production areas. Stink bugs continued to cause economic damage in the Trans-Pecos area with greater than 75% of the acres treated to control this pest. Bt cotton more than doubled in planted acres over 1998. This occurred primarily because of technology fee price restructuring and its effectiveness against various lepidopterous pests. Boll weevil eradication was approved for the Permian basin region and the El Paso-Trans Pecos region this year. A diapause program was initiated this fall for both regions with the first full season of eradication beginning in 2001. The St. Lawrence region did not vote in the boll weevil eradication program, but will continue with a producer-funded boll weevil diapause program that has been in place for approximately 30 years.

Virginia

An estimated 107,000 acres were planted in 2000 in Virginia. Early season cool and dry conditions caused delayed planting in many fields. Overall dry soil conditions during planting time, followed by intermittent rains, resulted in uneven plant stands, and in many fields, non-uniform seedling emergence. In dry fields, plants emerged only in areas where soils were heavier and had moisture. Intermittent rains about two weeks after planting allowed most other plants to emerge. This resulted in fields with basically two plant ages and sizes and caused difficulties throughout the rest of the season in terms of timing of post emergence herbicide applications, insect management, and application of growth regulators.

Once into the season, rainfall continued and ranged from more than ample to excessive, depending on location. Overall, the season was wetter than normal and considered by some to have been one of the wettest in recorded history. This caused additional problems with nutrient leaching, excessive plant growth and poor timing of herbicides, plant growth regulators and insecticide applications.

With all of these challenges, the crop looks good and yields are optimistically estimated at 800 pounds lint per acre. At the time of this writing, many producers are behind on application of harvest aids and predicted cool weather may limit the effectiveness of late applications.

Estimates of cotton acreage planted to cultivars with the BG gene range from 25-50%, depending on the estimator and area of the state. Most of that was stacked gene RR/BG cultivars. None were known to be planted with BG alone.

Cool, dry early-season conditions resulted in both heavy thrips populations and slow seeding growth – the worst possible combination for creating the potential for excessive thrips damage. Preliminary data show 300-400 lb lint/acre losses in unprotected vs. protected cotton. Most producers applied Temik 15G in furrow, or on a limited basis Gaucho 480 to seed, for thrips control. The heavy thrips pressure required most producers to make an average of 1.5 foliar applications/acre, up from 0.75 in 1999. Many producers, especially those with RR cotton cultivars, elected to tank-mix thrips insecticides with post emergence herbicides. Unfortunately, waiting for the herbicide application delayed the application of insecticides and allowed seedlings to sustain rather high levels of thrips damage.

Although there were several reported product failures, investigation showed that a combination of factors (excessive thrips pressure, delayed insecticide application, insufficient coverage or insecticide rate) was responsible for thrips damage. Where treatments were timely, good coverage was achieved, [and rates were sufficient], and thrips control with standard insecticides was excellent. Spot samples of thrips populations did not reveal new species, but predominantly the common *F. fusca*.

Cotton aphid populations were unusually high in many fields (estimated 25%) and at an unusual time. Where populations normally occur at two times, on seedlings soon after early season foliar thrips treatments or soon after bollworm treatments in August, in 2000, populations built up and persisted almost throughout the squaring and early flower period in June and July. Although beneficial populations were also large (predominantly lady beetles and parasitic wasps), aphid populations remained active causing damage especially to terminals. Based on previous experience and lack of product efficacy or availability, producers were advised not to treat, but to give beneficials time to bring aphid populations under control. Aphids did finally disappear in late July and did not resurge.

Bug damaged fruit, especially young bolls, became evident in 5-10% of fields in June and July. Most appeared to be *Lygus* rather than stink bug. The problem appeared to be more common than in previous years. Some fields showed as much as 15-20% damage during the early boll formation period, although it was difficult to find nymphs or adults in the numbers that would have caused that amount of damage. An estimated 1000 acres were treated with pyrethroids, and this was prior to the initiation of bollworm sprays.

Bollworm populations were moderate and lower than expected based on mid-July field corn surveys. Excessive and frequent rainfall most likely accounted for the reduced pressure by drowning some pupae in corn fields, washing off eggs and in general, creating less favorable conditions for bollworm survival. However, most producers made two applications for bollworm, as recommended, based on initiation at egg threshold. There was much discussion about product choice, spray rates and intervals.

A first year cypermethrin adult vial testing program – 2 locations, 9 sampling events, 843 moths - (Craig Payne, State Univ. West GA) revealed rather alarming levels of moth survival (as high as 23% at the 5ug rate in early August). These results have not been analyzed and are considered preliminary.

ECB populations were very high in one location where producers planted strip till into fields with existing volunteer corn plants. Larvae damaged main stems and petioles early in the season. No other infestations were reported. In general, bollworm sprays appear to be preventing ECB population build up or boll damage.

Cutworm - very few reported, reduced compared with previous years.
Fall armyworm - none reported.
Spider mite - spotty, light infestations early, only.
Boll weevil - none trapped.

Research Progress and Accomplishments

Alabama

Research was centered on field trials of new chemistries for lepidopterous species, thrips, aphids, plant bugs and stink bugs; and, evaluations of Bollgard II for broad spectrum lep control. **(Department of Entomology and Plant Pathology, Auburn University, Auburn, AL)**

Arizona

Knowledge of parasite dispersal within and between silverleaf whitefly infested crops is essential for assessing biological agent impact. Our mark-release-recapture studies with *Eretmocerus emiratus* in cotton and melon fields in Arizona have resulted in the development of a unique protein marker applied externally or internally with individuals assayed using a protein-specific antibody. The marking technique has played a major role in securing almost $200,000 extramural funding for the Western Cotton

Research Laboratory. It has also been adopted by other researchers for their studies on insect dispersal.

Work is being done to improve whitefly hatch rates, survivorship and development on an artificial feeding system. Accomplishments include the use of an autoclavable Teflon membrane, optimization of sucrose diet concentration and diet pH, and use of known age eggs (5-6 days). This system will help us better understand how dietary constituents influence various life-history traits of *Bemisia tabaci.* We also tested a number of aphid artificial diets and identified one that is equivalent to the standard yeast extract diet. We are continuing to improve these diets. Whitefly experiments have also identified a 14L:10D photoperiod for producing greater hatch rates, shorter development time, and better survival than a 10L:14D photoperiod.

Imidacloprid (Admire) is one of the most important new chemistry insecticides for whitefly control. We conducted studies to better characterize what lab bioassay results tell us about the relative susceptibility of *B. tabaci* populations to Admire. This work was carried out in the laboratory and greenhouse using whiteflies collected from California and Arizona. We found that Admire uptake diminishes with increasing concentrations. Thus, special precautions need to be taken when interpreting results of Admire bioassays. These results should hold much interest for whitefly workers worldwide who are concerned about potential resistance to Admire.

A whitefly trap developed at the laboratory has been modified to increase trap catches. The innovation may result in greater use of the trap, particularly in greenhouses integrated with parasites, since the trap does not catch parasites in contrast to the most commonly used yellow sticky card traps.

We evaluated the abundance and activity of predators and parasitoids of *B. tabaci* in relation to use of buprofezin and pyriproxyfen use in the field. In general, most predator species are not significantly affected by the use of these insect growth regulators compared with an untreated control. The materials are compatible with biological control in cotton. In contrast, broad-spectrum insecticides are detrimental to the natural enemy complex. Predation and weather were major but parasitism minor mortality factors affecting whitefly eggs and nymphs. We found that several common predators may preferentially prey on parasitized whitefly when given a choice of parasitized and unparasitized prey. These findings have implications for the estimation of mortality rates from life table studies and biological control of whitefly in general.

Entomopathogenic fungi, and insect growth regulator evaluations for *Lygus* nymphs and adults showed that none of the treatments sufficiently controlled high *Lygus* populations. The treatments need to be retested under moderate *Lygus* populations representative of endemic rather than epidemic levels.

We quantified the greater attraction of cantaloupe over cotton to determine the use of cantaloupe as a trap crop to protect cotton. Differences in infestations observed between these two crops in the field substantiated by greenhouse results. The current studies build a strong case for the potential of cantaloupes to serve as a trap crop to protect cotton.

Research is being conducted to develop field-sampling methods using a manual sticky cotton thermodetector (SCT) and an automated, high-speed thermodetector (H2SD). The development of sampling plans has involved three inter-related factors: 1) description of the sampling distribution, 2) selection of the optimal sample unit, and 3) determination of the number and allocation of sample units. Sample data collected from a total of 60 sites from 1995-1999 in Arizona and California. A total of 13 different sample units have been examined. Results showed that lint stickiness is randomly distributed in the field, and that smaller sample units much more efficient than larger sample units. Further analyses determined that more effort should be expended in collecting more samples from the field rather than performing additional thermodetector assays on subsamples from the same sample unit (a common practice in all lint quality measurements).

Development of insecticide resistance by whiteflies is a common occurrence. We are investigating and developing methods of preventing or slowing resistance development. Resistance monitoring results show no reduction in susceptibility to recommended insecticides. In some cases, whitefly susceptibility to certain insecticide rotations and introduction of novel chemistries is successfully combating whitefly resistance development.

Bemisia tabaci/argentifolii is a pest of agricultural and horticultural systems worldwide. Its major impacts on cotton include reductions in yield, degradation of lint quality by honeydew deposition, and the potential threat of virus transmission. Significant progress has been made. *Bemisia* is an "ecosystem" pest, and the current practice of insecticide-based management targeting each affected crop separately is neither sustainable nor economically/environmentally sound. An ecologically based pest management strategy depends on a mechanistic understanding of the factors that govern pest population development in the mosaic of host crops year-round. Experimental plots of alfalfa, fall cantaloupe and native weeds have been established at the University of Arizona, Maricopa Agricultural Center. Sampling of whitefly and natural enemies, and establishment of whitefly cohorts for life table studies will begin in the early fall. Low-temperature-capable incubators have been secured for laboratory portions of the study that will examine survival and reproduction of Bemisia at sub-zero temperatures.

Understanding insect dispersal patterns is often the key to the control of pests. The successful monitoring of insect dispersal often requires a reliable method to mark insects. The marking technique is easier, faster, safer, cheaper, and more stable than the most commonly used techniques for marking. The technique has been adopted by many other scientists and has generated nearly 200 thousand dollars in extramural funding.

Lygus movement from alfalfa to cotton after the alfalfa is cut is a major economic pest issue. We marked *Lygus* with a protein, released them in alfalfa, and recaptured them in cotton. In field cages, topically marked *Lygus* recovered from the cages for at least 17 days. The movement of predators was included in the study, and these results form the base for further studies to quantify movement and impact on crop production as well as methods to control *Lygus*.

Transgenic cotton has been a major technological development, and it is essential to understand how it can be most effectively integrated into cotton production systems. We are studying the susceptibility of pink bollworms to Bt toxin in Arizona, California and Mexicali Valley, Mexico by sampling and bioassaying using the Cry 2Ab toxin. The data will provide the baseline from which pink bollworm populations in the future can be compared to determine if Bt resistance is developing and at what level.

Effects of transgenic and non-transgenic cottons on natural enemies complexes are important issues. Our results suggest that there are no direct or indirect effects of Bt toxins on populations of natural enemies. These results suggest the need for documentation of natural enemy - pest interactions in the two cotton cultures in comparison to conventional chemical control systems.

To investigate grower concern for reduced transgenic cotton efficacy in late-season because of breakdown or non-expression of the toxic protein, we compared the susceptibility of Bt and Deltapine 5415 (non-Bt) cotton bolls to PBW at periodic intervals during the first and second cotton fruiting cycles. High percentages of both Bt and non-Bt cotton bolls had numerous larval entrance holes in the carpel walls of the bolls. Less than 1% of the Bt cotton bolls and over 70% of the non-Bt cotton bolls were found with live PBW larvae. Bt cotton bolls of the late-season second fruiting cycle were as resistant to PBW infestation as Bt cotton bolls of the first fruiting cycle.

Baseline testing of the pink hibiscus mealybug to various insecticides in greenhouse bioassays initiated and field testing of various neonicotinoid insecticides for their potential use in management of this insect initiated. The pink hibiscus mealybug is a polyphagous pest that attacks many crops including cotton. This work was completed in the Imperial Valley, the first site within the continental United States that the pink hibiscus mealybug has invaded. We are building a database for various insecticides that may be effective in future chemical control and resistance management of this pest.

Responses of *L. hesperus* in a Y-tube olfactometer are being conducted to identify potential volatile plant attractants. Year 1: Using behavioral tests (y-tube olfactometer), we will determine the cues that both 5th instar nymphs and adult *Lygus* respond to when searching for their host plant. Year 2: We will analyze the headspace volatiles of our plant material and identify potential attractants. Year 3: Synthetic attractants will be tested in a variety of venues: Y-tube olfactometer, horizontal wind tunnel and in field trials if promising compounds are identified.

The integration of additional Bt cotton cultivars featuring the new Cry 2Ab toxin is being implemented in cotton production systems nationwide. Data gathered in our laboratory for the pink bollworm will be especially useful in those states where pink bollworm is a significant pest.

Silverleaf whiteflies, a major cotton pest, are adapted to survive in extremely hot and arid environments. The involvement of sorbitol accumulation and heat shock proteins as mechanisms for thermotolerance was assessed. The research found that both mechanisms operate in response to heat stress; sorbitol provides a long termed response and heat shock proteins provide rapid relief. The research demonstrates that ketose reductase, the enzyme that synthesizes sorbitol in whiteflies, would make a potential target for controlling whiteflies.

Environmentally friendly approaches to silverleaf whitefly control, including the use of insect pathogens, are needed for cotton production. The Chilo iridovirus was introduced into whitefly cell cultures to determine if this virus may be a candidate whitefly pathogen. We demonstrated that whitefly cells susceptible to virus infection. Identification of the Chilo iridovirus as a whitefly cell pathogen indicates that the virus may provide a novel approach for whitefly control.

A major accomplishment has been pioneering research detailing the biological mechanism that confers heat-stress tolerance to silverleaf whiteflies and aphids. The mechanism involves the accumulation of polyhydric alcohols (polyols) which act as thermoprotectants, allowing enzymes to remain functional under high temperature conditions. Considerable evidence has been provided that demonstrates a direct relationship between sorbitol accumulation and decreased mortality in whiteflies. The enzyme that regulates sorbitol biosynthesis, ketose reductase, has been isolated and cloned, and this enzyme utilizes a novel mechanism that was heretofore undescribed. This enzyme provides a potential target for developing a new biorational approach to controlling whiteflies and, as such, the research has generated considerable interest from industry. This research led to investigation of aphid metabolism and it appears that aphids possess a similar heat-tolerance mechanism as whiteflies. Aphids accumulate mannitol in response to increased environmental temperature. Although the biochemistry has not been elucidated to the same extent as for whiteflies, the evidence is strong that this mechanism may provide a new approach for aphid control.

Stickiness of harvested cotton, caused by fecal secretions (honeydew) produced by whiteflies, is a major problem for the cotton textile processing industry. Research focused on identification of the complex mixture of carbohydrates in whitefly honeydew has contributed to solving this problem. A major sticky component of honeydew is trehalulose, a carbohydrate that is not found in the insect gut but is produced as it passes from the insect. Several other components of honeydew have been identified and characterized. In collaboration with industry, an enzymatic method to digest and thereby eliminate honeydew carbohydrates on cotton was tested on a large scale. The method has potential to be developed for use by the cotton industry.

Significant progress has been made in efforts to crystallize ketose reductase, a silverleaf whitefly enzyme that impacts adaptation of this serious crop pest to high temperature environments. The crystal structure of this enzyme should be completed during this year, allowing for detailed molecular analysis of the enzyme. This will provide a new mechanism for the design of chemicals that could be used to inhibit the enzyme and provide a novel approach to controlling this pest.

We have identified, characterized and purified a key enzyme in silverleaf whiteflies that regulates carbohydrate metabolism of the insect and has potential commercial value. We have prepared the paperwork for submitting a patent for various uses of this enzyme, but it must be cloned prior to submitting a formal patent. We hope to finish this work during FY2002.

We will complete a comprehensive analysis of how plant nitrogen nutrition regulates nitrogen metabolism of the silverleaf whitefly. Specific effects on insect reproductive efficiency will be determined. Mechanisms regulating synthesis of rare amino acids, including involvement of whitefly endosymbiotic bacteria, will be identified. This research will provide necessary fundamental information relevant to development of novel management approaches to control whitefly outbreaks.

Pathways for carbohydrate metabolism in whiteflies characterized to determine their potential as targets for control. The research examined pathways associated with high temperature tolerance and examined how inhibition of these pathways affected survival. The research showed that polyol accumulation provides whiteflies with an unconventional mechanism for high temperature survival and that the process depends on the activity of an unusual enzyme called ketose reductase. The research identified a process in whiteflies that could be the focus for development of new and very specific compounds to control whiteflies.

Cotton fiber stickiness due to cotton aphid honeydew is a major problem in the textile manufacturing industry. This is the third year of our investigating this problem by testing the effect of various insecticides on subsequent population outbreaks of the cotton aphid (*Aphis gossypii*). It is our hypothesis that spraying for other insects alters the cotton leaf food source for aphids, leading to aphid population outbreaks several weeks following spraying. We have been testing this hypothesis by analyzing leaves from sprayed cotton fields in Vernon, TX for soluble sugars, starch and total amino acids at weekly intervals. These results are being compared to aphid population behavior in these plots. Of all the variables tested, populations of cotton aphids best-tracked cotton leaf sucrose and moisture contents in field experimentation in the high plains of Texas.

Little is known about how plant nitrogen nutrition influences nitrogen metabolism of the silverleaf whitefly, although such information has important implications in management of this insect pest. A procedure was developed to analyze free amino acids in the whitefly, and the effect of cotton N nutrition on amino acid uptake and metabolism by the whitefly was determined. With two days of feeding on nitrogen-deficient cotton plants, the amino acid content of whiteflies was decreased and the excretion of amino acids was nearly completely eliminated. Nitrogen fertility management could have a large impact on whitefly populations.

Cotton fiber stickiness due to honeydew from phloem-feeding insects is a major problem in the textile manufacturing industry. This project is designed to identify the sticky components in honeydews, the chemical mechanism of their formation from dietary sucrose, and to determine ways to ameliorate the sticky nature of cotton from honeydew-infested fields. Using a thermodetector to analyze honeydew allowed to fall on clean cotton, it was found that honeydew secreted by the silverleaf whitefly was considerably stickier per unit weight on cotton fiber than honeydew from the cotton aphid, even though honeydew from the former insect occurs in smaller droplets. Therefore, threshold levels at which problems occur in textile mills might be different for the two honeydews.

Aflatoxins are carcinogenic toxins produced by members of the *Aspergillus flavus* group of fungi. There are currently no methods that growers can apply in order to reliably and economically prevent aflatoxin content of crops from exceeding mandated levels. It has recently become apparent that the aflatoxin producing potential of fungi resident in agricultural areas might be reduced through competitive exclusion by atoxigenic strains. However, the utility of atoxigenic strains in commercial agriculture needs to be determined and methods are needed to optimally utilize atoxigenic strains both regionally and locally. A process for production of commercially useful quantities of high-quality atoxigenic strain inoculum is needed in order to adequately test and develop field aspects of atoxigenic strain technology. Development of a production process that is also economical is necessary to create a potential for this technology to become commercially useful.

A pilot scale process capable of producing 1,400 lb. of material per day was developed by ARS in collaboration with the Arizona Cotton Research and Protection Council and is under evaluation at a pilot facility under construction in Arizona. This process is the second phase of the scale-up and retains the initial criterion of being able to be run by a relatively low technology grower organization. The second phase pilot-process was used to produce over 100,000 lb. of atoxigenic strain inoculum used to treat over 10,000 acres of cotton included in trials directed at developing protocols for area-wide aflatoxin management programs based on atoxigenic strain technology. Atoxigenic strains may become the first practical technology for limiting aflatoxin contamination on the farm. **(USDA-ARS-Western Cotton Research Lab, Phoenix, AZ)**

Five nominal thresholds for Lygus chemical control were examined in a large, replicated field design and compared with an untreated control. Lygus population dynamics and resulting yields, quality and economics were measured and analyzed. For the second year, the most economical approach was to control Lygus under the '15/4' threshold. This level (15/4) denotes 15 total Lygus bugs per 100 sweeps with at least 4 nymphs. Taking action based on total or adult numbers only will generally result in more sprays and a potential for lower yields, and lower economic returns. This test confirms the newly introduced (1999) Lygus action threshold recommendations. In a companion study, 3 Lygus control compounds (Orthene 97, Vydate C-LV, Regent) were rotated according to 3 different rotational regimes. This study was initiated after 1999 to identify confounding factors in threshold studies that depended on a set rotational regime. I.E., if the control period was initiated with Orthene rather than Vydate or Regent, could one expect a different outcome? The results indicated no significant differences among the 3 different regimes suggesting that the order in which these compounds are used should not influence conclusions about Lygus thresholds.

Lygus population dynamics were monitored weekly starting in March throughout the agricultural landscape of Western Pinal County. This effort was initiated to identify any sources or harborages for Lygus as well as to inform growers about the movement patterns and management options available to them. An advisory group of growers of cotton, alfalfa, and seed-alfalfa guided the effort and reviewed results weekly. Sampling concluded in July and helped to identify the relationship between these 3 production systems (cotton, alfalfa for forage, and alfalfa for seed). In addition to these crops, weeds were also monitored. Other crops grown within the area included melons (cantaloupes and watermelons), potatoes, small grains and experimental crops (e.g., lesquerella). All of the samples were georeferenced and the entire community mapped. Future analyses should reveal the relative attractiveness of each host crop within the community.

In a sixth year of large-scale integrated whitefly management tests, we established three treatment blocks (IGRs, conventional chemistry, and UTC) totaling 21 acres. In addition to documenting historical trends in whitefly population dynamics and relative number of sprays required by regime, this study was designed to produce "sticky cotton" within the UTC. The crop fruited very quickly and cut-out well in advance of normal production for this area. This combined with timely late season rains mitigated what stickiness may have been present. All samples revealed non-sticky cotton regardless of the regime. The IGR regime required just 1 spray, and the conventional chemistry regime required 2 sprays against whiteflies.

Seasonal population and mortality dynamics of whiteflies are under intensive study in a collaborative research project with the USDA-WCRL. Field study areas have been established at two climatically different locales in AZ (Yuma and Maricopa). In each area, multiple host plants are established in a large matrix of replicated plots. These plants include cotton, cantaloupe, broccoli, alfalfa, Lantana, and winter and summer weed assemblages (dominated by Malva spp. and *Physalis wrightii*). Life tables are being constructed for natural and artificially-established cohorts in each host plant area. Early and repeated frosts in the fall and winter of 2000 have contributed to high rates of tissue damage, desiccation and death. These conditions lead to high, if not, complete whitefly egg and nymphal mortality. Air temperatures have been as low as 27 F. This study should better explain whitefly seasonal survival and pest potential across Arizona's diverse agricultural landscape. This, in turn, could lead to opportunities for exploiting weaknesses in this species life and seasonal cycles.

A series of tests was conducted with Bt transgenic cottons. In 2000, a second and final year of study was completed for a "non-target organisms" study. One recurrent parent and Bollgard and Bollgard II transformed varieties were compared under three different insecticide regimes, UTC, leps unsprayed, and sprayed. Boll-, plant-, canopy-, and ground-dwelling arthropods were surveyed throughout the growing season. All taxa have been or will be differentiated into morphotypes and counted. Arthropod communities under the nine different systems (3x3) will be compared and contrasted to identify positive, negative, and incidental effects of the transgenes. In addition to arthropod abundance, efficacy on pink bollworm was measured. Bollgard provides outstanding protection against PBW damage and survival; however, Bollgard II demonstrated control and/or limits to PBW development at an order of magnitude higher than original Bollgard.

Fifteen experimental varieties from five families and including single or multiple combinations of 4 different Bt transgenes were studied for agronomic and entomologic performance. Within some families, 1-gene (Cry1AC or Cry2AB) and 2-gene isogenic lines were compared to their null, untransformed counterparts. In all but one instance, the Bt transgenic varieties provided excellent control of natural and artificial infestations of PBW. The 2-gene versions provided even superior, nearly complete, control and cessation of PBW development. Agronomic performance of each variety was excellent and comparative to the family from which they were derived. No developmental or performance anomalies were noted. A second lepidopteran was also examined and evaluated under natural conditions, Citrus Peelminer (Mamara spp.). In this case, all Bt varieties exhibited a high degree of control; however, the Cry2AB either alone or in combination provided even greater control of the CPM.

The adoption of Bt cotton varieties has risen rapidly in the locations of Graham County where the pink bollworm pressure is the greatest, so a comparative demonstration was performed on the Safford Agricultural Center in the 2000 cotton growing season. Three different cotton types (Pima, Non-Bt Upland and Bt Upland) were grown in blocks which were treated with two different insecticide regimes (only pyrethroids vs. a pyrethroid / organophosphate rotation). Comprehensive post-mortem plant mapping was performed, and yields were obtained from the different demonstration areas. The objectives of the study were to demonstrate the effectiveness of the Bt technology in reducing insecticide use and its effect on the 'bottom-line' economics of cotton production in high PBW pressure areas, and to add to our database of comparisons between pyrethroid only and pyrethroid/OP insecticide treatments. The results will be forthcoming in the annual University of Arizona College of Agriculture and Life Science Cotton Report (http://ag.arizona.edu/crops/cotton/cotton.html).

Arizona has a long history in chronic insect invasions. As Arizona's agriculture continues to diversify, it has become increasingly important for the "cotton grower" to know what's growing on the other side of the fence. Accordingly, it has become more important for University research and extension faculty to develop research, solutions, and recommendations that are consistent with multiple-crop communities. Our experience during the past decade with Bemisia whiteflies that are shared among melon, vegetable, and cotton producers and with Lygus bugs that are shared among safflower, alfalfa, and cotton producers highlights the importance of developing integrated solutions. Towards this end a Cross-commodity Research and Outreach Program (CROP) is under development in Arizona. This group includes interdisciplinary scientists from across the College and the State. One major pathway to the clientele in the future is through the internet. Our first project, under development in 2000 and slated for introduction in 2001, is a completely integrated crops Web site. The Arizona Crop Information Site (ACIS; http://ag.arizona.edu/crops) will house all of the independent, research-based information that the University produces and provide a convenient "one-stop shopping" experience for producers looking for information about crop production and protection in Arizona. Through this explicit interdisciplinary offering, we hope to better tailor our research and outreach efforts for the benefit of producers of cotton and other agricultural products in Arizona. **(University of Arizona, Maricopa Agricultural Center, Maricopa, AZ)**

Arkansas

Research continues on improving and validating the COTMAN program specifically in areas of early season square loss and irrigation termination. Research is also ongoing in integrating key aphid predators and parasitoids into a treatment threshold model for the cotton aphid. Work is ongoing and expanding in evaluating the lethal as well as sub-lethal effects of newer insecticide chemistries on predators and parasitoids in cotton. **(Arkansas Cooperative Extension Service, University of Arkansas and Arkansas Agricultural Experiment Station, Little Rock and Fayetteville, AR)**

California

Field plots were established to evaluate the effect of registered and experimental insecticidal compounds against cotton aphids, spider mites, *Lygus* bugs, and beet armyworms. For *Lygus hesperus*, the pyrethroid products continue to provide the best control, although the length of residual control has declined compared with 5 years ago. Provado, several organophosphates, and Vydate also provided good control. On spider mites, Zephyr showed good activity at least through 4 weeks after application. Kelthane and Comite were intermediate in terms of activity. Savey, in this test on a developing infestation, also showed excellent activity. Acramite, a product under development, showed control in the same range as Zephyr. Cotton aphids were most effectively controlled with Furadan (~98% reduction). Provado, vydate, and lorsban provided acceptable control. Several experimental neonicotinoid products performed well with Assail being nearly equal to Furadan for aphid reduction. Fulfill also significantly reduced the population level. Research continued on the interaction between applied nitrogen level and cotton aphid population dynamics. In seven grower field plots, there were significantly more aphids in plots with 200 lb N/A compared with 50, 100, or 150 lb N/A. Intensive small plot tests showed that aphid development was 19% faster and fecundity increased 2.5 fold in plots with 250 compared with 0 lb N/A. Plots with 0 lb applied N/A were stressed but produced ~75% of the lint yield as plots from the 100 lb treatment (the highest yielding treatment). Cotton aphid seasonal life history was studied for the second year. Pomegranate trees appear to be the key crop for aphid overwintering in the sexual phase (i.e., eggs), whereas asexual aphids can be found on winter annual weeds, residual cucurbit plants, and citrus during the winter and early spring.

Varieties continue to be introduced in the SJV. To evaluate current pest management guidelines for arthropods, trials continued to be sampled weekly for arthropods for a second year. Nine varieties in 14 replicated trials were sampled weekly for arthropods. Both sweep net counts and leaf samples were collected. No consistent difference was noted among varieties in the same location. Current *Lygus* thresholds have been under evaluation in replicated plots for several years and appear to be relevant.

Insecticide bioassays of *Lygus*, aphids and mites continue to be collected. New methodology for *Lygus* bioassay is under development.

Regional *Lygus* management is a high priority for research and extension activities. Studies were initiated to evaluate the value of alfalfa hay to limit *Lygus* movement into cotton. *Lygus* movement into uncut strips was studied relative to alfalfa harvesting. The implications to hay quality and value were examined through the proportional mixing of old and new hay. Landscape level analysis of cropping patterns and *Lygus* movement has commenced. A western state *Lygus* conference was held in November to bring experts from all affected commodities. A proceeding summarizing the presentations was published (http://www.uckac.edu/cottonipm/). **(Cooperative Extension Service, Kern County, Tulare County, Kings County, Kearney Agricultural Center, Parlier; UC, Davis; and UC, Riverside)**

Louisiana

The geographic distribution of several thrips species found on seedling cotton during 1996-99 was summarized in 2000. After the cotton had emerged, thrips collected and identified by species. Tobacco thrips, *Frankliniella fusca* (Hinds), was the most abundant species collected from cotton seedlings at all locations. Western flower thrips, *Frankliniella occidentalis* (Pergande), densities varied both temporally and spatially among sample sites, but did not exceed 30% of the total thrips sampled at any location within any year. The occurrence of soybean thrips, *Neohydatothrips variabalis* (Beach), also varied greatly (0% to 20%) among locations and years but was more consistent near Winnsboro. Across locations and years, the occurrence of flower thrips, *Frankliniella tritici* (Fitch), (0% to 19%) was variable as well. Factors such as environmental conditions or availability of winter host plants may influence the thrips species infesting seedling cotton. These surveys indicated the presence of western flower thrips at all sites in one or more samples and suggest that western flower thrips may be adapting to seedling cotton in Louisiana. Therefore, the potential for western flower thrips to become established as a new seedling pest of cotton in the regions covered by these surveys should be recognized. In 2000, samples taken at the Northeast Research Station showed that as high as 40% of the total thrips population on seedling cotton western flower thrips. Samples following organophosphate insecticide sprays for seedling thrips control revealed nearly pure populations of western flower thrips.

The potential of reducing tarnished plant bugs, *Lygus lineolaris* (Palisot de Beauvois), by reducing native plant hosts on the margins of cotton fields prior to planting was evaluated in a series of experiments conducted on Panola Plantation in Tensas Parish. Observations included weed density, weed species identity, tarnished plant bug density and reproduction in native hosts, and tarnished plant bug density in adjacent cotton fields. Herbicides applied to kill broadleaf native hosts in February and March. For the first experiment, tarnished plant bug adult numbers low throughout the sample period on native hosts in the vegetation-managed area. Mean density of tarnished plant bug adults (2 per 25 sweeps) and nymphs (1 per 25 sweeps) peaked on May 9 in the vegetation-managed area. In the non-managed area, tarnished plant bug adults on native hosts peaked at ca. 8 insects per 25 sweeps on May 23. Tarnished plant bug nymph populations peaked on April 17 and remained high until May 9. In the second experiment, tarnished plant bug adults averaged less than 5 per 25 sweeps and nymphs averaged less than 3 per 25 sweeps along cotton field borders within the vegetation managed area. Higher densities of tarnished plant bug adults (5 per 25 sweeps) and nymphs (2 per 25 sweeps) occurred in the non-managed area. In both experiments, tarnished plant bug densities in cotton fields low during the sample period. Boll weevil eradication blanket sprays at pinhead square began in these areas during late May. Tarnished plant bug numbers decreased to zero after the initiation of these sprays. Although malathion sprays and routine maintenance of the field borders reduced tarnished plant bug populations, early season sweep data along field borders indicate that populations on wild hosts provide a reservoir for cotton field infestations.

In 2000, several tests evaluated insecticide efficacy against thrips; cotton aphids, *Aphis gossypii* Glover; tarnished plant bug; tobacco budworm, *Heliothis virescens* (F.); and bollworm, *Helicoverpa zea* (Boddie); beet armyworm, *Spodoptera exigua* (Hubner); and soybean looper, *Pseudoplusia includens* (Walker). Several seed treatments including Adage 5FS, Gaucho 480S and other experimental compounds in one or more tests significantly reduced thrips populations below the number in the non-treated control plots, but did not consistently provide satisfactory control of thrips. Similar variation in the level of thrips control with Temik 15G was also observed. The presence of western flower thrips may be influencing the results of these tests. In a foliar insecticide test, Orthene 90S, and Bidrin 8EC provided the most consistent control of thrips adults and larvae on seedling cotton. A pyrethroid, Karate-Z 2.08 SC, did not reduce thrips numbers as much as that observed in the non-pyrethroid treated plots. Actara 25WG, Centric 40WP, Fulfill 50WP, and Furadan 4F provided the most consistent control of cotton aphids and significantly reduced the number of aphids compared to that in the non-treated plots. Cotton plots treated with Actara 25WG, Centric 40WP, Orthene 90S, and Capture 2EC demonstrated significant levels of toxicity to native infestations of tarnished plant bugs in field tests and also against tarnished plant bugs in cage studies. The experimental insecticides, Denim 0.16EC, Steward 1.25SC, and Intrepid 80WP, generally provided satisfactory control of beet armyworm and soybean looper that was comparable to that of Tracer 4SC and Larvin 3.2F. In 2000, tobacco budworm populations were high during August and resistant to pyrethroids. In all tests that included a pyrethroid or pyrethroid as the primary component in a tank mix, numbers of damaged fruiting forms and infestations of tobacco budworm larvae in those plots not statistically different from those in the non-treated controls when the tobacco budworm was the dominant Heliothine species. In those same tests, S-1812 35WP, Denim 0.16EC, and Steward 1.25SC, generally provided satisfactory control that was comparable to that of Tracer 4SC. Louisiana bollworm populations are still effectively controlled with pyrethroids. Tracer 4SC and none of these experimental insecticides demonstrated efficacy levels greater than that provided by the pyrethroids against bollworm, regardless of application timing and larval size. The commercial insecticides, Curacron 8EC and Larvin 3.2F are still effective against Louisiana bollworm populations. Ground application of Tracer 4SC and Steward 1.25SC in 6 GPA was significantly more effective against tobacco budworm than aerial application of the same products at 3 GPA.

In 2000, 30 pairs of pheromone-baited wire cone traps used to survey species composition of tobacco budworm and bollworm. The adult vial test (AVT) was used to monitor pyrethroid resistance in these species. Over 750 tobacco budworm moths assayed for pyrethroid resistance from May to August 2000 using a discriminating concentration of 10 µg in the adult vial assay. Percent survival in May, June, July, August, and September was 45%, 31%, 46%, 73%, and 61%, respectively. Tobacco budworm survival in May and Jun indicates that a large percentage of the tobacco budworm population was resistant to pyrethroids before growers began to use pyrethroids for their control. These data further indicate that pyrethroids may no longer provide effective control of tobacco budworm populations in Louisiana; thus, pyrethroids removed from the list of products recommended to control tobacco budworm. Over 1050 male bollworm moths assayed against a 5 µg/vial concentration of cypermethrin. Percent survival for May, June, July, August, and September. was 14%, 20%, 24%, 12%, and 12%, respectively. No bollworm control failures with pyrethroids documented in Louisiana during 2000. Both species also monitored for susceptibility to spinosad with the AVT. Tobacco budworm survival to 5 µg/vial and 15 µg/vial concentrations of spinosad ranged from 21% to 37% and 0% to 7%, respectively. Bollworm survival to 5 µg/vial and 15 µg/vial concentrations of spinosad ranged from 50% to 51% and 4% to 25%, respectively.

Several Bollgard and Bollgard II cotton cultivars and elite lines evaluated in field trials against native populations of tobacco budworm, bollworm, soybean looper, and beet armyworm. Infestations of these insect pests during August extremely high and significant differences in insect control and seed cotton yield observed among cotton lines. The Bollgard and Bollgard II lines had significantly less injury to fruiting forms compared to that in the conventional lines. Those lines containing the Bollgard II technology had significantly less foliage injury produced by the soybean looper and beet armyworm compared to the Bollgard and conventional lines. Seed cotton yields of the Bollgard and Bollgard II lines significantly higher than that of the conventional lines. However, only a few of the Bollgard II lines actually outyielded the Bollgard standard, NuCOTN 33B.

Fresh cotton tissue bioassays conducted in Northeast Louisiana to investigate bollworm survival on floral structures in Bollgard and Bollgard II cotton. Cotton flower buds (squares) and white flowers removed from NuCOTN 33B (Bollgard) and its parental variety, Deltapine 5415 (conventional). In addition, squares and flowers removed from Deltapine 50, 50B, and 50BII (Bollgard II). Squares and flowers dissected into individual components, placed into 9.0-cm Petri dishes, and infested with bollworm. At 72 hours after infestation (HAI), bollworm survival was higher on square and flower anthers compared with other structures on Deltapine 5415 and NuCOTN 33B. Bollworm survival was higher on all floral structures from Deltapine 5415 compared to the corresponding structures from NuCOTN 33B at 72 HAI. ELISA tests indicated that CryIA(c) expression in Bollgard varied among floral components. Bollworm survival did not always correspond with variation in protein levels. Trends in bollworm survival on Bollgard II were similar to those on Bollgard and conventional cotton. However, survival was lower on all structures of Bollgard II compared to Bollgard and conventional cotton at 72 HAI.

Field studies evaluated differences in bollworm larval movement on conventional, Deltapine 5415 and Bollgard, NuCOTN 33B, cottons. Three experiments included in this study. The first experiment was designed to document differences in bollworm movement on conventional and Bollgard® cotton. When larvae placed in the terminals of non-flowering cotton plants, differences in bollworm movement observed within 1-h after infestation. Significantly more bollworm larvae found in plant terminals of DP 5415 than in terminals of NuCOTN 33B. On flowering plants that infested, significant differences in the number of nodes moved, infested squares and infested bolls observed between DP 5415 and NuCOTN 33B. Similar results detected when multiple adjacent plants infested with bollworm larvae. These data suggest that bollworm larvae hatching on Bollgard cotton move more rapidly down the plants compared to larvae on conventional cotton.

Field tests continued during 2000 in North Louisiana to evaluate the effects of terminating insect control strategies at selected intervals during late season on seed cotton yields. Termination intervals based on cotton plant development used plant mainstem nodes above white flower (NAWF) and heat unit (HU) accumulation. The treatment termination intervals based on crop development rules included NAWF5 + 350 HU and NAWF5 + 450 HU. The termination intervals based on weather oriented rules used 17 August as a final cutout date in Louisiana. Insecticide treatments terminated on ca. August 17 and August 17 + 350 HU. For two cultivars, Deltapine 20B and SureGrow 747, seed cotton yields not significantly increased by applying insecticide treatments NAWF5 + 450 HU. However, as in previous years, yields numerically increased as insecticides applied until the final termination treatment. **(LSU Agricultural Center's Northeast Research Station, St Joseph and Winnsboro, LA; Louisiana Cooperative Extension Service, Winnsboro, LA; and Department of Entomology, Baton Rouge, LA)**

Mississippi

In July 2000, the ARS released a new soybean (*Glycine max*) germplasm line, DT98-2448, that naturally resists leaf feeding by velvetbean caterpillar (*Anticarsia gemmatalis*) and soybean looper (*Pseudoplusia includens*). This line will give soybean breeders an additional option for developing insect-resistant soybean varieties for farmers. DT98-2448 was developed from parentage that includes crosses with DP3589, a commercial cultivar that is adapted to the clay soils of the lower Mississippi River Valley. The other parent, PI229358, which donated the insect resistance, originates from Japan. Both insects can be very devastating pests of soybean in the southeastern U.S. Since its release, 14 seed requests for DT98-2448 have been filled for national and international public and private soybean breeders.

The European corn borer, *Ostrinia nubilalis*, infests corn (*Zea mays*) grown east of the U.S. Rocky Mountains causing an estimated 1 billion dollars worth of damage annually. GEMS-0001 (PI614142) corn germplasm resistant to damage caused by the European corn borer was released by the ARS in July 2000. Parentage from this line yielded 105.3% more kg/ha than the commercial check average. This line will be useful for developing resistant hybrids that can be grown in non-transgenic refuges and for markets that are not willing to use genetically modified corn. Thirty-one requests for GEMS-0001 have been received since its release date. A CRADA is being negotiated with Pioneer Hybrid International, Inc. to develop commercially available hybrids derived from this line.

Thirteen commercially available transgenic Bt cotton cultivars were evaluated in small-scale field plots. The effect of soil type, plant parts, cultivar, and stacking with a herbicide-resistant gene on insect survivorship and expression of the Bt gene (Cry1Ac) was examined for intrinsically tolerant Lepidoptera (i.e. the fall armyworm, *Spodoptera frugiperda*, and the bollworm, *Helicoverpa zea*). Wild populations of high-quality insects were utilized. Eleven commercially available conventional cotton cultivars were also examined as controls. Results indicate that two Bt varieties (NuCOTN 33B & DP458B/RR) sharing the same parental background (DP5415) expressed significantly more Bt throughout the growing season than the other eleven varieties. These data indicate that Bt varietal differences may be under genetic control.

Twenty-nine commercially available cotton cultivars were evaluated in small-scale field plots. Insect efficacy, yield, and quality were recorded. The effect of soil composition on yields and lint quality was examined.

Recent advancements make it possible to determine what a moth species fed on as a larva. The implications of this type of technology are extraordinary for area-wide management of migratory pests such as *H. zea*; however, this technology is in its infancy. Before one can be sure of what a pest fed on as a larva, certain profiles must be developed for different hosts (i.e. wild hosts, corn, cotton, grain sorghum, etc.). Moth species were collected from pheromone traps and larvae from corn and reared on that host until pupation. These individuals were then placed in ethanol and sent to North Carolina State University for analysis.

Studies have indicated that some foliar insecticidal rates can be reduced on Bt cotton compared to conventional cotton. Laboratory and field studies using an insect-growth regulator insecticide (Intrepid®) were conducted for beet armyworms and fall armyworms from Bt cotton and conventional cotton to address these rate definition questions.

Production of insects for state, private and USDA-ARS research by the Stoneville Rearing Unit required maintenance of six insect species: *Heliothis virescens, Helicoverpa zea, Anticarsia gemmatalis, Spodoptera exigua, Cardiochiles nigriceps,* and *Microplitis croceipes*. Support of USDA-ARS scientists at six locations, university personnel at 13 sites, and 24 private industries required production of 147,700 *H. virescens* pupae, 62,250 *H. zea* pupae, 55,601 *A. gemmatalis* pupae, 93,600 *S. exigua* pupae, 136,620 *C. nicriceps* cocoons, 124,959 *M. croceipes* cocoons, 6 million *H. virescens* eggs, 15.5 million *H. zea* eggs, 13.9 million *A. gemmatalis* eggs, and 23.4 million *S. exigua* eggs. Additional research support included mixing, dispensing, and filling 34,310 30-ml cups and 4,047 multicellular trays with artificial diet. Total diet mixed and dispensed in 2000 was 15,328 liters. Several tours were provided to industry and university personnel and 4^{th} though 12^{th} graders from throughout the Mississippi Delta. Approximately 71 researchers located in 33 states and 3 foreign countries participated in the Insect Distribution Program

We cooperated with scientists in the Application and production Technology Research Unit at Stoneville in evaluating insect counts throughout the season in conventional and ultra-narrow-row (UNR) cotton (both dryland and irrigated). Insect numbers were extremely low in 2000 as in 1999; however, trends indicated that boll weevil and tarnished plant bug numbers may be higher in UNR but beet armyworms may be reduced. The speculated cause for these minor differences is that a denser canopy in the UNR cotton favors boll weevil and tarnished plant bug reproduction (protection from heat, poorer insecticide penetration) and deters beet armyworm because it prefers a spotty stand of cotton.

Comparison of numbers of boll weevils captured in Washington County from March–October for 1995-2000 indicated over 99% reduction in boll weevils from August-October in 2000 after diapause treatments began August 1, 1999 in the now statewide boll weevil eradication program when compared to other years. Before boll weevil eradication (1995-1998), numbers captured in traps increased approximately 20-fold between spring and fall; in 1999 during boll weevil eradication numbers declined by 75% during the same period. Numbers of weevils captured in 2000 were reduced over 96% from 1999, indicating a highly successful boll weevil eradication in this part of the state.

Moth traps records in 1999 collected at the same trap sites since 1995 showed that numbers of beet armyworms, bollworms, and tobacco budworms were again low in comparison to earlier years and only slightly exceeded 1999 which was the lightest on record. Bollworms and tobacco budworms have consistently been lower (bollworm 40%, budworm 80%) since 1996 (the year Bt cotton was introduced) than from 1985-1996.

Results from a fourth year of testing for the best time to spray for cotton aphids confirmed results for the previous three years in showing that no treatment produced significantly higher yields than the untreated check. This means that under the conditions of four different years, insecticide treatments for cotton aphids were not economically justified.

Five insecticides were evaluated in replicated plots for tarnished plant bug (TPB) control in Stoneville 4691-B cotton. New insecticides Steward and Assail were evaluated at four rates. One other new insecticide, Regent, was applied at one rate. Vydate and Bidrin were used as the standards against the new chemistry. TPB populations were low at the beginning of the season and developed slowly, even in the untreated check because of two pinhead applications of malathion. Sweep net samples on August 2 in check plots averaged more than 6 TPB/50 sweeps. Populations in all treatments were lower than the check. Drop cloth samples during the same time averaged 2.5 TPB/12 feet of row or 2722 per acre in the check. Populations in all treatments averaged less than 1 TPB/12 feet. Seasonal averages when sampled by sweep net and drop cloth showed that plant bug populations in all treatments remained below that of the check. Yields of seed cotton were very erratic in the non-irrigated cotton because of hot dry weather.

A large field plot study was carried out to evaluate temik applied in-furrow and as a sidedress application for control of early season cotton pests. Treatments were temik in-furrow at planting at 0.52 and 0.75 lb AI/A, temik in-furrow at 0.52 and 0.75 lb AI/A followed at pinhead square with a sidedress application of 0.75 lb AI/A, and Temik in-furrow at 0.52 lb AI/A, plus a foliar application of Vydate at the 3rd true leaf stage. There was also a Goucho seed treatment. Temik in-furrow and Goucho were effective in controlling thrips. Aphid populations were light to moderate and lower in the sidedress treatments. The lowest yield was 845 lbs lint in the treatment with temik in-furrow at 0.52 lb AI/A. Other treatments averaged 944-1038 lbs of lint cotton.

A large field plot study in two locations was carried out to evaluate insecticide on a 20- inch band, and as a broadcast application for insect control. Cotton in both locations was Stoneville BXN 45 (non-Bt). One location was non-irrigated and the other irrigated. Treatments (20 inch band vs. broadcast) were replicated 4 times at each location. Insect populations were low on the non-irrigated field. Only two applications were made during the season. Six applications were applied on the irrigated field where worm infestations were higher in the 20-inch band treatment than in the broadcast treatment. Fruit mapping throughout the season indicated no differences between treatments in the number of bolls found on the 1st and 2nd fruiting position. There was also no difference in maturity. At harvest there was no difference in yield between treatments at either location.

The 3rd and final year of an economical and biological evaluation of Bt and non-Bt cotton has been completed. An average of 14 farms was included in the study each year. Farms selected represented the different growing regions of the Mississippi Delta. Producers on each farm grew Bt and non-Bt cotton. The project was a cooperative effort between ARS and Delta Research and Extension Center. There were no differences in agronomics in producing Bt and non-Bt cotton. The value of Bt cotton at the present time is totally dependent on the severity of the tobacco budworm infestation. Biological (insect) data collected in 1998 showed that because of a heavier budworm problem, there was a significant reduction in insect control costs for Bt cotton. In 1999, all cotton insect problems were low, and the data indicated a smaller cost for insect control in conventional cotton. In spite of extreme weather conditions, yields and cost of insect control were not significantly different from other years in 2000 with no significant difference in either yield or cost between Bt and conventional cotton. There were no yield advantages of growing Bt vs. conventional.

Studies on several aspects of reproductive diapause in the tarnished plant bug begun in 1998 continued in 2000. These studies showed that nymphs are sensitive to changing day length, and that nymphs developing at a day length of about 13.5 h or less begin producing adults in diapause. As the day length continues to decrease, the number of adults produced in diapause increases. Nymphs collected on weeds in the last week of September and during all of October 2000 produced adult populations of which >90% of the males and females were in reproductive diapause. However, a few reproductive adults were also produced. These results were nearly identical to those obtained in 1999. This past winter reproductive diapause was terminated by mid- to late-December and viable eggs were found along with first instar nymphs on wild host plants in late-January in the Delta. These nymphs required about 40 days to become F_1 adults in March. These results were the same as in 1999. The winters of 1998-2000 were mild. Hopefully, the upcoming winter will have some cold weather periods in it so that their effects on reproductive diapause in plant bugs can be determined.

A study on the effects of the multiple applications of malathion for boll weevil control in the Mississippi Boll Weevil Eradication Program on malathion resistance in plant bugs begun in 1999 was continued in 2000. In 1999, tarnished plant bugs were collected from three locations in Washington County (Winterville, near Avon, and along the Old Leland Road) in the last week of July, and their levels of tolerance to malathion was determined using a glass vial bioassay. In the first week of August, fall diapause applications with malathion to all cotton in the county were begun as part of Boll Weevil Eradication. Since August is a month in which a high percentage of the total plant bug population is in cotton (because of an absence of abundant wild hosts), the several applications of malathion could act as an intensive selection pressure for insecticide resistance. To test this hypothesis, plant bugs were collected in late-October (after all diapause applications) from the same 3 locations and their tolerance to malathion was again determined. The LC_{50} value for malathion for susceptible plant bugs from Crossett, AR was 4.1 micrograms per vial. The LC_{50} values for plant bugs from the 3 locations in Washington County in late July were 17.8, 3.4, and 3.7 micrograms per vial for Old Leland Road, Winterville, and Avon, respectively. Their LC_{50} values determined in late-October after diapause applications were 81.8, 72.2, and 24.2 micrograms per vial for Old Leland Road, Winterville, and Avon, respectively. Comparing October values to July values showed a 5 to 21-fold increase in resistance. The highest LC_{50} value of 81.8 is 20 times higher than the susceptible bugs from Crossett. In February (overwintered adults) and March (F_1 adults) 2000, adults from the Old Leland Road location were again tested. Their LC_{50} values of 16.31 (February) and 12.20 (March) showed resistance was still significantly higher than susceptible bugs, but about 5-fold lower than they were in October. The reason(s) for the large decline in resistance is unknown. In the spring of 2000 and in the fall of 1999 and 2000 plant bugs were collected from 6 locations in Region 1, 6 locations in Region 2, and 5 locations in Region 3 of the Mississippi Boll Weevil Eradication Program and tested for malathion resistance. At all locations in Regions 1 and 2, resistance to malathion was significant. The only locations with non-significant resistance were found in Region 3. The highest resistance was found in Region 2 in the fall of 2000. Plant bugs collected from near Delta City and Louise had resistance 24- and 31-fold higher, respectively, than susceptible bugs.

A survey to determine if plant bugs in the Delta have increased tolerance to Orthene was conducted in 1998 and 1999 and repeated in October 2000. The same 20 collection locations (4 in AR, 2 in LA, and 14 in MS) were used three years. Plant bugs collected at each location were tested for resistance to Orthene using a glass-vial bioassay. LC_{50} values obtained for each location were compared to an LC_{50} value for Orthene obtained from testing susceptible bugs from Crossett, AR. The highest amount of resistance found in any of the 3 years was 4.6-fold found in bugs collected in 1999 near Cummins, AR. This level of resistance would probably decrease the effectiveness of Orthene, but would probably not cause a control failure. The overall mean LC_{50} for Orthene for plant bugs from all 20 locations was 4.64, 4.99, and 5.49 for 1998, 1999, and 2000, respectively. The mean resistance ratio was 1.5, 1.6, and 1.8 for 1998, 1999, and 2000, respectively. Thus, the 3-year trend is one for a slight increase in resistance to Orthene.

A large experiment designed to evaluate control of tarnished plant bugs in cotton by reduction in numbers of wild hosts available for plant bug population buildup in the spring was conducted for the third year in 2000. Four areas (3 in Washington and 1 in Sunflower Counties) each 3 X 3 miles in size, were used again as in 1999. Two of the areas (checks) received no treatment, while the other two areas were treated in March with a broad leaf weed killer (Trimec) or mowing. The treated areas were near Dunleith and Tribbett, and the check areas were at Hollandale and Kenlock. Treatments were applied only to those marginal areas by roads, fields, or ditches, in which wild hosts were found. Prior to treatment, wild hosts were sampled for plant bugs in all 4 areas. In addition, densities of the wild hosts were determined. These samples were repeated at the same locations 3-4 weeks after treatment. In June and July, cotton fields were sampled for plant bugs each week using a sweep net. The number of samples per field varied with field size and ranged from 10 to >50. Each sample was 10 sweeps taken back and forth over a single row as the sampler walked down the row. In most weeks 15 fields were sampled in each of the 4 experimental areas. Numbers of fields sampled decreased in some weeks due to heavy rain or widespread application of Furadan for aphids. Group IV and V soybeans were extensively sampled in 2000 (no corn fields found in any of the 4 test areas). Soybean fields were sampled with a sweep net for adults and a drop cloth for nymphs. Five soybean fields were from the treated area at Tribbett and 13 fields were from the two check areas sampled each week. There were no soybean fields planted in the treated area at Dunleith. In cotton fields bordered by soybeans, extra samples were taken in the cotton field along its border with the soybeans. These samples were taken 100 ft or less from the border to determine if soybeans influenced numbers of plant bugs in cotton.

Plant bugs averaged 0.25 adults and nymphs per 10 sweep sample in the two check areas, and 0.17 per sample in the two treated areas over the 10-week sampling period. This was an average of 32% reduction in numbers of bugs in the treated areas. Analyses of weekly data found significant differences in number of bugs during the second and third weeks of July. In the second week, significantly more bugs were found in the check areas, a mean of 0.168/sample vs. 0.058 in the treated areas. In the third week of July there again were significantly more bugs in the check areas, a mean of 0.353/sample vs. 0.182 in the treated areas.

Tarnished plant bug populations in the soybeans were significantly higher in the treated area at Tribbett each week during the last week in May and first 3 weeks of June. Populations averaged 500-700 per acre per week in the fields in the two check areas and 6100 per acre per week in the fields at Tribbett. The highest population of 12,316 per acre was found in the treated area at Tribbett during the last week in May. Soybeans influenced numbers of bugs found in cotton adjacent to them. Plant bugs averaged over the 10-week period were 0.40 per sample in the extra samples taken in cotton less than 100 ft from its border with soybeans. In samples taken in cotton >100 ft from an edge, they averaged 0.22 per sample, while in samples in cotton <100 ft from an edge without soybeans they averaged 0.20 per sample. In samples <100 ft from an edge bordered by soybeans they averaged 0.38 per sample. Means found for the numbers of bugs captured at each of the field sample locations were not significantly different in any week. A benefit to cost analysis performed on the data from the experiment by Mr. Fred Cooke, Economist, Delta Branch Experiment Station, found that for every dollar spent in protecting the cotton in the treated areas in 1999, a benefit of $8.51 was obtained due to decreased insecticide costs. In 2000, the benefit was $10.28.

The recent report on persistence of the CryIAb protein from transgenic corn tissue in the soil led to our interest in the fate of CryIAc protein from transgenic cotton tissue in the soil. Results from the study showed that: (1) Larval growth bioassays are a sensitive tool for detecting CryIAc bioactivity in the soil, and (2) CryIAc bioactivity was not detected at any of the field sites planted with transgenic cotton.

We studied the effect of *B.t.* cotton on the cotton bollworm- *Helicoverpa zea* single-nucleocapsid nuclear polyhedrosis virus (HzSNPV) interaction, and whether lower rates of the virus might be effective against cotton bollworms on *B.t.*-transgenic cotton. Results from the laboratory study showed that HzSNPV fed to 4 day old *H. zea* larvae produced a dose dependent mortality response. An additive mortality response was observed for early instar larvae of *H. zea* exposed to HzSNPV and *B.t.* endotoxin. Results from the field study using plant sleeves to hold the insects showed the mean number of live insects decreased as the virus application rate increased.

A pathogen survey conducted for the red imported fire ant, *Solenopsis invicta* in the Mississippi Delta established that a *Thelohania* sp. was present in red imported fire ant populations located on a National Wildlife Refuge site in Sunflower County, MS. The *Thelohania* spp. from *S. invicta* was morphologically indistinguishable from the *Thelohania solenopsae* reported in *S. invicta* in Florida.

Surveys for pathogens of the red imported fire ant, *Solenopsis invicta*, in Mississippi revealed a neogregarine occurring in both immature and mature stages of the imported fire ant on a farm in Harrison county, MS. The neogregarine from *S. invicta* was morphologically indistinguishable from *Mattesia geminata* reported in *S. geminata* in Florida.

Field populations of bollworm and tobacco budworm were monitored for their tolerance to the Bt toxin Cry1Ac. No changes were observed in populations of either insect.

The genetic architecture of resistance plays an important role in determining how and when an insect population evolves tolerance to an insecticide. The bollworm, *H. zea* (Boddie), is more intrinsically tolerant of Cry1Ac than another major pest of cotton, tobacco budworm, *Heliothis virescens* F. We created F2 families from full-sib matings using males collected from the field. Survivorship and growth on Cry1Ac diet were recorded to estimate the heritability of tolerance to Cry1Ac in *H. zea*. Differences among families were observed.

The development of an artificial diet by Allen Cohen, (ARS, Mississippi State) subsequent collection of a base of several thousand native plant bugs (TPB) by SIMRU members and others, and an intensive rearing effort by the Biological Control and Mass-Rearing Research Unit resulted in the establishment of a strong TPB colony at Mississippi State. This colony provided a consistent supply of bugs for the sterility research undertaken this year.

Matings between unirradiated TPB resulted in 26% egg hatch; matings between unirradiated males and irradiated females resulted in 0.5% egg hatch; matings between irradiated males and unirradiated females resulted in 18% hatch; and, matings between irradiated males and females resulted in 0.05% hatch. We consider the hatch of eggs for our unirradiated insect pairings to be unacceptably low, and we expect it to increase when we discover its cause.

Mortality among the irradiated insects increased with each replication and, as with egg hatch, varied unacceptably from replication to replication. Average LT_{50}'s (time in days at which 50% of test insects had died) among the four replications ranged from 11.5 to 48 days and LT_{90}'s ranged from 24 to 71 days. Reasons for the variability are being investigated. Use of CO_2 to handle the insects did not appear to be a direct cause.

Hatch of eggs produced from crosses of F_1 male progeny (of irradiated male and unirradiated female pairings) and unirradiated females was 2.1%. Hatch of and between F_1 male progeny (of pairings of unirradiated insects) and unirradiated females was 14.2%. We again considered hatch from the unirradiated pairings to be unacceptably low. For our fourth replication, in addition to egg hatch, we measured the percentage of eggs developing to the point where eyes of unhatched nymphs could be clearly seen. Such development averaged 16% for pairings between F_1 male progeny (of irradiated male and unirradiated female pairings) and unirradiated females and 59% for pairings between F_1 male progeny (of pairings of unirradiated insects) and unirradiated females. These data show significant differences in nymphal development between the treatments, and that much greater egg hatch is attainable; however, the lack of greater hatch in these eggs is as yet unaccounted for.

In cooperation with researchers at the University of Arkansas (N. P. Tugwell) and Arkansas State University (T. G. Teague), the effect of TPB feeding on plant maturity was investigated at Marianna, AR. Third and fourth instar TPB nymphs were released onto cotton plants of different ages by placing them in tubes attached to the base of the plants. Squares of plants in a second treatment were damaged with fine forceps to simulate TPB damage. The control consisted of plants treated with insecticide to reduce or eliminate any natural occurrences of TPB on them. Preliminary results indicate a greater delay of maturity in TPB damaged plants than in plants artificially damaged or undamaged plants.

No significant progress in boll weevil research was made in 2000. In 1999, field cage research with a boll weevil attracticide showed promising results. Severe weather and formulation problems prevented significant progress in 2000. Research on boll weevil diapause showed no difference in diapause of weevils caged on plants of different ages. This research was conducted earlier in the season than desired because of the imminent applications of malathion for boll weevil control. Extreme boll weevil pressure on a later replication begun in northern Arkansas resulted in the test being aborted.

Field studies were conducted to evaluate the effectiveness of an egg parasitoid, *Anaphes iole*, on *Lygus lineolaris* eggs embedded in different plant hosts. Results indicate that plant species in which host eggs were laid had considerable impact on parasitism rates. Parasitism was lowest (<20%) in *Erigeron philadelphicus*, *E. annuus*, and *Medicago sativa*. Parasitism was highest (35-50%) in *Conyza canadensis*, *Oenothera speciosa*, and *Ambrosia trifida*. Moreover, location of host eggs on individual plant species also affected parasitism. For example, host eggs deposited in the receptacle of *A. trifida* flowers suffered >80% parasitism, while those laid in the anthers were subjected to only ca. 25% parasitism. Mechanisms leading to the observed differences in parasitism may be physical (e.g., interference of plant structures with wasp oviposition, insertion of host eggs to a depth beyond which wasp ovipositor will reach), and/or chemical (e.g., compounds produced by host plant which disrupt chemoreception of wasps). Lab observations with both *Erigeron* species indicated that female wasps recognized *L. lineolaris* eggs, but that glandular trichomes interfered with the wasps' ability to oviposit.

Residual toxicity of field-weathered residues of pesticides to *A. iole* was evaluated. Field rates of nine insecticides were applied to tagged leaves of field cotton. Tagged leaves were removed at 0, 2, 4, 8, 16, 23, and 30 DAT and setup using a bioassay method developed in 1999. Immediately after treatment, residues of nearly all compounds (Orthene, Karate, Baythroid, Provado, Actara, Tracer, Regent, and Vydate) resulted in nearly 100% mortality. Steward resulted in 70% mortality at this time. Residual toxicity of Regent and Tracer declined relatively slow; at 30 DAT wasp mortality remained >90%. Mortality from Baythroid residues was nearly 100% up to 8 DAT, after which mortality declined to ca. 50% at 30 DAT. Mortality from Actara and Karate residues was ca. 90% up to 4 DAT, after which mortality declined to ca. 20% at 16 DAT. Mortality from residues of Orthene declined to ca. 20% at 16 DAT. Mortality from residues of Provado, Vydate, and Steward declined to ca. 25% at 8 DAT.

Foreign exploration was conducted in South America (Argentina and Paraguay) and Eurasia for natural enemies of *L. lineolaris, Helicoverpa zea, Heliothis virescens,* and *Spodoptera* spp. This work led to the discovery of a previously undescribed braconid wasp, *Leiophron argentinensis* Shaw which occurs throughout much of northern Argentina and southern Paraguay where it parasitizes mirid nymphs on many host plants. *Leiophron argentinensis* is multivoltine and appears to be active year-round in subtropical regions. Several undescribed mymarid egg parasitoids were also collected. Those collected in Eurasia were reared from eggs of *Lygus* species, while those collected in South America have unidentified hosts. Three undescribed species of *Campoletis* were discovered in Argentina. Two species were reared from *Helicoverpa gelotopoeon*, and one species from *Spodoptera frugiperda*. Lab colonies of the *Campoletis* spp. and *L. argentinensis* were initiated.

A study of the population dynamics of *L. lineolaris* and its natural enemies begun in 1999 was continued in 2000. Four insecticide-free alfalfa, *Medicago sativa*, fields were monitored in Mississippi from April through October. *Lygus* egg densities, insect abundance, and plant development were assessed weekly. Collection methods included sweeping, yellow bowl traps, and malaise traps. Preliminary results indicate that *L. lineolaris* passed several generations on alfalfa. Although generalist predators were common, parasitoids host-specific to *L. lineolaris* were rarely collected. Drought-induced decline in host plant quality appeared to be an important factor in suppression of *Lygus* densities.

A field study was initiated on the flight dispersal of parasitoids. Objectives were to: 1) develop mark-release-recapture methodologies, and 2) assess the impact of climatic and physiological factors on wasp dispersal. A preliminary trial was conducted to determine the effect of nutritional state on dispersal of *A. iole* and *M. croceipes*. Samples are still being sorted, but results suggest that the methods used are suitable for *A. iole*.

The feeding response of food-deprived *A. iole* wasps to solutions of 14 naturally occurring sugars and a commercial beneficial insect food source was determined. All compounds elicited a feeding response, although the sugars differed with respect to the lowest concentration at which they accepted (acceptance threshold). Several compounds were accepted at concentrations as low as 1/256 M, and one sugar at 1/512 M. Thus, the sugar receptors of *A. iole* appear to be extremely sensitive. Compared to studies on other insects, the responses of *A. iole* differ considerably with respect to the range of sugars accepted as well as the acceptance thresholds.

A survey of nymphal parasitoids of *L. lineolaris* begun in 1999 was continued in 2000. More than 4000 nymphs were collected in the Mid South from March through October on *Erigeron* spp., *Medicago sativa*, *Conyza canadensis*, *Trifolium incarnatum*, and *Ambrosia trifida*. Collection sites included those from 1999 in addition to new sites. From these nymphs, only one parasitoid, an unidentified Euphorine braconid, was reared. For reasons unknown, nymphal parasitoids of *L. lineolaris* appeared to be uncommon in 2000 in the areas sampled.

A lab colony of *Peristenus howardi* was initiated in 1999. This wasp is a nymphal parasitoid of *L. hesperus* in the western US. It is a newly described native species that is multivoltine and has a female-biased sex ratio. Females readily sting early instar *L. lineolaris*; the F_1 generation increased 15-fold over the founding stock. However, only six wasps emerged in spring 2000 and the colony was in danger of being lost. In an effort to maintain the colony, additional collections were made in 2000. From these collections *P. howardi* was reared from *L. hesperus* nymphs collected from alfalfa and weeds in northern Idaho, a considerable range extension for the wasp. However, at the present time, the wasp colony is not strong enough to permit the previously planned studies.

Microplitis croceipes and *Toxoneuron nigriceps* were used in preliminary studies of tritrophic interactions between cotton, a herbivore, and natural enemies. Field studies focused on the attraction of these wasps to cotton plants emitting inducible volatiles induced by exogenous applications of jasmonic acid. Wind tunnel studies focused on differential attraction of the wasps in response to cotton plants emitting volatiles induced different treatments. Preliminary results suggest that wasps can detect and orient to plants emitting induced volatiles.

Studies of molecular cloning and characterization of digestive enzymes of *Lygus hesperus* and *Lygus lineolaris* were initiated. Digestive enzymes, such as trypsin and chymotrypsin, may play important roles during feeding. They also cleave Bt protoxin to form an activated toxin. Modified genes or enzyme profiles may be responsible for Bt resistance in insects. Study of these enzymes in *Lygus hesperus* and *L. lineolaris* will lead to understand feeding biochemistry and physiology, and to provide molecular information for transforming host plants. Major digestive enzymes in *L. hesperus* and *L. lineolaris* have been partially characterized. One full sequence and several partial sequences of proteinase cDNAs have been obtained from both *L. hesperus* and *L. lineolaris.*

Development of PCR (polymerase chain reaction) techniques to detect *Lygus* egg parasitoids is in progress. Because the egg parasitoid, *Anaphes iole*, is such a tiny wasp, use of the traditional dissecting method is very difficult for monitoring or evaluation of this biological control agent. We have developed a very specific and sensitive PCR technique to detect this wasp at very early stages. Ribosomal DNA fragments have been sequenced from both wasp and host insect. Specific primers have been designed for parasitoid and host insect. Laboratory studies indicated that the PCR can specifically detect the parasitoid within *Lygus* eggs immediately after oviposition.

Studies of pyrethroid resistance mechanisms in *Lygus lineolaris* are underway. Most insects develop pyrethroid resistance primarily through elevated gene expression of cytochrome P450 oxidases to detoxify insecticides, and through gene modification of the sodium channel to become insensitive to pyrethroids. Full sequences of cytochrome P450 oxidase cDNAs and partial cDNA sequences of sodium channel have been obtained from both resistant and susceptible stains of *Lygus lineolaris*.

A cooperative study with Mycogen/Dow AgroSciences was conducted to test a new transgenic line of corn for efficacy of resistance to fall armyworm and southwestern corn borer. The Mycogen/Dow Agrosciences line had a two-fold increase in efficacy when compared to the transgenic (Cry1Ab) check.

Two varieties of Bollgard II® (Monsanto) were evaluated for Lepidopterous control. In addition, season-long expression of both proteins was monitored. Laboratory results indicate improved efficacy against these pests while expression profiles indicated dual-protein action throughout the season.

Studies are in progress with scientists at Mississippi State University and Louisiana State University to evaluate the effectiveness of a pre-cotton-planting alternate host destruction program for management of the tarnished plant bug.

A study has been initiated with Alabama A&M University to conduct laboratory and field research on the fate and persistence of the Cry1Ac protein from cotton in the soil in Alabama. **(USDA, ARS, Southern Insect Management Research Unit, Stoneville, MS)**

We increased the in vivo rearing of the *Lygus* egg parasitoid *Anaphes iole* and developed a new system for holding *Lygus* egg packets in sting boxes that increases efficiency by approximately 60%. Preliminary in vivo rearing techniques and an artificial diet, which contains no insect components, for *Anaphes iole,* were developed. Using this diet, *Anaphes iole* have been reared to the prepupal stage. Development was comparable to that in *Lygus* eggs. However, pupation did not occur. This is believed to be a technique issue, not a diet issue.

A machine for preparing 4 in. x 6 in. gelcarin oviposition packets for use in mass rearing of *Lygus* spp. has been designed and built.

We developed an artificial diet and oviposition system for *Lygus lineolaris*, which allows us to produce continuous generations of these insects with no recourse to natural foods.

The digestive enzymes such, as protease and elastase, can be induced and repressed in *Lygus hesperus* according to diet ingredients. This enzyme induction/ repression system helps to explain the feeding versatility of the plant bug complex.

We characterized and localized the digestive enzymes in salivary glands and guts of *Lygus hesperus* and *Lygus lineolaris*. These studies show that the principal mode of feeding action by these plant bugs is extra-oral digestion, helping to explain the feeding versatility and the ability to extract nutrients from otherwise toxic plants.

The digestive enzymes in *Orius insidiosus* have been shown to predispose these insects to utilization of plant nutrients. This helps explain how *Orius insidiosus* can supplement their insect eating habits with plant feeding to gain nutrients in addition to water.

The big-eyed bug, *Geocoris punctipes*, which has been reared for many years in the laboratory, was found to be fully capable of reverting to predation on live aphids and lepidopteran larvae. In answer to concerns that laboratory colonies of insects, especially those fed artificial diets, would lose their predatory ability, big-eyed bugs that had been colonized on artificial diet for over 50 generations were shown to maintain their feeding characteristics as predators.

Quality assessment technology was developed for determining the freshness of artificial diets for predators, plant bugs, and lepidopterans. The system includes measurements of vitamin C, protein profiles, lipids, and sugars. Vitamin C is especially susceptible to oxidative degradation, even in the refrigerator. Larger molecular weight proteins are also vulnerable to degradation.

Quality assessments were developed by using hemolymph proteins tested with antibody technologies. These quality assessment techniques allowed early detection of *Lygus hesperus* and *Lygus lineolaris* that had been malnourished (compared to individuals that fed highly nutritious diets).

Antinutrients from soy, lima bean, and chicken egg were characterized and shown to have adverse effects on both *Lygus hesperus* and *Lygus lineolaris*. To a great extent, heat treatment of these antinutrients (autoclaving, flash heating) detoxified these components. **(USDA, ARS, Biological Control and Mass Rearing Research Unit, Mississippi State, MS)**

Just as a map can be used to guide one to a final destination, so can a multispectral image of cotton fields be used to assist in the selection of sampling sites for insect pests. Scouting efforts coupled with the use of imagery can determine where some insects, like the tarnished plant bug or Heliothines, prefer plants that are more vigorous (i.e., rank). If a relationship between the status of the crop and insect abundance can be established, then it is possible to also use global positioning (GPS) and geographic information systems (GIS) to direct commands to a spray boom and place insecticides at a particular location and rate in a cotton field. A multi-agency, multi-disciplinary, team along with commercial and farm entities investigated and implemented these approaches on selected fullscale cotton fields during 1999 and 2000.

Using GPS and GIS technology, it is possible to considerably reduce the amount of insecticide (an hence cost) needed for a single application. However, at other times, these same tools indicate that the best decision is to spray or not spray the entire field. Use of a spatially equipped sprayer may also improve insect control so that later applications may not be necessary. For example, during 1995 and 1996, four applications for insect control in the first 90 days of production for a specific field were necessary. These records suggest a similar pattern of inputs for other years. The 1999 and 2000 spray patterns differed in number (3 in 1999; 1 in 2000), and in space and time with the result that additional applications in the same period of time as in previous years were not required. Therefore, the work suggests that economic and environmental benefits are achievable with this creative approach to pest control. The system may also integrate favorably with the use of transgenic varieties. The chief limitations are the expertise and management of the tremendous information needed. These are obstacles that can be overcome by the design of additional software tools. (**USDA, ARS, Crop Simulation Research Unit, Mississippi State, MS**)

Continued testing of Bt transgenic cotton cultivars (Bollgard and Bollgard II) were done, including laboratory and field assays. Both laboratory and field studies indicate that Bollgard II cotton, expressing two insecticidal proteins (Cry1Ac and Cry2Ab) of *Bacillus thuringiensis*, will have greater activity on caterpillar pest populations. Bollworm, fall armyworm, beet armyworm, soybean looper, saltmarsh caterpillar and tobacco budworm were more susceptible to Bollgard II cotton than the original Bollgard technology (expressing only one insecticidal protein (Cry1Ac). In relatively small plot tests at three different locations, Bollgard II plots did not require supplemental insecticide applications to control any of caterpillar pests. However, no supplemental insecticide applications were needed to Bollgard plots at 2 of 3 locations. At one location, a single insecticide application was only required in Bollgard plots for a combination of bollworm and fall armyworm caterpillars. These data will have ramifications for the management of cotton pests and pest resistance to Bt cotton.

Insecticide evaluations in Bt cotton indicated that reduced rates of at least some insecticides can be used for bollworm control. Steward (0.065, 0.075, and 0.09 lb AI/A), Asana (0.04 lb AI/A), Tracer (0.067 lb AI/A), and Karate (0.03 lb AI/A) gave similar control of bollworm populations (85%) compared to an untreated control and a Vydate (0.33 lb AI/A) treatment. In all treatments except for Tracer and the control, tarnished plant bug populations were significantly reduced by two insecticide applications. In non-Bt cotton (4 days after treatment), these same treatments (excluding Vydate) also gave significant control of a smaller caterpillar infestation composed equally of bollworm and tobacco budworm. In an aphid trial, Assail 70WP (0.0375 and 0.05 lb AI/A), Centric 40WG (0.047 lb AI/A), and Furadan (0.25 lb AI/A) performed better than Bidrin (0.50 lb AI/A), Provado (0.047 lb AI/A), Leverage (2.0 fl. Oz./a), and Fulfil 50WG + Latron CS-7 (0.25% v/v). However, all compounds except Leverage gave good control (> 96% control by 5 days after treatment). Control of cotton aphids in Leverage plots was 90% after 5 days.

Tests of mid-season tarnished plant bug thresholds were largely unsuccessful because of naturally low populations of this pest and poor establishment when insects were released. However, data are being collected and analyzed to help define optimum sampling protocols for plant bugs, particularly after cotton has begun blooming.

Tests to evaluate systemic insecticides applied sub-furrow at planting for control of tarnished plant bugs at pinhead square stage were planted in two locations. Results indicated that at least one compound has potential to reduce plant damage by either tarnished plant bugs or false chinch bugs that infested the plots simultaneously. Activity of the compounds was probably inhibited by lack of rainfall and less than optimum uptake of the material by the roots.

Review of many years of collections of thrips from seedling cotton has determined that immature thrips can be found within 7 days after planting. This indicates oviposition at or before the cotyledons or fully opened, and possibly just as the plants crack the soil enough for access from thrips. Seventeen species of thrips have been collected from seedling cotton in Mississippi and a key to the species is in preparation. The vast majority of collected specimens are tobacco thrips. The collection (ca. 6,000 specimens) of thrips housed at the University of Georgia has been catalogued and will be made available via the internet with the soon to be finished catalogue of thrips at Mississippi State University.

Overwintering tobacco budworm (TBW) and corn earworm (CEW) pupae were sampled in 33 untilled cotton fields in Monroe County in northeast Mississippi Feb.-March 2000 by digging a total of 6,286 m-row. TBW averaged 9/ha^{-1} and CEW 4/ha^{-1} in nonBt-cotton fields, which constituted 27 % of fields in the study area. No TBW or CEW pupae were found in Bt-cotton fields. The densities in non-Bt-cotton fields were down from 303/ha^{-1} and 67/ha^{-1} for TBW and CEW, respectively, the previous year. Unlike the previous four years, spring 2000 tillage did not destroy all of these pupae because tillage was two weeks later than usual: adult TBW emergence started ca. 14 April 2000 (estimated from pheromone trap and emergence cover catches) when nearly half of the fields had not yet been tilled, and CEW emergence was even earlier. Cumulative catches in thirteen pheromone traps of TBW populations emerging from overwintering averaged 15/trap^{-1}, which was down from 92/trap^{-1} the previous year. Corresponding catches for the CEW in 2000 and 1999 were 4.6 and 44/trap^{-1}, respectively. A total of 772 TBW larvae and 475 CEW larvae were identified from weekly sampling of five species of wild host plants in the study area Sept.-Nov. 1999. On prickly sida, it was estimated that a total of 2.6 and 2.9 unparasitized, late instar TBW and CEW larvae, respectively, were produced per 50 sweep sample unit. The corresponding estimates in fall 1998 were 10.2 and 0.6. From these density estimates and the pheromone trap catches the following springs, it is possible to estimate that the effective fall, wild host plant area in 1998 was 60 % greater than that in 1999. **(Department of Entomology and Plant Pathology, Mississippi State University, Mississippi State, MS)**

Missouri

Both experimental and registered cotton insecticides were evaluated in seven field trials. These tests included: at-planting and foliar thrips trials; plant bug / fleahopper control; and bollworm trials.

In an in-furrow thrips trial conducted at Portageville, all plots treated with insecticides had significantly lower thrips populations [predominantly tobacco thrips, *Frankliniella fusca* (Hinds)] than the untreated ones 18 days after planting. Plots treated with Adage (seed treatment) and Temik (0.6 and 0.75 lb AI/A) had the lowest thrips populations. The top three treatments in yield (lb seed cotton/A) were Temik (0.6 lb AI/A), Adage, and Temik (0.75 lb AI/A).

In a Portageville foliar thrips trial, all nine treatments had significantly lower thrips infestations than the untreated plots 3 and 6 [with the exception of Actara (0.036 and 0.062 lb AI/A)] days after treatment (DAT). The top three treatments with the lowest thrips counts at 3 DAT were Temik (0.75 lb AI/A), Adage (seed treatment), and Fury (0.024 AI/A). At 6 DAT the top three treatments with the lowest thrips counts Adage, Address (0.21 lb AI/A), and Temik (0.75 AI/A). The top three treatments in yield (lb seed cotton/A) were Adage, Temik (0.75 lb AI/A), and Orthene (0.21 lb AI/A). The Adage and Temik treatments were the only ones with yields greater than 1000 pounds per acre. All other treatments had yields below 750 pounds per acre.

Moderate plant bug infestations were observed in both Portageville plant bug trials. The following data are from one trial taken to yield. Pretreatment counts indicated uniform plant bug [predominantly tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois)] and beneficial (ladybird beetles and minute pirate bugs most common) populations were present. At 2 DAT, all insecticide treatments had significantly lower plant bug infestations than the untreated plots. The top three treatments with the lowest number of total plant bugs [adults and nymphs of the cloudy plant bug, *Neurocolpus leucopterus* (Say); the cotton fleahopper, *Pseudatomoscelis seriatus* (Reuter); and the tarnished plant bug] were Bidrin (0.5 lb AI/A), Calypso (0.047 lb AI/A)+Steward (0.09 lb AI/A), and Vydate (0.33 lb AI/A). At 6 DAT, the top three treatments with the lowest number of total plant bugs were Bidrin (0.5 lb AI/A), Calypso (0.047 lb AI/A)+Steward (0.09 lb AI/A), and Vydate (0.33 lb AI/A). At 13 DAT, the top three treatments with the lowest number of total plant bugs were Orthene (0.5 lb AI/A), Calypso (0.047 lb AI/A), and Orthene (0.25 lb AI/A).

At 2 DAT, the top three treatments with the highest beneficial populations were Steward (0.09 lb AI/A), Calypso (0.047 lb AI/A), and Steward (0.075 lb AI/A). At 6 and 13 DAT, several treatments had higher beneficial populations than in the untreated plots. The top three treatments in yield (lb seed cotton/A) were Calypso (0.047 lb AI/A)+Steward (0.09 lb AI/A), Steward (0.09 lb AI/A), and Steward (0.11 lb AI/A). All insecticide-treated plots had yields greater (range of 43 to 597 pounds) than those in the untreated plots.

Moderate bollworm infestations were observed in all three Portageville bollworm trials. The following data are for one trial taken to yield. At 3 DAT, the top three treatments with the lowest number of damaged fruit (squares, blooms, and bolls) were Karate (0.033 lb AI/A), Steward (0.09 lb AI/A)+Lannate (0.38 lb AI/A), and Karate (0.025 lb AI/A)+Tracer (0.067 lb AI/A). At 9 DAT, the top three treatments with the lowest number of damaged fruit were Karate (0.025 lb AI/A)+Steward (0.11 lb AI/A), Steward (0.09 lb AI/A)+Asana (0.032 lb AI/A), and Karate (0.033 lb AI/A).

At 3 DAT, the top treatments with the highest beneficial populations were Steward (0.11 lb AI/A), Karate (0.025 lb AI/A)+Tracer (0.067 lb AI/A), Steward (0.09 lb AI/A)+Curacron (0.05 lb AI/A), and Steward (0.09 lb AI/A)+Lannate (0.038 lb AI/A). At 9 DAT, the top three treatments with the highest beneficial populations were Steward (0.09 lb AI/A)+Curacron (0.05 lb AI/A), Steward (0.09 lb AI/A)+Asana (0.032 lb AI/A), and Steward (0.11 lb AI/A). The top three treatments in yield (lb seed cotton/A) were Karate (0.033 lb AI/A), Karate (0.025 lb AI/A)+Tracer (0.067 lb AI/A), and Steward (0.09 lb AI/A)+Asana (0.032 lb AI/A). All insecticide-treated plots had yields greater (range of 400 to 767 pounds) than those in the untreated plots.

A total of 834 cotton bollworm male moths were collected in pheromone-baited cone traps and tested for susceptibility to cypermethrin. These vial tests were held in conjunction with the Insecticide Resistance Action Committee's *Helicoverpa zea* monitoring program. Percent mean survival of moths at the 5 and 10µg doses of cypermethrin were 21.6% and 10.1%, respectively. Survival in the control vials was greater than 97%.

A state Cotton Incorporated-funded project looking at different infestation levels of boll weevils and their economic impact was concluded in 2000. Yield data among thresholds were again inconclusive at both locations (Clarkton and Portageville). No significant yield differences were observed among the different thresholds at either location; however, the treated plots had averaged yields of approximately 68 and 110 pounds more seed cotton per acre at Clarkton and Portageville, respectively, than in the untreated plots. **(University of Missouri, Agricultural Experiment Station, Delta Research Center, Portageville, MO)**

<u>**New Mexico**</u>

Selected microencapsulated formulations of malathion were field and lab tested for residual activity against boll weevil and *Catolaccus grandis* for the second year in collaboration with the USDA/APHIS Phoenix Methods Development Lab. Detailed results are available elsewhere in the Proceedings.

Variation in insect resistance in Bt cotton was evaluated for the 4th year. High levels of nitrogen reduced bollworm damage and numbers. However that effect is highly variable. Highly vegetative plants also had higher damage, which was apparently due to higher egg lay rather than a direct effect on resistance in Bt cotton. We have also continued testing to evaluate the effect of Bt cotton on beneficial arthropods in New Mexico. Populations of beneficial arthropods in Bt and recurrent parent plots were compared for the third year by sampling 100 row feet plots with and insectavac.

Another project is evaluating the impact of our arid environment and crop microclimate on populations of arthropods in cotton. The impact of our management practices on crop microclimate and insect mortality is also being tested. For example, the arid conditions of the NM desert valleys are associated with very high mortality of immature boll weevils. In field tests, up to 100% early season mortality was recorded. Row orientation and row spacing also affected crop microclimate and boll weevil mortality, with higher mortality in standard row spacing and east-west oriented rows.

Effect of predators on bollworm egg mortality is being evaluated using eggs glued to plants and correlating mortality and predation densities. In one test Karate® and malathion treated plots had 25% mortality of bollworm eggs eight days post treatment compared to 55% mortality in the check plots. There were 5, 7 and 85 predators /100 row feet in Karate, malathion and check plots respectively.

Intercropped cotton tests with alfalfa, canola, sanfoin and hairy vetch resulted in high numbers of beneficials in the intercrop plots. There was, however, little movement to the adjacent cotton without cultivation or herbicide application in the intercrop. Hairy vetch harbored the highest number of predators and parasitoids.

The impact of overwintering habitat on boll weevil was tested for the last year. Urban habitats have been a critical factor in boll weevil establishment in New Mexico particularly in the desert river valleys. In the eastern high plains, as in Texas, other habitats such as shinnery oak and grasslands become increasingly important overwintering habitats.

A project to evaluate the use of Bt cotton as a trap crop for pink bollworm was completed. Although the concept shows promise, there are a number of problems that make it problematic in New Mexico. The primary problem is creating enough of a difference in initial squaring between the Bt cotton trap crop and the susceptible crop. **(Cooperative Extension Service and Department of Entomology, Plant Pathology, and Weed Science, New Mexico State University, Artesia and Las Cruces, NM)**

North Carolina

Several insecticide screening tests were carried out in 2000. 1) In a 12-treatment at-planting and foliar insecticide test for thrips, few yield differences were found between treatments due to only moderate thrips levels and good compensatory conditions at this Rocky Mount location. Gaucho seed treatment and both rates of Centric 40 WG showed numerically higher overall levels of thrips than the untreated check at the initial 3.5-week assessment. 2) Although the difference was not significant, both Steward 1.25 SC and Tracer 4 SC had approximately 100 lb more lint than Karate 2.08 Z 2.08 CS, in an early season budworm test. This trend is consistent with previous tests. 3) In a 10-treatment bollworm insecticide test, Steward 1.25 SC, Tracer 4 SC, Denim 0.16 SC, and Intrepid 2 SC, all tank-mixed with Dyn-Amic (0.5% v/v), showed less efficacy against bollworms in conventional cotton than the pyrethroids Baythroid 2 E, Decis 1.5 E, Fury 1.5 E, Karate Z 2.08 CS, and Leverage 2.7 S (Baythroid plus imidacloprid). 4) A single bollworm application following an Orthene over-spray on Bollgard cotton in a 7-treatment test revealed significantly greater bollworm damaged bolls in the Tracer, Steward, and Denim plots than in the Karate or Leverage plots.

Two early season tobacco budworm tests were carried out for the 7th year in southern North Carolina in an area of moderate second generation budworm pressure. Treatments in the first small plot, replicated test included various square and terminal removal plots, coinciding with the arrival of the second generation tobacco budworm generation flight. Except for the 100% square/100% terminal removal treatment, neither the 50%/50% square/terminal removal, the 10 large square removal per row foot or the Tracer and Karate insecticde 'checks' showed yields significantly greater than the untreated check. A second test, which evaluated pyrethroid alternatives for control of second generation tobacco budworms, compared Tracer and Steward at low rates with Lepinox (a foliar Bt), and the pyrethroid Karate. Yields were statistically the same, though both Steward and Tracer had numerically higher yields than the pyrethroid.

In a late-season insect (bollworms, European corn borers, fall armyworms and stink bugs) boll damage comparison of Bt (Bollgard) vs. conventional (pyrethroid-protected) fields under producer conditions, 76 Bollgard fields were compared with 76 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 5 years, 1996 through 2000 (864 total fields). The producer-managed Bollgard fields sustained approximately 2/3 as much overall boll damage as the conventional cotton fields, and were treated 2 less times (see Cotton Insect Report in previous section for individual late season pest differences).

An annual survey of North Carolina's licensed independent crop consultants working on cotton was continued in 2000 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 in conventional and in Bollgard cotton. Additional growers and selected county agents were contacted to make the survey more representative of the overall producer population. Most of the results from this survey are provided in the North Carolina Cotton Insect section above.. Only 14% of the Bollgard cotton was not treated in 2000, while 70%, 15%, and 1% of the remainder of the Bollgard acreage received 1, 2 and 3 applications, respectively, primarily for bollworms, but also for stink bugs and occasionally for plant bugs.

Three Bollgard tests were undertaken in 2000 which addressed: 1) efficacy of the Cry X gene (Bollgard II), 2) bollworm thresholds, and 3) the relative susceptibility of various commercial Bollgard varieties to bollworms and stink bugs. In Test 1, the Bollgard II line had no damaged bolls or live bollworms in all but a single scouting assessment, for a mean of essentially 0%, while the check and DP 50 BG treatments sustained 15% and 6% boll damage, respectively. Test 2 investigated the timing of a single pyrethroid application relative to the 10% egg threshold on conventional cotton. All timings showed boll damage significantly less than the untreated check, while, numerically, the 10% egg threshold and the 2 and 3 week post egg threshold treatments showed lower yields than the application put on one week after the egg threshold. In a test of 14 commercial Bollgard varieties, there were some differences in boll damage from stink bugs and bollworms, but none of these differences were significant as was the case in 1998 and in 1999.

Adult vial testing for bollworm tolerance to pyrethroids and Tracer 4 SC revealed low moth survival at several 'neutral' sites-- that is, not chosen for a suspected insecticide failure. However, survival in cypermethrin-treated vials was in the 15% to 20% range @ 10 micrograms in moths selected from 4 fields in which bollworm survival was unexpectedly high following apparently well timed pyrethroid treatments. These results suggest that bollworms, although still susceptible to pyrethroids in most fields in North Carolina, nevertheless are showing increased tolerance to pyrethroids to the point at which control problems may be occurring.

A study of the effect of conservation tillage on thrips, bollworms and fire ant (*Solenopsis invicta)* populations was initiated in 2000 at 2 locations, a wheat cover/strip till test in Edgecombe County and a weed cover/stale seed bed test in Scotland County. Early indications suggest that both thrips levels and bollworm damage to bolls may be lower on several kinds of conservation tillage. Also of interest is the possible impact on the lower surviving bollworm larval population in Bollgard cotton. **(Cotton Extension IPM Project, Department of Entomology, NCSU.)**

Larvae were field collected from either Bt or non-Bt sweet corn. Larvae collected from a Bt host transferred to artificial diet containing 0.1 µg/ml of CryIAc toxin. Selection experiments were performed to determine the rate of adaptation to varying levels of CryIAc. The selected colony developed ca. 50-fold resistance to CryIAc in only 6 generations and ca. 100-fold in 10 generations. Reciprocal crosses of control and selected individuals revealed high LC_{50} values for the progeny of these crosses which suggested that the resistance trait for Bt may be inherited as a dominant or incompletely dominant gene. Studies on cross-resistance to CryIIA toxin revealed low levels of cross-resistance as the selected strain was only 3X more resistant to CryIIA than the susceptible strain.

In three field studies Bollgard II lines (15813 and 15985) sustained significantly lower terminal, square, and boll damage compared to a commercial Bollgard variety (DP 50B) and a conventional cotton variety (DP 50). There were no significant differences between Bollgard II lines with respect to any of the data recorded.

The four genotypes were also evaluated in greenhouse environments for resistance to two bollworm populations; one population had been selected for thirteen generations for tolerance to the CryIAc toxin and the other population was field collected just prior to plant infestation. In the greenhouse Bollgard II lines significantly reduced penetration of cotton fruit for both the field and laboratory-selected strains of bollworm compared to DP 50B. However, larval survival and fruit damage by the laboratory-selected bollworm strain were significantly higher than that of the field-collected, non-selected strain.

A greenhouse study was performed to assess the damage and reproductive potentials of the two thrips species under environmental conditions simulating May 1-21 in North Carolina. Through measurements of plant biomass at the end of the study and visual plant damage ratings, the damage potential of tobacco thrips was found to be significantly less than that of the western flower thrips. There were no differences found in the reproductive potential of either species on either of two cotton varieties, DP 436RR and ST 474.

In a test for efficacy against bollworm, Steward provided control equal to that of the standards, Tracer and various pyrethroids. S-1812, a compound with unknown chemistry, provided efficacy against bollworm equal to a medium rate of Tracer but less than that provided by a pyrethroid standard. Pyrethroids remain effective against bollworm in North Carolina, even though over the last two years we have recorded increased survival at the critical dose in adult vial tests. In tests of insecticides for efficacy against thrips species none of the insecticides evaluated provided a level of efficacy comparable to the Temik standard. Actara as a foliar spray applied either once or twice was inferior to foliar spray standards (e.g. Orthene). Also, the Adage seed treatments (3.2 and 4.0 oz AI/cwt) did not provide effective control of thrips. **(Department of Entomology, North Carolina State University, Raleigh, NC)**

Oklahoma

Several Bollgard trials were conducted in 2000 to further evaluate the value of this technology under Oklahoma conditions. Bollgard cotton provided sufficient bollworm control and produced increased yields to compensate for technology fees in all entries. Bollgard varieties increased profits for irrigated production compared to conventional cotton varieties regardless of management regimes. Drought limited dryland cotton production by reducing yields dramatically. Enhanced yields to compensate for Bollgard technology fees did not occur, increasing the monetary loss for Bollgard varieties compared to conventional varieties.

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

Research continued in 2000 to determine the impact of planting date on boll weevil management in cotton grown under dryland conditions. Previous research during years with high boll weevil survival indicated planting date is critical, regardless of management scheme, to raise profitable cotton. Despite no boll weevil damage, 2000 results continue to emphasize May-planted cotton. However, yields in neither planting were not profitable due to the prolonged drought. **(Oklahoma Cooperative Extension Service, Altus, OK)**

South Carolina

Pyrethroid insecticides performed well on bollworms, and no field failures were documented. Resistant bollworms were first confirmed in Hampton County in 1996; thereafter, field failures were observed in 1997 and 1998. A resistance monitoring program started in 1996 was continued in 2000, with some individuals surviving cypermethrin at both 5 and 10µg levels. The number of resistant moths was comparatively low, considering the large numbers of moths collected and tested in the Savannah Valley area.

Two foliar sprays of Centric 40 WG at 1.9 and 2.5 oz/acre and Orthene 97 at 1.25 and 2.5oz/acre were compared to Temik 15G at 5 lbs/acre in-furrow. Temik was significantly more effective than the foliar treatments in reducing thrips damage; however, there were no significant differences in yield. Payload 15G at 6.7 lbs/acre, Orthene 97 at 2.5 oz/acre, and Gaucho 600 seed treatment at 4.8 oz/acre were significantly less effective in reducing thrips damage than Temik at 5 lbs/acre in both DP 5415 and DP 5415 RR cotton varieties. Yields were not significantly different between insecticide treatments or between the RR and conventional variety. Lint yields in untreated plots were not significantly lower than in those treated with insecticides in either test.

In small plot tests, alternative insecticides (Tracer, Steward) did an adequate job of controlling bollworm. Both of these compounds were much easier on beneficial species compared to pyrethroids when used at suggested bollworm rates. A limited amount of Tracer was used on predominately tobacco budworm populations in late June with good control. In two EUP trials, Tracer and Steward were compared to Karate in large plots. Tracer was more effective than Steward on cotton bollworm; however, yields were similar. Neither of these two materials controlled stink bugs. Tracer, Steward and Larvin will be recommended for resistance management where field failures have occurred with pyrethroids.

Several studies comparing conventional, Bollgard and Bollgard II cotton varieties indicated Bollgard II to be more effective than Bollgard on cotton bollworm. It also appeared to be much more effective against armyworms and soybean looper.

As in previous years, research indicated early-season (June) disruption of beneficials with broad-spectrum insecticides (for plant bugs) increased July populations of bollworm and armyworms. We continued to recommend avoidance of early-season, broad-spectrum materials. **(Clemson University Pee Dee Research and Education Center, Florence, and the Edisto Research and Education Center, Blackville, SC)**

Tennessee

Thrips numbers were much higher than in previous years with the western flower thrips infesting new areas. Research indicated that the best control was achieved with in-furrow sprays of Orthene. Orthene seed treatment was somewhat competitive with other in-furrow granular and spray treatments due to the presence of this new pest of seedling cotton in Tennessee. Adage (thiamethoxam) cotton seed treatments were again quite comparable to Temik for efficacy against thrips, and yields did not differ significantly. Early-season thrips control on ultra narrow row cotton comparing Gaucho seed treatment, Orthene seed treatment followed by Bidrin foliar spray, Bidrin foliar spray alone and in-furrow treatments of Temik did not differ in efficacy or produce differences in yield.

The performance of early-season thrips management programs in herbicide tolerant cotton (Roundup Ready and BXN) was not affected by the herbicide program (Roundup or Buctril compared to Cotoran + Prowl). Differences were noted between insecticide treatments.

Bt cotton containing a second gene for suppression of lepidoptera did not differ from the single gene Bollgard cotton in efficacy or yield. The infestations were almost exclusively bollworm and tobacco budworm.

At the Ames Plantation, PM 1218 BG/RR produced the highest yield, but did not significantly differ from SG 501 B/RR, DP 428 B, ST 4691 B, SG 125 B/RR, ST 4892 BR or DP 451 B/RR. At the West Tennessee Experiment Station, PM 1218 BG/RR produced the highest yield, but did not significantly differ from ST 4892 BR when compared to nine other Bt varieties and three conventional varieties. At the Milan Experiment Station, DP 428 B produced the highest yield, but did not significantly differ from PM 1218 BG/RR or DP 388, a conventional variety. **(University of Tennessee, West Tennessee Experiment Station, Jackson, TN)**

Texas

Work continued on conservation biological control in cotton in the southern Blacklands area. Previous work has indicated that grain sorghum and other crops may contribute great numbers of natural enemies to nearby cotton fields, but obtaining sufficient numbers of marked insects in mark-capture experiments has proven difficult. To circumvent this problem, stable-carbon isotope techniques were used, a natural mark originating within the crop plants themselves. This technique allowed for discriminating between predators feeding in cotton (a C3 plant) and corn or grain sorghum (C4 crops), and to also determine if eggs produced in cotton come, in part, from resources in nearby corn or sorghum. This work, which focused on the convergent lady beetle, *Hippodamia convergens*; suggested that movement of adults into cotton was intense for a period of approximately five weeks, starting with the onset of early lady beetle populations in cotton, but some (very reduced) movement occurred until the dispersal of the beetles from cotton. Additionally, the data indicated that the eggs of *H. convergens* are partially derived from nutrients consumed in corn or grain sorghum, but only in one week (of six reproductive weeks) was this contribution evident when samples were examined in a pooled fashion.

Vial bioassays with boll weevils were conducted during 1999 and 2000 to estimate their susceptibility to malathion in Texas. Weevils tested were from Burleson County in 1999 and from Burleson, Lubbock, Hidalgo and Nueces Counties in 2000. The susceptible strain of boll weevils obtained from the USDA-ARS in Stoneville, Mississippi (1999) or Mission, TX (2000) was used as an internal control. Differences in boll weevil susceptibility to malathion depending on weevil age or geographical origin were determined. In 1999, weevils from Burleson County of 2-3 days of age were the least susceptible and exhibited the highest LC50 among the populations tested, with an 8-fold increase over that of the susceptible population. In 2000, weevils from Nueces County (South East Texas) and Hidalgo County (Lower Rio Grande Valley) were the least susceptible of the four populations. Weevils from Lubbock were highly susceptible to malathion. The increase in tolerance to malathion in boll weevils detected by this method indicates that monitoring for resistance should continue, with special attention to young weevils emerging from squares in areas under the eradication program. This project was funded by Cotton Incorporated. **(Department of Entomology, Texas A&M University, College Station, TX)**

Work on the use of irrigation to reduce aphid honeydew on cotton lint has been completed. Experiments conducted in 1998 and 1999 tested the effects of one, two and three applications of water at volumes of 0.25 and 0.50 inches per acre. Overhead and in-canopy (with chemigation splash pads) nozzle positions also were tested. In 1999, cotton aphid numbers and the numbers of sugar droplets on lint were over twice as high as in 1998. In spite of this, hypothesis tests from sticky spot analyses of both years' data yielded similar results. Comparison of treatment combinations revealed that application of as little as 0.25 inches of water, applied as an overhead or in-canopy spray significantly reduced the number of sticky spots on lint when compared to the untreated check. Analysis of main effects indicated no significant differences in sticky spot reduction between the overhead and in-canopy nozzle positions, or between the 0.25 and 0.50 inch application volumes. However, three applications of water significantly reduced the number of sticky spots when compared to one and two applications, in both years reducing the number of spots to less than ten.

Investigations continue on winter survival rates and spring-summer emergence profiles of boll weevils overwintering in burned and non-burned CRP grasses. Results to date demonstrate that the benefit of burning CRP grasses as a cultural control for boll weevils extends beyond the first year. 1998-99 winter survival rates were observed to be 0.0, 0.07 and 3.0% in the winter burn (February 1999), spring burn (April 1999) and non-burned grass areas, respectively. After one year of plant regrowth, winter survival rates of 0.96 and 1.04% were observed from the original winter burn and spring burn plots, while 19.6% of the weevils survived and emerged from the non-burned grass. In the study region, weevils emerging from overwintering habitat after approximately 15 June present a much greater threat to cotton due to their increased potential to live long enough following emergence to locate and colonize fruiting cotton. During both study years, overwintered emergence from the burned areas was completed by mid-May. In contrast, 19.4 and 28.7% of the surviving weevils emerged from the non-burned areas after 15 June of 1999 and 2000, respectively. Differences in winter survival potential and timing of emergence are both influenced by the quantity of plant biomass on or near the soil surface. After two years of regrowth, total plant biomass of the burned areas is approximately 35% of the non-burned grass, which suggests the benefits of the cultural control burn continues beyond the second year. **(Texas Agricultural Experiment Station, Lubbock, TX)**

Studies continued to investigate the influence of irrigation and insecticide treatments on cotton aphid buildup late in the season. Dryland cotton was hindered by the third consecutive summer of drought and high temperatures. Essentially no rain was received from July through September, and daily high temperatures exceeding 100ºF were common through this time period. Cotton aphid numbers remained below 1.3/ leaf in dryland cotton from July 6 to September 19, when sampling was terminated. In irrigated plots with early termination of irrigation (August 7), aphid numbers built to 32.0 per leaf on July 31, but numbers declined and did not exceed 10.1 for the remainder of the season. In plots receiving a late irrigation on August 25, aphid numbers exceeded 200 per leaf on September 7.

Beet armyworms essentially were not present in a row spacing and planting date test at Chillicothe. Aphid numbers averaged <1/leaf throughout the season, but numbers were significantly highest in the plant two rows skip two rows treatment (0.76/leaf), intermediate in the plant two rows skip one row treatment (0.54/leaf), and significantly lowest in solid planting (0.28/leaf). These relationships parallel those in the 1999 test at Munday. Aphid numbers were not significantly influenced by the three planting dates of early May, late May, and early June. Whitefly numbers were significantly influenced by planting pattern, but not by planting date. Numbers averaged <3/leaf throughout the season. Whitefly nymphs were significantly highest in the plant two skip one row configuration (2.87/leaf), intermediate in solid planting (2.54/leaf), and significantly lowest in the plant two skip two rows configuration (2.13/leaf). **(Texas Agricultural Experiment Station, Vernon, TX)**

One objective of the Corpus Christi cotton research program was to examine the effects of insect resistant Bt-transgenic plants on the abundance of pests and their natural enemies. Two Bt and two non-Bt varieties were sampled, and we found that most insects, including natural enemies, were at levels too low to make comparisons. The two insect herbivores that were relatively abundant, thrips (several species) and cotton aphid, were both found at higher densities on the 2 Bt varieties than the 2 non-Bt varieties. About 4.1 and 5.6 thrips per leaf were counted on the Bt varieties NuCot33B and PM1218BG/RR, respectively, and only 2.0 and 2.9 thrips per leaf respectively were counted on the non-Bt varieties Fibermax832 and Fibermax989. Similarly, about 0.35 and 0.30 aphids per leaf were counted on the Bt varieties NuCot33B and PM1218BG/RR, respectively, and only 0.09 and 0.14 aphids per leaf were counted on the non-Bt varieties Fibermax832 and Fibermax989, respectively. This did not occur because of differential feeding damage on Bt vs. non-Bt plants, as there was virtually no insect damage to leaves. Other possible reasons that will be examined in the future are nutritional and maturity differences.

Boll damage was similar for Bt and non-Bt varieties, but square damage was less (as is expected) for Bt varieties than for non-Bt varieties. An average of 14.4% and 10.1% square damage, respectively, was found for the Bt varieties NuCot33B and PM1218BG/RR, and 21% and 27% square damage, respectively, was found on the non-Bt varieties Fibermax832 and Fibermax989.

In a multiple regression of the effects of thrips density, aphid density, square damage and boll damage on lint yield, all except boll damage were significant and accounted for about 35% of the variation in yield. Although yield decreased with increasing damage, yield actually increased with increasing thrips density and increasing aphid density, possibly as an artifact of the increased insect numbers on Bt crops which yielded better. **(Texas Agricultural Experiment Station, Corpus Christi, TX)**

Research continues in the southern Rolling Plains on determining movement of natural enemies and pests between crops and non-crop areas. Some of the work was shifted to the southern Blacklands because of better weather conditions. Bollgard was evaluated at several sites in the High Plains in a large plot configuration. These studies indicate statistically significant increases due to caterpillar control, but in some cases these differences were not economically significant. Bollgard II was evaluated in several sites across the state in small plots. A report on Bollgard cotton performance in northern Rolling Plains irrigated cotton, 1996 through the 1999 has been completed. This project was continued into the 2000 production season, but results have not been completed. This year as with the last two years, Bollgard and conventional cotton were inspected weekly, and insecticidal applications were based on insect infestations. This year even less insecticide was used in the conventional cotton than in 1999. The Bollgard® cotton did not have to be treated for beet armyworms or cotton aphids. The conventional cotton was treated for cotton aphids.

Alternate hosts of *Lygus* species (including wild and cultivated) were surveyed in the northern Rolling Plains and High Plains areas. Additionally, species determinations were made with the High Plains samples.

A boll weevil trapping program was conducted with County Extension Agents in Motley, Dickens and Kent counties (northern Rolling Plains counties) with the support of Texas Boll Weevil Eradication Foundation. With the support of County Extension Agent Dale Dunlap and Demonstration Assistant Priscilla Green and the Texas Boll Weevil Eradication Foundation, boll weevil traps were run in Collingsworth County. Trapping results have not been completed but do show a boll weevil decrease of 92% and 96% in numbers as compared to results from August and September 1999. The GRID boll weevil trapping project was continued into its 6^{th} year in the High Plains area. This is a cooperative project between Extension and Plains Cotton Growers, Inc. and involves about 900 traps in 28 counties. We continued a 6 year survey of boll weevil overwintering sites in 21 counties in the High Plains, evaluating relative importance of various habitats on attracting weevils and their survival. Dry conditions in the overwintering sites appeared to have a profound effect on boll weevil survival. Dig-up cage studies at three north to south sites in the High Plains in cooperation with the Experiment Station allowed for partioning of winter mortality on a three-week increment.

Daily bollworm, tobacco budworm, and beet armyworm moth trapping was done at the Research and Extension Center at Vernon, and in Collingsworth County. Bollworms and budworms were trapped at the Texas Agricultural Experiment Station at Munday, and beet armyworms at the TAES at Chillicothe. Both bollworm and budworm moth numbers captured during the 2000 cotton production season were well below average, as established by trapping program in this area since 1982.

Work was continued in the High Plains area on evaluating different sampling methods for cotton fleahoppers and *Lygus* bugs. Visual, sweep net, drop cloth and KISS sampling techniques were compared. Thus far, the drop cloth method appears to be the most effective and time efficient. Additional sampling investigations were conducted in Far West Texas on cotton fleahoppers, plant bugs and stink bugs. The beat bucket method was included here. Validation of the COTMAN model continued in the South Texas and High Plains areas. This included evaluations of SQUAREMAN in IPM programs, and BOLLMAN as a tool to determine when to terminate insecticide applications for boll weevils and bollworms, as well as when to terminate the crop. The south Texas study evaluated stink bug puncture vulnerability using BOLLMAN.

A number of extension entomologists and IPM agents evaluated both Bollgard and Bollgard II cottons for economic Heliothine management under different cropping systems. Insecticide efficacy trials were conducted with new and existing insecticides against thrips, cotton fleahoppers, bollworms, beet armyworms, cabbage loopers, cotton aphids, boll weevils, and western tarnished plant bugs. These insecticides are included in Table 3.

Northern Blacklands small plot, replicated field trials were conducted to evaluate Adage (300 gm ai/100 kg seed) seed treatment and Temik for thrips control. Actara (21.5 grams ai/ hectare), Centric (53 and 70 gms ai/h) were evaluated as foliar sprays for thrips control and compared to the standard Address (acephate) and Bidrin. Acetamiprid was evaluated at 0.0375, 0.05 and 0.075 lbs. AI/A as a foliar spray for thrips control and compared to Bidrin as a standard. Bollgard II cotton was compared to Bollgard and DP 50 in a replicated, small plot field trial. However, only plant mapping data were obtained as few lepidopteran pests were present in the trial. Nine cotton varieties were evaluated for tolerance to fleahoppers in a small plot, replicated field trial with and without insecticide treatment. Unfortunately, fleahopper numbers were well below treatment thresholds across the trial. Initial field work was completed to determine the density and distribution of fire ants mounds in cotton and their role as predators of bollworm eggs.

In tests conducted in the Coastal Bend area, Adage, Gaucho, Temik and Admire applied at-planting provided significant control of aphids through 55 days after planting. Lint yields in plots treated with these materials produced 100-165 lb./acre more lint than untreated cotton. In another study, Temik 15G applied at 2.3, 4.0 and 5.8 oz/1000 row ft reduced thrips, aphids and plant damage substantially compared to untreated cotton. Returns over the untreated cotton were $11.65, $14.13 and $0.22 per acre for the 2.3, 4.0 and 5.8 oz/1000 row ft application rates, respectively. In a foliar spray study, Furadan, Bidrin, Provado, Assail (Aventis) and Calypso (Bayer) provided effective aphid control in a declining aphid population. In a caterpillar control study, Karate and Leverage did not provide tobacco budworm control but Tracer, Steward and Denim provided excellent control. Aphids increased in Karate plots but were low in Leverage-treated cotton. Denim (.0075 and 0.01 lb. ai/A) provided good control of spider mites. In another study, cotton varieties DPL 50Bll, DPL 50B, DPL 33B and DPL 50 were compared. All transgenic B.t. varieties contained significantly lower numbers of tobacco budworms and less damage.

In High Plains insecticide screening trials, Orthene still provided the best control of the western tarnished plant bug compared to Denim, Steward, Assail, Centric, Vydate and selected pyrethroids. In cotton aphid control tests, Assail appeared to be the heir apparent for Furadan 4F. Centric was second best with Fulfill outperforming Provado. Capture flared aphid numbers as in years past. The most promising insecticides in a beet armyworm test included Denim, Steward and Intrepid. **(Texas Agricultural Extension Service, Lubbock, San Angelo, Dallas, Corpus Christi, Weslaco, TX)**

We have examined the effects of cotton defoliants alone and in combination with full and half rates of insecticides on boll weevil mortality, fecundity, and flight behavior. Def+Karate and Def+Guthion exhibited substantial synergism in both laboratory and field plot tests (75-98% mortality of boll weevil adults). Weevils surviving Def+Karate and Karate treatments deposited fewer eggs. In preliminary flight mill trials, defoliants did not affect weevil flight behavior, but Karate increased flight activity and distance flown. Defoliation differentially affected whitefly nymph mortality and parasitoid survival depending on whitefly instar.

Boll weevil populations were 1.3 to 5 times lower in a conservation-tillage (cs) dryland cotton field than in an equivalent neighboring conventional-tillage (cv) field throughout the growing season. Soil moisture in the cs field was adequate early in the growing season, and the cotton set fruit early. The cv cotton suffered early moisture-stress causing plants to shed fruit, diverting resources to vegetative growth. Consequent early closure of the cv cotton canopy resulted in much higher survival of weevils in fallen infested squares than in those in the cs cotton where soil surface temperatures averaged 30°F higher.

Aerial digital images of experimental cotton plots subjected to simulated boll weevil damage indicate that plants with higher square damage levels had a different spectral response than those with lower damage levels.

Reproductive rate, intrinsic rate of increase, and limiting frequency of reproduction were determined for boll weevil females provided with different numbers of cotton squares. The results will be used to develop a standardized assay for boll weevil fecundity that will be used in a wide range of experiments. It also is providing fundamental information necessary for understanding boll weevil population dynamics and oviposition behavior in the field.

We determined in laboratory, greenhouse and field cage trials host preference for beet armyworm oviposition under no-, two-, and five-choice assays, as well as life-table parameters involving combinations of wild and cultivated host plants common in the subtropics. These studies demonstrated a hierarchy of preference for, and survivabilty on, common host plants. Pigweed is the most preferred host, and cotton is a host of intermediate preference. Beet armyworm development time, mortality, fecundity, and the number and longevity of female progeny are significantly higher when reared on pigweed than on cotton, cabbage, sunflower, and bell pepper.

There is a growing concern that cotton gins located in active eradication zones, which receive modules from adjacent infested areas may be releasing weevils in gin trash. A method for sampling weevils from gin trash was developed -- basically a 5-gallon bucket fitted with an unbaited pheromone trap in the lid. Trash from three commercial gins was sampled in the Lower Rio Grande Valley and one live weevil (apparently only 1-3 days old) was recovered. Groups of weevil adults were marked, placed in gin trash, and passed through one of five fans in the research gin at the Cropping Systems Research Laboratory in Lubbock. No live weevils were recovered. Infested green bolls were also passed through the fans and the resulting debris searched for live weevils. Two intact, and three almost-intact adult weevils were recovered from the 3 reps of feeder fan boll debris. One of the weevils apparently survived the fan as a pupa or young adult. Debris from the other 4 fans harbored no intact or almost-intact weevils. The feeder trash fan was the only one with an rpm below the standard for pink bollworm quarantine.

An effective fall trap-cropping system would concentrate potentially overwintering weevil populations where they could be controlled with minimal cost and environmental contamination. Cotton fields were bracketed by 8 rows of late-planted cotton baited with pheromone, and mark-recapture studies showed for the second year that these late-fruiting trap rows are very attractive to weevils forced from the main field by defoliation and shredding. We evaluated the effectiveness of a photoactive dye bait as the killing agent in the trap rows. When fresh, the bait is picked up by at least 50% of the weevils entering the trap rows. Experiments involving blocks of adjacent fields will be necessary to determine if weevils escaping the trap rows of their original field are arrested by other nearby trap rows. It will also be necessary to improve the efficiency of the bait as the killing agent.

Improved understanding of interactions between wind speed, wind direction, temperature, and pheromone trap position within trap lines will lead to increased effectiveness, economy, and quality of information from trapping programs. Recent experiments showed that wind speed is negatively correlated with weevil captures, but that brush lines can slow the wind enough to increase captures by 4.5-fold on the lee side. We have also shown that traps spaced at 15-m intervals can interfere with one another when winds strike the line at an angle, such that the trap furthest upwind captures significantly more weevils than some of the traps within the line. The number of degree-hours during the day is positively associated with total daily capture of weevils in pheromone traps.

Our recent work has shown that cuticular hydrocarbon profiles change with age of the boll weevil under controlled conditions, and they may prove useful in estimating the age of field captured boll weevils. Hydrocarbon profiles of weevils from an independent data set are currently being analyzed to determine the precision of age estimates, as are profiles from weevils reared on different diets (bolls vs. squares) as a first step in identifying other sources of variation that may confound age effects.

A hemolymph protein has been identified that appears to track fat body condition. It is very abundant in weevils with diapause characteristics, and is present but scarce in reproductive weevils of both sexes. The N-terminus has been sequenced and has revealed that it is a hexameric storage protein. The purified protein was isolated and used in conjunction with a synthetic peptide (from the N-terminal sequence) to raise polyclonal antibodies in rabbits. The antibodies will be tested to determine the feasibility of producing a diagnostic kit that can be used by field researchers. A genomic library has been constructed and is being screened for the storage protein gene.

Restriction fragment length polymorphism profiles of a large boll weevil mtDNA fragment are being determined for LRGV weevil populations and will be compared with those from other geographic regions to determine frequency of long-range dispersal. A USDA-funded Post-Doctoral Associate will be hired to accelerate progress in this project.

Beet armyworm was shown to prefer *Amaranthus hybridus* for oviposition. The choice appeared to be made based on both olfaction and other cues, probably visual. First instar stayed on whichever host it encountered first, but the more motile third instar showed a significant preference for pigweed leaves over cotton leaves. Analyses of free amino acid accumulations, which are the most readily utilized form of amino acids by insects, demonstrated that pigweed has a greater diversity of free essential and non-essential amino acids, and greater quantities of most free amino acids than cotton, so the selection of pigweed by the gravid female appears to be based on nutrition. In another study, kaolin (a white mineral applied in water) application to laboratory and greenhouse cotton foliage and to excised squares resulted in a delay in boll weevil feeding and oviposition on the treated plants and squares. In a small plot test, the field that received applications of kaolin, including the untreated control plots, produced significantly more cotton lint than adjacent fields that had no kaolin applications; one of the adjacent fields received two pre-emptive Guthion applications and the other field had no insecticide applications. Within the kaolin treated small plot field, less square damage was recorded in the kaolin treated plots as compared to the control plots until later in the season. This indicates that boll weevils might avoid kaolin treated cotton plants in favor of untreated plants, but it also shows that boll weevils will feed on treated squares or on squares growing on treated plants when other food sources become more scarce. A third experiment showed, using grandlure-baited sticky board traps, that late- and post-season field disturbances (i.e., defoliation, harvest, shredding, stalk pulling, and mold boarding) result in large numbers of boll weevils becoming airborne and to move between the field and nearby brush lines. This study suggests that this information can be useful for timing late- and post-season interventions for reducing boll weevil populations that would otherwise overwinter. A fourth study determined that a pre-emptive spray of Leverage (Baythroid + Pravado) followed five days later with an application of Guthion in commercial fields significantly reduced injury to squares during the first few weeks of squaring, but lint yield comparison showed that pre-emptive spraying resulted in a non-significant ($P = 0.137$) but 1.25 X higher yield than the fields that were not pre-emptively sprayed. Throughout the growing season, pre-emptively treated fields received 2.5 X more boll weevil control sprays, counting the pre-emptive treatments, than those fields that did not receive pre-emptive sprays. **(USDA, ARS, Subtropical Agricultural Research Laboratory, Weslaco, TX)**

Virginia

Seven field experiments were conducted to investigate several issues regarding thrips management in cotton and to further develop recommended practices for Virginia growers. Highlights of six of these are highlighted below.

Evaluation of Broadcast and Banded Rates of Orthene 97 on Gaucho 480 Treated Cotton to Develop Recommendations for Herbicide Tank-Mix (Broadcast) or Banded Options. Orthene 97 applied as a band at 0.15 lb AI/A to Gaucho 480 (0.3 lb AI/cwt) treated seedlings provided levels of control equal to Orthene 97 banded at the 0.25 lb AI/A rate; when broadcast, it took the 0.39 lb AI/A rate of Orthene 97 to achieve levels of control equal to the 0.15 lb AI/A band rate; Gaucho 480 plus the 0.15 and 0.25 lb AI/A Orthene 97 bands provided significantly better control compared with Temik at 0.75 lb AI/A, alone, on 3 of 4 sample dates; control with Gaucho 480 plus 0.15 lb AI/A of Orthene 97 broadcast was not significantly better than Temik at 0.75 lb AI/A, alone; Gaucho 480 plus the 0.25 lb AI/A and 0.39 lb AI/A rates of Orthene 97 broadcast provided levels of control that were significantly better than Temik at 0.75 lb AI/A, alone, on 2 of 4 sample dates.

Use of COTMAN to Evaluate Fertilization Enhancement for Mitigating Thrips Damage. Applications of N improved yields of thrips damaged cotton but did not offset the losses compared with thrips protected cotton. Plant growth and development curves generated by COTMAN mapping techniques provided useful insights into how plants responded to both thrips damage and N applications.

Use of Different Harvest Dates to Evaluate 'Earliness' Conferred by In-Furrow and Seed Treatments. Temik at 0.75 lb AI/A provided the best thrips control on all dates, except it was equal to Gaucho 480 (0.3 lb AI/cwt) on the first date in one test; Gaucho 480 (0.3 lb AI/cwt) provided significantly better levels of control compared with Admire (0.05 lb AI/A) on 6 of 8 sample dates; Gaucho 480 (0.3 lb AI/cwt) provided significantly better control compared with Adage (0.3 lb AI/cwt) on all sample dates; Admire (0.05 lb AI/A) provided significantly better control compared with Adage (0.3 lb AI/cwt) on 6 of 8 sample dates.

Evaluation of Adage 5FS Seed Treatment Rates. Control with Adage at either rate tested (3.2 or 4.8 oz AI/cwt) was always significantly less than Temik at 0.75 lb AI/A; Adage at 4.8 oz AI/cwt plus Orthene 97 at 0.25 lb AI/A banded provided significantly better levels of control than the 3.2 oz AI/cwt Adage rate plus Orthene 97, on 3 of 4 sample dates; Adage at the 4.8 oz AI/cwt rate plus Orthene 97 at 0.25 lb AI/A provided equal control equal to Temik at 0.75 lb AI/A on 3 of 4 sample dates.

Evaluation of Foliar-Only Applications for Product Efficacy, Timing and Impact on Yield. Only Orthene 97 banded at 0.15 and 0.25 lb AI/A provided equal control to Temik at 0.75 lb AI/A, on 2 of 4 sample dates; all Orthene 97 treatments provided significantly better control than either Centric 40WG at 0.05 lb AI/A or Vydate C-LV at 0.25 or 0.5 lb AI/A, on all sample dates; control with Centric 40WG was not significantly different from the untreated control on the last sample date; Capture 2E at 0.05 lb AI/A provided equal or better control than most Orthene 97 rates; control with Vydate C-LV at 0.25 of 0.5 lb AI/A was not significantly different from the untreated control on 2 of 4 sample dates.

Evaluation of Orthene 97 in Herbicide Tank Mixes on BXN and RR Cultivars. Orthene 97 tank mixed with Roundup Ultra (0.75 lb AI/A) and Staple (0.06 lb AI/A), or Buctril (0.5 lb AI/A) did not cause any tank mix problems, no phytotoxicity was observed, and treatments achieved expected levels of thrips control. Six field experiments were conducted to develop programs for improving bollworm management in Virginia. Briefly, data showed that two pyrethroid sprays, the first applied at egg threshold and the second in five days, are effective in controlling bollworm and minimizing boll damage. Of the pyrethroids tested, all provided significantly better bollworm control and lint yield increases compared with the untreated control. Bollgard cultivars tested all achieved higher lint yields when treated one time with a pyrethroid, but in most cases, conventional cultivars treated two times resulted in higher yields compared with Bollgard cultivars treated one time. Use of COTMAN to determine last effective spray date showed that any additional sprays (more than the two recommended sprays), after NAWF=5 + 350 or more heat units, did not improve bollworm control or lint yields. Tracer 4SC applied at the 0.062 lb AI/A rate provided levels of bollworm control and lint yields equal to Baythroid applied at 0.028 lb AI/A. **(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 2000 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 2000 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 2000.

State	Pesticide (lbs AI/A)	Target Pest
Alabama	Intrepid	2001 Insect Control Recommendations
Arizona	None	
Arkansas	Steward 1.25	Lepidopteran pests and tarnished plant bugs
California	Confirm	
	Savey (Section 18)	
	Furadan (Section 18)	
	Steward (Section 18)	
Florida	None	
Georgia	None	
Louisiana	None	
Mississippi	No response	
Missouri	None	
New Mexico	None	
N. Carolina	None	
Oklahoma	None	
S. Carolina	Provado at 3.75	Aphids, plant bugs
Tennessee	None	
Texas	Steward (Section 18)	Beet armyworm
	Denim (Section 18)	Beet armyworm
	Intrepid (Section 18)	Beet armyworm
	Furadan 4F (Section 18)	Aphids
Virginia	None	

Table 2. Changes in state recommendations for treatment for arthropod pests of cotton for 2001.

State	Pesticide	Target Pest
Alabama		
Addition	tebufenozide (Confirm 2F) 0.12-0.25	Beet armyworm.
	methoxyfenozide (Intrepid 2F) 0.06-0.16	Beet armyworm andloopers.
	pyriproxyfen (Knack .86EC) 0.054-0.067	Silverleaf whitefly.
Deletion	bifenthrin (Capture 2EC)	Aphid.
Arizona	None	
Arkansas		
Additions	Acephate Orthene 97	Thrips
	Indoxacarb Steward 1.25 0.09-0.11	Bollworm, fall armyworm, and beet armyworm
	Indoxacarb Steward 1.250.11	Tobacco budworm
	Imadaclprid 1.60.0375-0.0469	Plant bugs
	Cyfluthrin 1.1 0.026-0.032	
	Leverage 2.7	
	deltamethrin 0.013-0.019	Cutworms
	Bifenthrin 0.06-0.1	White fly
	Capture 2EC	
	Fenpropathrin	
	Danitol 2.4EC +	
	Acephate Orthene 90S	
	Orthene 97	
California	Success	Beet Armyworm
	Confirm	
	Lepinox	
	Xentari	
Georgia		
Additions	Orthene 97	Cutworms, plant bugs, thrips, whiteflies
	Confirm 2	Beet armyworm
	Capture 2	Spider mites
Deletions	Ovasyn	All uses
	Bolstar	All uses
Louisiana		
Additions	Orthene 97	All insect pests where Orthene 90S was previously used
	Orthene 90	Whitefly control
	Orthene 97	
	Knack	
Deletions		All recommendations for boll weevil
Missouri		
Additions	Intrepid 2F	Armyworms (beet and fall)
Deletions	None	
New Mexico	None	
N. Carolina	Tracer 0.063-0.089	Soybean and cabbage looper
Oklahoma	None	
S. Carolina		
Additions	Steward	Budworm, bollworm, armyworms, loopers
	Intrepid	Armyworms
	Leverage	Budworm, bollworm, aphids
Tennessee		
Additions	Confirm	Fall and beet armyworm, loopers
Texas		
Additions	Decis, Capture, Baythroid, Fury	Cutworms
	Intrepid	Beet armyworm
	Steward	Beet armyworm
	Tracer	Beet armyworm (organic cotton)
	Adage	Thrips
Deletions	Gaucho	Thrips
	Cygon	Fleahopper, aphids, tarnished plant bug, spider mites
Virginia		
Additions	Gaucho 480 at 8 oz/cwt seed	Thrips
	Penncap-M 2F at 0.5-1.0 pt	Plant bug
	Orthene 75S at 16 oz	Stink bug
	Orthene 97 at 12.0 oz	Stink bug
Rate Changes	Orthene 75S at 3.2 oz, broadcast at 5.3-8.3 oz	Thrips
	Orthene 97 at 2.5 oz; broadcast at 4.1-6.4oz	Thrips
	Decis 1.5EC at 1.9-2.56 oz	Bollworm
Deletions	Payload	Thrips
	Cygon 4EC	Thrips

Table 3. Promising pesticides screened in 2000 for control of cotton arthropod pests.

State/Pesticide (lbs AI/A)	Target Pest(s)
Alabama	
S-1812 4.0 at 0.075-0.2	BW, TBW, Soybean looper
Denim at 0.16 at 0.0075-0.01	BW, TBW, Soybean looper
Intrepid 80WP at 0.35	Soybean looper
Steward 1.25 at 0.032-0.09	BW, TBW, Soybean looper, TPB
Acetamiprid (Assail) 70WP at .038-.05	TPB, Aphid
AC 836519 2.0 at .15-.2	Soybean looper
Adage (seed treatment) at 300g/100 lb seed	TPB
Larvin 3.2 at .06	TPB, SB
Novaluron 10EC at 0.011-.045	
Centric 45WG at .047-.062	
Arkansas	
indoxicarb, Steward 1.25	Heliothine control
methoxyfenozide, Intrepid	
emamectin benzoate, Denim pyridayl (proposed ISO name of S-1812) thiamethoxam, Actara, Adage, Centric thiacloprid, Calypso	Plant bugs and aphids
Arizona	None
California	
Trilogy at 1 qt	Spider mites
Organic Solutions at 1:150	
UCC-D2341 4L at 1 pt	
UCC-D2341 4L at 1.5 pts	
V1283 72WDG at 0.065 lb AI/A	
Cinnamite at 85 oz/100 gal	
Actara 25WP at 3 oz/A	Cotton Aphids
Fulfill 50WG at 2.7 oz/A	
Fulfill 50WG + Zephyr 0.15EC	
Fulfill 50WG + Lorsban	
Fulfill 50WG + Provado 1.6F	
Calypso 4 SC at 0.75 fl oz	
Calypso 4 SC at 1.5 fl oz	
Assail 70WP at 0.57 oz/A	
Assail 70WP at 1.15 oz/A	
Vydate C-LV at 25.5 oz	
Bollwhip at 1 qt/A	
Novaluron 10EC at 0.011 lb AI/A	Lygus Bugs
Novaluron 1ED at 0.0225 lb AI/A	
Novaluron 10EC at 0.045 lb AI/A	
Leverage 2.7 SE at 3.75 fl oz/A	
Calypso 4 SC at 3 fl oz/A	
Georgia	None
Louisiana	
Adage 5FS	Thrips, TPB, aphids
Acetamiprid 70SC	TPB, thrips, aphids
Actara 25WG	TPB, thrips, aphis
Bollgard II	Various Lepidoptera larvae
Centric 40WP	TPB, whitefly
Denim 0.16EC	Bollworm, tobacco budworm, TPB
Fulfill 50WP	TPB, aphids
Intrepid 80WP	Bollworm, tobacco budworm, soybean looper
Steward 1.25 SC	Bollworm, tobacco budworm, TPB, soybean looper
S-1812 4EC	Bollworm, tobacco budworm, armyworms, soybean looper
Mississippi	None
Missouri	
Actara 25WG at 0.036, 0.62	Thrips
Adage 5F	Thrips
Assail 70WP at 0.025, 0.05, 0.1	Bollworm eggs
Calypso 4SC at 0.023, 0.047, 0.094	Bollworm, plant bugs
Centric 50WG at 0.047, 0.062	Plant bugs
Leverage 2.7SE at 0.079	Bollworm
RH-2485 2F 0.12	Bollworm
Regent 2.5E at 0.025, 0.038	Plant bugs
Steward 1.25SC at 0.065, 0.075, 0.09, 0.11	Bollworm, plant bugs

North Carolina	
Bollgard II	Bollworm, budworm, Eruopean corn borer, and fall armyworm
Steward 0.11	Bollworm
Denim 0.012	Bollworm
Intrepid 0.25	Bollworm
South Carolina	
Centric	Aphids
S-1812	Budworm, bollworm, loopers, armyworm
Tennessee	
Adage 600F at 300g AI/cwt	Thrips
Leverage 2.7SC at 8 oz IFS	Thrips
Leverage 2.7SC at 20 oz/cwt	Thrips
Admire 2F .0375 + Orthene 90S at .55 IFS	Thrips
Actara 25WG at .047	Plant bugs
Calypso 4SC at .047	Plant bugs
Centric 40WG at .047-.062	Plant bugs
Steward 1.25 SC at .075	Plant bugs
Texas	
Adage 5FS at 4.8-7.6 oz/cwt seed	Thrips
Admire 2F at 3.2-6.4 oz/A	Thrips
Actara 25WG at 0.31 oz/A	Thrips
Assail 70WP at 0.0375-0.075 lb AI/A	Thrips
Centric 40WG at 0.75-1.0 oz/A	Thrips
Furadan 4F at 4.0-8.0 oz/A	Aphids
Fulfill 50WP at 0.085 lb AI/A	Aphids
Actara 25WG at 0.047 lb AI/A	Aphids
Assail 70WP at 0.85-1.7 lb AI/A	Aphids
Calypso 4SC at 0.025-0.047 lb AI/A	Aphids
Centric 40WG at 0.025-0.047 lbs AI/A	Aphids
Assail 70WP at 0.85-1.7 oz/A	Cotton fleahopper
Actara 25 WG at 1.6-3.2 oz/A	Cotton fleahopper
Calypso 4SC at 1.5 oz/A	Cotton fleahopper
Steward 1.25SC at 0.06-0.1 lb AI/A	Cotton fleahopper
Steward 1.25SC at 0.09 lb AI/A	Plant bug
Assail 70WP at 0.05-0.1 lb AI/A	Plant bug
Denim 0.16EC at 0.01 lb AI/A	Plant bug
Calypso 4SC at 0.047 lb AI/A	Plant bug
Centric 40WG at 0.047-0.063 lb AI/A	Plant bug
Actara 25WG at 0.047 lb AI/A	Plant bug
Steward 1.25 SC	Bollworm
Valent S-1812 at 0.01 lb AI/A	Bollworm
Intrepid 80WP at 0.05-0.2	Bollworm
Denim 0.16EC at 0.01 lb AI/A	Bollworm
Valent S-1812 at 0.1 lb AI/A	Beet armyworm
Steward 1.25 SC at 0.11 lb AI/A	Beet armyworm
Denim 0.16EC at 0.01 lb AI/A	Beet armyworm
Intrepid 80WP at 0.05-0.2	Beet armyworm
Valent S-1812 at 0.1 lb AI/A	Cabbage looper
Steward 1.25SC at 0.11 lb AI/A	Cabbage looper
Denim 0.16EC at 0.01 lb AI/A	Cabbage looper
Intrepid 80WP at 0.05-0.2	Cabbage looper
Virginia	
Bollgard II	Bollworm
S-1812 at 0.15 lb AI/A	Bollworm
Centric 40WG at 0.05 lb AI/A	Thrips
Adage 5FS at 3.2 and 4.8 oz AI/cwt seed	Thrips
Steward 1.25EC	Bollworm, thrips, beet armyworm