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55TH ANNUAL CONFERENCE REPORT ON COTTON INSECT RESEARCH AND CONTROL

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Foreword

There were 13,293,500 acres of U.S. Cotton (Upland and Pima) harvested with an average of 687 lbs of the lint per acre (USDA – January 2002, report) in 2001. Arthropod pests of cotton reduced yield by 4.53% in 2001. The bollworm/budworm complex reduced yields by 1.228%. The bollworm was the predominant species to attack cotton in 2001 and was estimated to make up 72% of the population. No other pest exceeded 1% in reducing yields. *Lygus* (0.982%) and early season thrips (0.795%) were 2nd and 3rd respectively. Stink bugs (0.768%) and aphids (0.275%) rounded out the top five cotton insect pests for the year. Beltwide, direct insect management costs amounted to $52.33 per acre and losses were $26.27. Cost plus loss was estimated at $1.158 billion (see M. R. Williams, this Proceedings).

Crop and Arthropod Pest Conditions

Alabama

Cutworm populations were normal, and a good number of high-risk acres received a prophylactic pyrethroid treatment against this pest. Thrips populations were very moderate, but there were numerous control problems associated with at-planting insecticides due to weather aggravations. Cotton aphids flared on a good number of acres in early June, and a modest number of controls were applied. Few aphid problems occurred thereafter, and populations crashed due to disease in mid-July. Most areas were wet for most of the summer, making conditions good for cotton and tarnished plant bugs. Plant bug populations never really got out-of-hand. Instead, they reached moderate-to-high levels in late June and sustained that level on into August where controls were not applied. Plant bugs were generally under-treated and considerable (in-season) damage occurred. In addition to lost yield, plant-bug-damaged fields were later in opening than those fields where damage was minimized. Two-spotted spider mite infestations were very common in July and August and may be related to at-planting systemic insecticide being dissipated by heavy rains. Acaricide applications were minimal. Isolated but significant problems with tobacco budworms occurred in July. More uniform worm pressure was encountered in early August and involved the bollworm as well as the tobacco budworm, but overall infestations were in the 5 – 10% range, and most fields were never treated. Beneficial arthropod populations were lower than average. The red imported fire ant population, in particular, was much reduced by the cold weather during the 2000-2001 winter.

North Alabama planted 280,500 acres in 2001 in which ca. 40% utilized Bollgard technology. Yields should average over 800 pounds of lint per acre or slightly above.

The 2001 crop season began under very dry conditions. Some areas had no rainfall between late March and June 1; therefore both planting and emergence were delayed. However, once weather patterns changed, adequate rainfall occurred throughout the growing season. In fact, significant boll rot occurred in certain areas in late August and early September. Harvest weather was excellent and the statewide yield will be near record high (750-800 lbs.).

Insect pressure overall was some of the lowest in history. Many fields were never treated with a foliar insecticide. The average number of foliar sprays made in central and south Alabama averaged one or less. Thrips were quite heavy and damage was evident; some Adage seed treated fields required a foliar thrips spray and even Temik at planting had thrips injury. Plant bugs reached thresholds in a limited number of fields in the early season and eventually became more abundant in all fields that went unsprayed for most of the season. Aphids never built to excessive levels and crashed before exerting significant stress on the 2001 crop.

Overall the bollworm and budworm pressure was very light. Only a few localized fields ever reached threshold. Therefore, little difference in damage or insecticide sprays was recorded between Bollgard and conventional cotton. Other leaf pests (fall armyworm, beet armyworm, looper) were near non-existent. A few thousand acres of untreated cotton were infested late in the season in the Gulf Coast area with the southern armyworm. Defoliation was up to 40% in some of these fields.

Stink bugs were the major economic insect in southern Alabama in 2001. The heaviest pressure and greatest damage (fields were not treated) occurred in southeastern Alabama where both cotton and peanuts are grown. Up to 20% of the bolls were damaged in numerous fields. Adding to this damage in late season was the leaf-footed plant bug. Damage from this insect is similar to stink bugs.

Arizona

Arizona planted 285,500 acres of cotton in 2001 (incl. 7,500 acres of American Pima). Transgenic varieties dominated the marketplace with over 80% of all acres. Those varieties containing *Bt* transgenes comprised around 70% of the total acreage. Varieties stacked with both RR® and *B*t transgenes were planted on about 49% of the state's cotton acreage.

The 2001 season was an average to good year in terms of weather conditions and crop condition. The greatest problems were experienced at planting and stand establishment in the western part of the state where cold and wet weather compromised or delayed crop development. After stand establishment, early crop growth and in-season development were excellent with only short bouts of heat stress that limited fruiting for short periods. The monsoon season was early to average in initiation. Weather in September was unusually warm and dry once again allowing for some late production; however, many growers terminated irrigations earlier than normal in part due to the difficult economic conditions. Defoliation and picking were exceptionally early as a result of the open fall. Very little cotton was still in the field when frosts came in late November and December in most growing areas. Yields, in general, were off considerably from last year's record high, but well in line with long-term average yields for the state. Given the abbreviated season of production, these yields represent relatively quick and efficient fruiting with few losses to pests or weather. High micronaire values, which plagued production last year, have returned to more normal levels for our region.

Insect pressure in 2001 has continued to be low relative to long-term trends. Since 1996, which marks the introduction of *Bt* transgenic cotton and whitefly selective insect growth regulators (IGRs), foliar insecticide use has declined by over 50% overall. The 2001-year was similar to the last two years in terms of number of sprays with one notable exception, whiteflies.

Arizona's principal pests are pink bollworm, *Bemisia* whiteflies, and *Lygus* bugs (mainly *Lygus hesperus*). Pink bollworms have caused essentially no economic damage to *Bt* cotton, and, as a result of so much *Bt* cotton being planted in the general landscape, even non-*Bt* cotton is under less pressure by this pest. Very 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 very limited non-*Bt* acreages that were carried into late September and October production, some loss to this pest was experienced. While very much dependent on the maturity class of the varieties produced, losses of up to one-third of a bale (ca. 10%) to pink bollworm were possible this past year based on controlled studies.

Lygus bugs continue to constitute a larger proportional threat to growers than in past years when the other primary pests were in abundance. *Lygus* this year, however, were once again generally low throughout the state, though localized incidence of chronic invasions were still observed where alfalfa or safflower were poorly managed for this pest. In controlled tests, *Lygus* reduced yields in unprotected cotton by over 80% in an area that required ca. 4 *Lygus* sprays.

The largest change in pest pressure in 2001 was in whitefly densities. Threshold level densities initiated earlier for most locations than in any other year except 1996. Most fields reached threshold during the first two weeks of July; however, producer response to these invasions was not uniform. In the past, large numbers of producers would respond quickly with an IGR, and in part as a result of the areawide use of these effective compounds, populations abated quickly. This year, however, uncertainty about cotton markets, generally depressed economic conditions, and interest in deferring all foliar inputs as late as possible resulted in a rather slow-to-act behavior with respect to IGR usage and whiteflies. Some producers sprayed close to the recommended threshold with IGRs, and these acreages fared the best with no threat of stickiness and with the lowest spray costs. Unfortunately, however, in a false economy many producers opted either to wait longer before using IGRs—sometimes as late as 15 times the recommended threshold—or to deploy conventional, broad spectrum, adulticidal insecticides first. In both cases, the response was too late or not nearly as effective or economical as deploying IGRs first as is recommended. Even those that delayed or sought alternatives to IGRs ended up using them later. As a result, 2001 saw the second largest percentage of acreage treated with IGRs (ca. 60%). Few fields escaped any treatments for whiteflies. Consequently, more was sprayed and spent on whitefly control this past year than in the last several years. Also, and unfortunately, the risks for stickiness were higher than they have been since the first uses of IGRs (in 1996), though still considerably lower than the high risk years of 1992 or 1995.

Other pests occasionally reach treatment levels or otherwise cause damage in Arizona. Beet armyworms were even less of a problem than they were in 2000 when they broke out on young cotton in very limited acreages. Cotton fleahoppers, which built to unprecedented levels in 2000, were back to their usual innocuous levels in most areas in 2001. Very few bollworms or other lepidopterans were observed this year, though salt-marsh caterpillar was reported from some areas.

Arkansas

The majority of the cotton in the state was planted in a timely manner with a small acreage in SE part of the state going in exceptionally early. The season started out well with thrips pressure being lower than in previous years. Weather conditions ran the gambit throughout the season. Conditions were dry early on, then wet, and then dry again. A good number of acres were lost to severe hail damage particularly in SE Arkansas. Overall, the crop looked better than average throughout the season, and yields were higher than the average, particularly in NE Arkansas. Picking operations were hampered in the SE by heavy, extended periods of rain. In some instances, seed began to sprout in the lock while still on the plant. A significant amount of yield was lost during this rainy period. Conditions were the opposite in the NE. An extended period of dry weather at harvest kept pickers in the field with many growers finishing picking in record time.

The season started out with low thrips pressure overall across the state. Spider mites were beginning to be a problem on seedling cotton in NE Arkansas and were causing seedling death in some instances. However, rains moved in about the time mites were beginning to become a real problem. Mite populations crashed after heavy rains and were not a problem again until later in the season. Kelthane, Capture and Zephyr were used by many growers with good success making border treatments when mites began to build again.

Boll weevil eradication had a rocky start in the central zone with spring rains delaying trapping and causing several acres to be re-sprayed after being rained off. However, the program recovered and ran smoothly throughout the rest of the season until the events of September 11 grounded all aerial applicators in the state. Luckily the grounding was not permanent and fall diapause applications resumed.

Saltmarsh caterpillars were a problem early season, particularly in the SE part of the state. A number of acres were sprayed with pyrethroids with less than stellar results in some instances. Intrepid became the treatment of choice for this insect pest.

Plant bugs were a big problem throughout the state, and throughout the growing season. Tarnished plant bug was the predominant species throughout the state. Growers were making multiple applications for this pest by mid-to-late season. Control was difficult with apparent re-infestation occurring. This problem was compounded by difficulty in getting good insecticide coverage in dense canopies. It was believed that nymphs low in the canopy were moving up after insecticide applications, giving the appearance of re-infestation. Some growers made 5+ applications for these pests this year. Cotton fleahoppers were a significant problem in NE Arkansas. Growers in this area have begun to plant wheat or other cover in the row middles to combat blowing sand in the early season. Many used Round-Up Ready® cotton in this system and burn down the wheat/weed cover in the middles once the cotton has attained some size. It was at this time that many began to experience severe problems from tarnished plant bugs and cotton flea hoppers moving from the burned down vegetation in the middles to the cotton. Clouded plant bugs were also a problem in some areas with feeding on small bolls.

Bollworms were spotty throughout the season with some areas having fairly heavy infestations and being lighter in others. Many of the moths oviposited low in the canopy due to high temperatures in mid to late season. This resulted in many acres of *Bt* cotton requiring at least one application of a pyrethroid for this pest. Populations in *Bt* cotton were 100% bollworm. However, in conventional cotton there was a mix with tobacco budworm. Mixtures of other chemistries with a pyrethroid were used in many instances in conventional cotton.

Cotton aphid populations were light overall throughout the season with only a few hot spots requiring treatment for this pest. The aphid fungus appeared in July, taking care of those aphid populations that were present.

Bandedwinged whiteflies began to be a problem in some areas of the state in late season, particularly in eradication areas. Some fields did require treatment, but they were not difficult to control.

California

The 2001 growing season was very challenging in California. A total of 869,980 acres of cotton was planted (CDFA Pink Bollworm Program). Pima was grown on 212,350 acres (24.4 % of total acres), up from 16% of the cotton acreage in 2000. The San Joaquin Valley (SJV) grew 814,880 acres (94% of the state's total acreage) and nearly 100% of the Pima acreage. The southern deserts had 33,400 acres (an increase of 36%) and the Sacramento Valley acreage increased 17% to 21,700 acres of cotton. USDA estimates the overall yield in California to be 1,392 lbs/acres for Upland and 1,286 lb/acre for Pima (November estimates).

In the SJV, planting conditions were ideal during March but poor during April. Temperatures for planting cotton were unfavorable or marginal for 14 days in April, and during early April temperatures dropped to freezing, followed by rain. Most cotton was planted after April 20, 2001 and cotton planted during late March, in many but not all locations, required replanting. Temperatures in May were above average with 11 days with daily highs greater than 90° F and 4 days greater than 100° F. The summer was hot with 25 days between June 1 and August 31 with daily highs greater than 100° F. Cotton developed rapidly in June and July and overcame the late planting in most cases. Plants that were compromised by disease and cool temperatures recovered more slowly. Late-summer and early fall conditions were warm and conducive to boll maturation, and conditions during harvest were good.

Lygus pressure was light in most areas through most of the growing season. Exceptions were localized outbreaks near *Lygus* sources such as drying rangelands and desiccated cropland. Spider mite levels were at near unprecedented low levels with light populations not developing until August in most areas. Cabbage looper required treatment during May and June in many parts of the San Joaquin Valley. Insect pressure was light during June and July, but aphids and whiteflies developed in August and required multiple treatments. Whiteflies were the most problematic since 1995 and were more widespread in their distribution, with treatable levels further north in the SJV than in previous years.

Florida

Limited rainfall during late April and May resulted in delayed stand establishment in many fields throughout the panhandle. This situation was overcome in early to mid June when general rainfall was received throughout the cotton-producing areas of the state. Adequate rainfall continued through early September, keeping the cotton out of stress resulting in above-average yields on most farms. Harvest conditions were excellent during October and November.

Thrips populations were at high levels during April and May. Granular insecticides were used on most fields at planting and provided adequate control as indicated by low nymphal counts. Fields that received only Adage-treated seed for thrips frequently had populations that exceeded the threshold.

Lygus bug populations varied across the panhandle. In the western panhandle numbers were generally low, whereas in the eastern panhandle above-average populations were the rule early in the season. Rainfall in early June allowed the cotton to overcome much of the feeding damage. However, low numbers of *Lygus* persisted all season throughout the panhandle. Less than 2 percent of the acreage received an application for *Lygus*. Early season square set was generally high.

Grasshoppers again caused severe stand loss to several hundred acres of seedling cotton during June. Pyrethroids provided control where applied. Generally, after cotton grew beyond the seedling stage grasshoppers were no longer a problem.

Extremely heavy aphid infestations developed in most fields during mid June and persisted through early July. Organophosphate insecticides, such as Bidrin and dimethoate, were applied to some fields and reduced populations to acceptable levels. Centric provided excellent control in a field demonstration. The beneficial fungus disease, *Neozygites* spp., began reducing populations the second week of July and kept populations at acceptable levels for the remainder of the season.

Numbers of beneficial insects and spiders were at high levels all season where insecticides were not used. In many fields in the eastern panhandle, populations of minute pirate bugs and big-eyed bugs were higher than had been observed for several years. Numbers of most species developed on the early aphid population and helped provide control of worm pests. Fire ants were abundant all season in fields grown under strip-tillage. (Approximately 60% of fields were grown using this method of conservation tillage.)

Bollworm and tobacco budworm infestations were generally low all season. Bollworm moth catches were high in pheromone traps in some areas during August through mid-September. However, this did not translate into high larval infestations in most fields. This was due at least in part to the abundant numbers of beneficial insects previously noted. Some fields planted to conventional varieties were treated for bollworms in late August. Overall, conventional varieties averaged less than one application for bollworms and budworms. From 50% (east) to 80% (west) of the acreage was planted to Bollgard varieties.

Beet and fall armyworm infestations were very low season long. Few, if any, fields required treatment for these pests. Soybean looper infestations developed in many fields during late August to early September, but populations generally did not exceed threshold levels. Where thresholds were exceeded, effects on yields were minimal due to the abundant amount of plant growth that occurred during the season.

Stink bugs were first observed in cotton in late June, and populations increased in most fields during August and September. Although many fields experienced damaging levels following migration from peanuts during September, high numbers were also present in some cotton that was not located close to peanuts. Highest infestations occurred in field borders adjacent to peanuts. Some growers obtained adequate control by treating peanut fields or field borders next to peanuts. From 40% (east) to 75% (west) of the fields received an application for stink bugs.

Overall, this was a light cotton insect pest year for the third season in a row.

Yields were the highest recorded for a number of years, with some farms reporting 1300- pound averages. Statewide yields are projected by the Florida Agricultural Statistics Service to average 650 lbs of lint per acre.

Georgia

Approximately 1.49 million acres of cotton were planted in Georgia during 2001. After several years of hot and dry seasons, rainfall and temperatures were much more conducive for cotton production. As a whole, insect populations were light, but some sporadic problems occurred. This season was a prime example of why each individual field is scouted and treated on an as needed basis.

Thrips populations were moderate but appeared to peak later than normal during the season. The highest infestation levels occurred on early to mid May planted cottons. Preventive treatments applied at planting performed very well, suppressing thrips numbers below economic levels in most areas. Isolated problems of cutworms, grasshoppers, and false chinch bugs were reported and were generally associated with reduced tillage systems.

Plant bug numbers were higher than in previous years probably due to more abundant rainfall during early spring. However, few acres required treatment prior to bloom. During early to mid bloom, internal boll injury was apparent and plant bugs are believed to be responsible for some of this injury. Aphid populations were much lower when compared to recent years. As numbers built, the naturally occurring fungus quickly eliminated populations. The first report of this fungus was on June 25, which was a week to ten days earlier than in recent years.

Tobacco budworm and corn earworm populations varied significantly from area to area and even field to field. A small percentage of acres were treated during June and July, but economic infestations were more common during August and early September. Control of tobacco budworm with pyrethroids was difficult in parts of the state and is probably associated with resistance levels. *Bt* cotton provided excellent control of tobacco budworm, and only a small percentage of *Bt* acres were treated for corn earworm.

Stink bugs and other boll feeding bugs continue to be a primary pest of cotton in Georgia. Threshold levels of boll feeding bugs (stink bugs, plant bugs, leaf-footed bugs, etc.) were found in most areas during late July and August. However, significant variation did occur on a field-by-field basis. Fall and beet armyworm populations were unusually light. Soybean looper required treatment on a limited number of late planted fields. Although rainfall was more abundant, isolated fields were infested with spider mites. Silverleaf whitefly has been a troublesome pest in Tift and surrounding counties during recent years, but infestations did not materialize this past season.

Four boll weevils were captured in Turner County. Boll weevil eradication personnel reacted in a timely manner to manage this situation.

Louisiana

Planting conditions during mid-April to mid-May were almost ideal. Average to slightly below yields are expected in 2001 due to extended precipitation even in August which resulted in 10% to 90% crop loss from boll rot. Louisiana planted approximately 715,000 acres of cotton with an average state yield expected to be 675 lbs lint/acre. Approximately 84% of the acreage planted was planted to a *Bt*-cotton variety.

Insect pest populations ranged from extremely low to very high in 2000, primarily depending on the location. The most troublesome insects in 2000 were tarnished plant bug and stinkbug. Curiously, there was a density gradient that was highest near the Mississippi River and declined as distance from the river increased. Many fields near the Mississippi River were sprayed as much as 10 times for tarnished plant bug and stink bugs. This gradient occurred over a 30-mile area away from the river. Insect populations in fields greater than 30 miles west of the Mississippi River were almost non-existent.

Early-season insect populations were moderate. Initial problems were with high numbers of false chinch bugs in reduced tillage fields. Numerous fields were re-planted due to stand loss from false chinch bugs. 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.

All cotton production in Louisiana is in an active boll weevil eradication program. The Red River zone completed the fifth, and final, year while the Northeast zone completed the third year. Boll weevil populations in both zones were low. Thus, very few malathion sprays were required for boll weevil eradication. Very few fields in the Red River zone were sprayed for any insects.

Tobacco budworm and bollworm populations were not high in most areas of the state with the exception of the western side of Franklin Parish. Tobacco budworm densities in this area were very high with some fields sprayed as many as 8 times for tobacco budworm control. Tobacco budworm resistance to spinosad may have been documented in these areas.

Mississippi

Mississippi cotton producers planted approximately 1.7 million acres of cotton in 2001, which was a substantial increase over the 1.3 million acres planted in 2000. Approximately 80% of the crop was planted to transgenic *Bt* varieties, with Paymaster 1218 BG/RR®, Deltapine 451 BR, and Stoneville 4892 BR being the dominant varieties.

Active Boll Weevil Eradication Programs (BWEP) were underway in all areas of the state. The hill region, which contained approximately 554,000 acres, was in its fifth year of BWEP. The south delta region, consisting of approximately 276,000 acres, was in its fourth year, while the approximately 839,000 acres in the north delta was in the third year of BWEP. This was the final year for the BWEP in the hill region, but growers in this region voted to enter a ten-year Boll Weevil Eradication Maintenance Program. The annual assessment fee for this maintenance program, which is not to exceed $12.00 per acre, will be used to complete the eradication effort, service residual debt from the original program, and to run an effective eradication maintenance program. Growers in the south delta are scheduled to vote on a maintenance program in 2002.

The winter of 2000-2001 was relatively severe and low winter temperatures greatly enhanced Mississippi's boll weevil eradication efforts. As a result, boll weevil populations were extremely low throughout the state in 2001. As of July 4, only 7,252 boll weevils had been captured in the state, 99.3% less than were caught by this date in 2000. Eighty-seven percent of the fields in the state remained boll weevil free by July 4, and only 3.4% of the acreage in the state had been treated for boll weevils. By October 24, a total of 344,000 boll weevils had been captured in the state, which, despite the increased acreage, was 87% less than were caught by this date in 2000. Fifty-one percent of the fields in the state remained boll weevil free for the entire growing season, and only 32% of the state's cotton acreage received treatments of ULV malathion for control of boll weevils. Treated fields received an average of 3.8 malathion sprays per acre, which is an average of approximately 1.2 malathion sprays per acre statewide. No yield losses were attributed to boll weevils in 2001.

Thrips and cutworm pressure on seeding cotton was relatively light in 2001, but there were a number of unusual early season pest problems. Grasshoppers were observed causing stand reduction, and even stand destruction, in a few reduced tillage fields, especially in fields that had been planted to soybeans in 2000. False chinch bugs (*Nysius* spp.) were also a problem in some reduced tillage fields but were less common than they had been the previous year. Increased adoption of herbicide tolerant cotton varieties and reduced tillage systems are the primary reasons for the increased number of "unusual" early season pest problems.

Saltmarsh caterpillars were the most unusual pest problem in seedling cotton, especially in the delta region. Many fields of seedling cotton experienced infestations of late-instar saltmarsh caterpillars, which migrated from field borders. Plants younger than the three-leaf stage often suffered complete defoliation and even destruction of the terminal bud due to the feeding by these caterpillars, and a number of fields were treated for this pest to prevent stand loss. Plants that had developed to the five-leaf stage or beyond usually were able to tolerate the defoliation without sustaining serious damage. In some cases, re-infestation from field borders resulted in the need for multiple treatments. The growth regulator, methoxyfenozide (Intrepid), proved to be one of the more cost-effective treatments for this pest.

Cotton aphid populations were unusually low in 2001, and very few fields received a treatment for aphids. These low aphid numbers are attributed, at least partially, to the relatively low number of malathion treatments that were made by the BWEP before July 4. In past years regions that received multiple applications of ULV malathion before July 4 often experienced high aphid populations and/or required more treatments for aphids. Furadan was again available for use against aphids under a Section 18 Emergency Exemption, but there was relatively little use of this product because of the low populations. Thiamethoxam (Centric), which was labeled for use against cotton aphids in 2001, provided good control of aphids in fields and trials where it was used.

Early season tarnished plant bug populations were somewhat lower than normal throughout the state. However, the delta region experienced heavy infestations of plant bugs during mid and late season, due to heavy immigration into cotton from senescing alternate hosts. Because of the low numbers of boll weevils and the high percentage of *Bt* cotton, plant bugs were the most common insect pest in delta cotton in 2001. Some producers applied as many as seven to eight sprays, specifically to control plant bugs, but the average number of treatments applied to control plant bugs in the delta was approximately 3.7 sprays per field. Plant bug populations were much lower in the hill region, where an average of approximately 1.0 spray was applied to control this pest. Control was often difficult to achieve because of resistance and because many fields developed exceptionally heavy canopies that interfered with spray coverage. Acephate (Orthene) and dicrotophos (Bidrin) continued to be the most effective treatments for plant bugs, but the newly registered thiamethoxam (Centric) also provided good control. Successful control of established, late-season plant bug infestations required the application of repeated, close interval sprays. Despite this unusually heavy plant bug infestation, the yield potential of the 2001 crop was exceptionally high until it sustained heavy late-season weather damage.

Stink bugs continued to increase in importance as a pest of Mississippi cotton because of the reduced spray environment fostered by BWEP and *Bt* cotton, but they are still a relatively minor pest. Although it was not difficult to find low numbers of stink bugs in most fields, it was relatively uncommon to encounter fields with economically damaging infestations. However, damaging infestations of stink bugs did occur, especially during the late season due to immigration from maturing corn and/or soybeans.

With approximately 80% of the crop planted to *Bt* varieties, tobacco budworm infestations were relatively uncommon, but some non-*Bt* fields did require treatment for tobacco budworms. Bollworms were much more common, especially in the delta region, where corn acreage is more concentrated. Based on results of a statewide survey, *Bt* fields received an average of 0.8 sprays for control of bollworm/budworm, while non-*Bt* fields received 2.3 sprays. However, overall heliothine pressure was much heavier in the delta region than in the hills. *Bt* fields in the delta received an average of 1.3 bollworm sprays, while non-*Bt* fields received an average of 3.9 bollworm/budworm treatments. Populations were much lower in the hills, with *Bt* and non-*Bt* fields receiving an average of 0.2 and 0.6 bollworm/budworm sprays, respectively. It is noteworthy that there were many non-*Bt* fields, as well as *Bt* fields, in the hill region that received no foliar insecticide sprays yet sustained very little insect-induced boll damage. This is evidence of the success of the BWEP, which by eliminating boll weevils, allowed greater reliance on beneficial insects and reduced use of insecticides to control other insect pests.

Armyworms were not a problem in Mississippi cotton in 2001. Beet armyworms were uncommon, and although low numbers of fall armyworms could be found feeding on bolls in some fields, very few fields required treatment. Some late-maturing fields did require treatment for loopers, but this involved a very small percent of the total acreage. Damaging infestations of whiteflies were also uncommon, and only a few fields required treatment for spider mites.

As of mid-August, the 2001 crop had developed an exceptional boll load and yield potential was much better than average. However, a prolonged period of unusually heavy rainfall during late August and early September resulted in heavy yield loss. This yield loss was the result of unusually high levels of boll rot and "hard lock". Conditions were so severe that seed sprouting in bolls was commonly observed, and losses to boll rot and "hard lock" exceeded 20 to 30% in many fields. This weather damage was greatest on fields that had begun to open before the rainfall began, and late maturing fields were less affected. Fortunately, after this rainy period subsided, growers enjoyed a favorable harvest season, and little additional weather damage occurred. Despite this severe weather damage, estimated statewide yield is approximately 727 lbs (December NASS Estimate), which is higher than the previous two years, but below the five-year average of 761 lbs.

In summary, overall insect pressure was relatively low for the state as a whole, although the delta region did experience increased problems with plant bugs and bollworms. Excessive, prolonged rainfall during late season resulted in heavy weather related yield loss in what was otherwise an exceptional crop. Mississippi made excellent progress in its effort to eradicate the boll weevil, but low numbers of this pest are still present in the state. Statewide, insect-induced yield losses were estimated at 7.9%, and the estimated average costs of insect control were $95/acre. Overall insect pressure was considerably higher in the delta region, with an average cost of $108/acre, than in the hills where insect control costs averaged $69/acre.

Missouri

Missouri cotton growers planted approximately 395,000 acres of cotton in 2001. Early-season planting conditions were generally poor because of dry soil conditions, which prevented seed germination and emergence. Approximately 30,000-40,000 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 two to three weeks earlier than normal. Harvest conditions were good and the average

USDA yield estimate for 2001 (790 lbs) was 25.4% above the 5-year average (630 lbs) for Missouri. Overall, pest pressure in Missouri was moderate in 2001.

Thrips infestations were down compared to 1999 and 2000 but were still above normal in many fields. Dry conditions during planting were a major factor in prolonging seedling exposure to thrips feeding damage and slowing the plants' uptake of soil- and seed-applied insecticide treatments. Isolated outbreaks of burrower bugs (Hemiptera: Cydnidae), flea beetles, and yellowstriped armyworms were reported in reduced- or no-till fields.

Spring pheromone trap captures of overwintering boll weevils were down more than 90% in 2001 versus those reported in 2000. This was mostly due to severe cold, wet weather from December through February that greatly increased overwintering mortality. In-season populations slowly rebuilt, and Missouri growers averaged less than one insecticide spray per acre to combat weevil infestations. The Missouri Boll Weevil Eradication Program was initiated on August 13th and an average of 4.5 ULV Malathion sprays was applied per acre. Because of the terrorist attacks of September 11 and the subsequent grounding of aerial applicators, another planned application was lost.

Aphid populations steadily increased throughout May and June. On June 29 the Environmental Protection Agency granted Missouri's request for a Section 18 label for Furadan 4F; however, the label was never triggered under the Missouri Department of Agriculture's county-by-county guidelines. Aphid infestations generally were kept in check by insect predators (particularly the ladybird beetles) and parasitoids throughout most of the growing season. There was a slight rebound once the boll weevil eradication sprays were initiated, but aphid populations crashed in late August.

Plant bug infestations were above average and persistent throughout the middle and latter parts of the growing season. Multiple insecticide applications were required to control these infestations before being suppressed by the boll weevil eradication sprays. The greatest percent yield decrease among insect pests in Missouri was attributed to the plant bug/cotton fleahopper complex.

Bollworm infestations were below average in southeast Missouri during the 2001 growing-season. Initial reports of infested cotton fields did not occur until mid-July, and infestations remained light throughout the rest of the growing season. Most fields did not receive an insecticide overspray for bollworms.

In summary, plant bug infestations were high in 2001. Aphid and thrips infestations were moderate with localized hot spots. Armyworm, boll weevil, cotton bollworm, European corn borer, spider mites, stink bug, tobacco budworm, and whitefly infestations were light to absent in southeast Missouri.

New Mexico

This was an extremely good year for producing cotton in New Mexico. Yields were up in all parts of the state. Insect and weather related losses were low. September was warm which is critical for production of high yields. *Bt* cotton acreage was similar to previous years with the highest amount of *Bt* cotton in the Pecos and Mesilla Valleys. Acreage in the Mesilla and Pecos Valleys was down with 16,579 and 10,206 acres respectively. However acreage in the eastern High Plains of New Mexico is up so total acreage is similar to that over the past five years. Yields are expected to be much higher than average. Estimated statewide yields are 1.85 bales/acre.

Boll weevil eradication programs are in place throughout New Mexico. The south central program is in its final phases with captures limited to a small area around Las Cruces. The Pecos Valley program completed its first year and the second fall diapause program.

The eastern high Plains area (Lea, Rossevelt, Curry Co.) has three control zones, which are being operated by the Texas Boll Weevil Eradication program. Quay County has a voluntary monitoring program with 1-trap/5 acres. Although there were some weevils captured in 2000, no weevils were captured this year. Pest populations were very low. Bollworm and pink bollworm are the primary pests in cotton in New Mexico. Bollworm damage was very low. Pink bollworm populations were only high enough late-season to justify one insecticide application in the Mesilla Valley. There were also some significant populations very late season in the southern edge of Eddy County in the Pecos Valley.

North Carolina

Thrips levels were moderate to occasionally high throughout much of the state, with western flower thrips accounting for control difficulties in some areas for the third year in a row. Approximately 90% of N.C. cotton growers used an at-planting insecticide (including seed treatments) in 2001. Foliar treatments for thrips were applied to 49% of the acreage, down somewhat from the past two years, but higher than our long-term average of approximately 35%.

Second-generation tobacco budworms (June to early-July) were very low throughout the state in 2001. Less than 0.5% of the state's cotton acreage was treated for these early budworms, similar to the 1% treated in 2000, and significantly down from the 8.25% treated in 1999. Budworms were also on the low side in their next generation, which typically occurs from mid July through August along with our major bollworm generation. However, budworms were present in some northeastern counties and accounted for scattered control difficulties.

Cotton aphids occurred at moderate levels in many cotton fields. The aphid-parasitic fungus, *Neozygites fresenii*, generally arrived on schedule in 2001 and most cotton fields sustained very little aphid damage. By the end of the season, aphids in opening cotton were virtually nonexistent. Just under 2% of the cotton acreage was treated for aphids (on the low side). Biocontrol remains the major means of consistently reducing or eliminating populations of cotton aphids in North Carolina.

Plant bug numbers were low to moderate in most areas in the early part of the season (pre-bloom) but higher later in the season on Bollgard cotton in some of the eastern and southeastern counties. Approximately 7% of the state's acreage was treated for pre-bloom plant bugs this year, higher than our longer-term average of 2%. Approximately 6% of the Bollgard cotton acreage was treated specifically for post-bloom plant bugs in 2001. In significant portions of several eastern counties, plant bugs were a serious pest of small bolls.

The major mid-July to early-August bollworm moth flight generation averaged about 1 week later than our long-term average this past year. Flight intensity and egg deposition were down significantly from 2000, making trends in moth trap captures sometimes difficult to define and treatment decisions difficult. Statewide damage to bolls by bollworms on conventional cotton, at 5.74%, was on the high side considering the low pressure, and also over the 15-year average of 4.0%. The average number of insecticide treatments used for bollworms and other late season pests was 2.3, somewhat lower than the 15-year average of 2.8 applications. Bollworm establishment under bloom tags (dried flowers stuck to small bolls), now appears to be an annual problem in both conventional and Bollgard cotton. Adult vial tests for bollworm resistance/tolerance to pyrethroids revealed very low moth survival, and pyrethroids were generally effective against bollworms in 2001.

Bollgard cotton was planted on approximately 65% of the state's cotton acreage in 2001, up from 10% the prior year. Bollgard cotton was treated an average of 0.99 times, down somewhat from the 1.03 applications in 2000. Mean boll damage to Bollgard cotton from bollworms was less than one-fourth of that found in conventional cotton (1.14% versus 5.74%), and overall boll damage to Bollgard cotton, primarily due to stink bugs (4.34% in Bollgard versus 1.87% in conventional cotton), also was significantly lower this year (5.48% in Bollgard versus 8.0% in conventional).

Fall and beet armyworms caused very little economic damage in North Carolina in 2001.

As of this writing (late-December), 174 boll weevils were trapped in the fall at one end of a single cotton field in Lee County, and one boll weevil in an adjacent cotton field. Thus, these weevils appear to be contained. The field containing the large number of weevils was treated 19 times, the other field one time. These fields were picked on November 5, and the stalks were shredded and plowed under. The module from these fields was fumigated. This area will continue to be pheromone-trapped during the winter and spring.

It appears that North Carolina cotton producers will pick an average of approximately 730 lbs of lint from 930,000 acres in 2001.

Oklahoma

Over 190,000 acres were planted in 2001. Turbulent weather hampered cotton development throughout May. Below average rainfall in most regions of the state through mid August favored irrigated production and limited dryland production reducing harvested acres to 180,000. Abundant high temperatures resulted in a total of 3001 heat units accumulated between May 1 and October 1, exceeding the 50-year average of 2,881 heat units. The state's production average is projected at 575 lbs of lint per acre.

Despite widespread use of at-planting insecticides, thrips infestations built to damaging levels across the state. Cotton fleahopper infestations were widespread requiring many fields to receive two insecticide applications to prevent significant yield loss.

Bt cotton continues to be very popular in Oklahoma and represented 57% of the cotton acreage in 2001. Light bollworm populations existed throughout the summer. Conventional cotton received 1 or 2 insecticide applications to prevent damage. Stinkbug and whitefly infestations surfaced in July requiring treatment on limited acreage mainly in irrigated situations.

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. Severe yield loss would have occurred if Furadan had not been available for use. This aphid buildup was short lived and did not reoccur.

South Carolina

South Carolina farmers are expected to harvest 296,000 acres (State Statistician's estimate), which is up about 6,000 acres from 2000. As in 2000, a larger acreage was expected, but dry soil conditions in May and June prevented many growers from planting as much as they would have liked. Cotton production is forecast at 400,000 bales, which would be 6% more than last year. Yields are expected to average 649 lbs an increase of 22 lbs over last year.

Thrips were a problem on seedling cotton in most areas of the state. Growers treated over 90% of their acreage with Temik to control thrips, and many applied Temik 15G at rates of 5 lbs or more per acre to achieve nematode suppression as well. There were some problems in controlling thrips with soil treatments that may have resulted from the low rainfall in late May and June. In a test at Florence comparing foliar treatments with soil insecticides and seed treatments; none of the treatments provided significant increases in yields over the untreated, in spite of the fact that thrips numbers remained above 1 adult per plant from May 16 through June 5.

With the increase in strip-tillage, some new pests have been observed during the last few years. Beginning in 1999, reports of false chinch bugs in seedling cotton had become commonplace. In 2001, these insects were reported observed infesting cotton seedlings throughout the state in minimum-tillage fields. Where damage has occurred, it seems to have been limited to areas where small seedlings were infested with both nymphs and adults. The nymphs are apparently doing the most damage. False chinch bugs hung around in some fields until after cotton had bloomed. As many as two dozen or more adults were found in a single square, but no damage was observed. A few reports were received of large numbers of either burrower bugs or negro bugs infesting seedling cotton. Up to 40 bugs/plant were reported in one field. Grasshoppers were also prevalent this year, and they were often found in greater numbers in minimum-tillage situations. Most problems occurred from mid-June to late-July.

Tobacco budworms were few and far between. There was much less pressure in tobacco than usual in May and early-June, and 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 (as in 1999) with pyrethroids. However, insufficient numbers of moths were captured in pheromone traps to determine if pyrethroid resistance was part of the problem. About 80% of the acreage was planted to *Bt* varieties (75% was planted in 2000).

There were no reported failures with pyrethroids in controlling bollworms for the third consecutive year. Growers were generally able to control worms with 2 to 4 applications in conventional cotton varieties. About 70% of the *Bt* cotton acreage was treated an average of 1.5 times, while 25% was not treated at all.

Stink bugs have become a problem in all areas of South Carolina. This is not to say that every cotton field will have stink bug infestations, but it does mean that virtually every cotton field has the potential to suffer damage, and therefore, every field must be scouted for stink bugs and their damage symptoms. Clemson University recommended treating with insecticides on a boll-damage threshold of 15%, emphasizing the importance of examining quarter-sized bolls. Damage symptoms include: warty growths on the carpal walls, discolored lint, and shrunken seeds. Since we have begun using a damaged boll threshold, less emphasis has been placed on estimating actual stink bug numbers. With our next modification of the stink bug threshold, we plan to avoid referring to bolls with evidence of stink bug feeding as damaged. Instead, the threshold will be identified as 15% of bolls with evidence of stink bug feeding. With the present threshold, growers tend to think of a damaged boll as completely lost and they have questioned why we allow so much damage to their crop before controls are recommended.

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, the fungus, *Neozygites fresenii*, had controlled most infestations. As in 2000, beet armyworm and fall armyworm infestations were unusually scarce. Few infestations of tarnished plant bugs or cotton fleahoppers were reported above the lakes.

Tennessee

During the 2001 crop season, the most damaging and widespread insect group was probably the stink bug complex. Fields in almost every cotton county reached threshold levels and stink bugs had to be controlled with insecticides. There has been a bit of speculation as to why the pests were more abundant this year compared to previous years. Two factors that have contributed to the problem are the widespread adoption of *Bt* cotton and the success of the boll weevil eradication program.

Due to the adoption of *Bt* cotton, there has been a significant reduction in insecticide applications for the control of bollworm and tobacco budworm. In the boll weevil eradication program, only about 25% of the acreage had to be sprayed in the second year of the program in zones 2 and 3. This overall reduction in insecticide sprays has allowed the stink bug complex to increase throughout the season. It may also be true that the winters in recent years have not been too severe. This may have allowed greater survival of the overwintering adults.

The boll weevil eradication program is progressing very well. Through the first week in August, a total of 135,356 weevils had been collected in the 374,000 traps throughout Tennessee. During cycle 16, only 19.4% of the acreage in Tennessee had to be treated for boll weevils. Considering that fields are sprayed based on collection of a few weevils in the traps surrounding the fields, the program is making good progress toward eradication.

Early in the season, a relatively new insect was found feeding on seedling plants. The insect was identified as *Sehirus cinctus* (Palisot de Beauvois). This insect is in the ground or burrower bug family, Cydnidae. The bugs were found feeding on the undersides of the leaves. Dead nymphs were found on plants where the planting seed had been treated with Adage (thiamethoxam).

Thrips populations changed considerably this year compared to last year. Last season several western flower thrips were found on seedling cotton. This season, the predominant species at Jackson was the tobacco thrips, but many soybean thrips were collected from seedling plants. In Hardeman Co., collections contained western flower thrips (47%), tobacco thrips (32.7%) and soybean thrips (20.6%). False chinch bugs were also causing some problems. By the third and fourth weeks of June, many fields were receiving treatments for control of plant bugs. Due to the dry weather, spider mites became more of a problem. By mid July, several fields had been treated for aphids, plant bugs and spider mites. By early August, the aphid population was being effectively controlled by the naturally-occurring fungus, *Neozygites fresenii*. Although bollworms and tobacco budworms developed in isolated fields across West Tennessee, populations were not severe. It is speculated that the use of *Bt* cotton may be having a population suppression effect on the pest population, especially the tobacco budworm. Stink bugs remained a problem throughout the month of August and became serious pests in many fields.

Although the crop season was relatively dry, timely rains allowed most of the crop to produce well. Growers experienced a good harvest season and harvested an average of 690 lbs per acre from 605,000 acres. This is the highest yield since 1994 and is 87 lbs above the yield from 2000.

Texas

The 2001 harvested acreage was down considerably from the last two years when over 5 million were harvested. Most acreage lost was from the High and Rolling Plains areas due to the drought, high winds and hail. Only 4.4 million acres are projected to be harvested, and maybe less than 4.1 million bales. Moisture conditions going into the growing season were some of the best in years in much of the state but rains all but ceased for the bulk of the acreage during the summer. High temperatures and poor moisture conditions severely reduced yields in many areas of the state. Some late rains spoiled the harvest on some acres in the Blacklands and the Coastal Bend areas, but for the most part weather was warm and open for most of the harvest season.

Heat unit accumulations were again above normal, especially prior to September, which turned cool later in the season. Where water was sufficient, exceptional yields were again the rule; unfortunately, high irrigation costs coupled with the inability of most systems to keep up with water demands did result in reduced yields. This resulted in exceptional yields on that acreage where irrigation water was adequate.

Much of the state's acreage was planted to Round-Up Ready® varieties, although the percentage was down from last year because of poor cotton prices. Bollgard type cotton was planted on less acreage this year because of projected low cotton prices and the feeling by many producers that it wasn't a "paying proposition".

The 2001 pest situation was quite different compared to previous years with no clear "worst pest" arising during surveys. In fact, yield losses due to insects ranged between 1.8 and 9.5%, with the Northern Blacklands taking the prize for most activity. The boll weevil eradication program across much of the state's acreage and a summer drought severely limited insect increases and damage. Weather was again the greatest yield reducer, ranging from 32.3 to 58.5%. Only the Northern Blacklands area recorded low losses due to weather at 10.5%.

A colder than usual winter limited boll weevil survival in all northern areas and boll weevil numbers remained light until late season in all areas outside of active eradication zones. The drought and high summer temperatures were also major limiting factors for boll weevil population increases. Applications for boll weevil control by producers were limited mainly to the LRGV. The only areas left in the state without a full season eradication program are the LRGV, Upper Gulf Coast, Northern

Blacklands, the St. Lawrence area of west Texas, Southern Blacklands, the Southern High Plains, and Northern High Plains zones. The latter three zones initiated eradication activities this September with diapause applications. For all practical purposes, the boll weevil was not an economic factor for Texas, outside of eradication costs. There were no instances where eradication activities were thought to have increased pest problems. Boll weevils are now either eradicated or functionally eradicated from the Southern Rolling Plains, the Central Rolling Plains, The Trans Pecos area, the Permian Basin and the Western or High Plains zones.

Thrips were a problem only in the Blacklands and western Texas. Dry conditions forced thrips into cotton in high numbers but favorable cotton growing weather encouraged thrips to infest areas where their feeding was less likely to cause square damage. Therefore, yield losses due to thrips were held to a minimum even though many producers skipped treatments in an effort to save money.

False chinch bugs were again a problem as they are every so many years. The more severe infestations reduced stands in field margin areas but were not a factor later in the season. These infestations were reported across the entire northern area of Texas.

Even though there were some good early season rains, they were either inadequate or poorly timed to result in sufficient alternate hosts to cause a serious cotton fleahopper or *Lygus* bug problem in most areas. Most early problems were in the Blacklands and in the Southern Rolling Plains areas. Most High Plains *Lygus* problems developed late in the season when boll protection was needed in a few fields. Even so, *Lygus* and thrips were probably the two most important pests this year. Stink bugs were reported as a small problem in the Coastal Bend area.

There were many beet armyworm moths captured in traps early in the season, especially in the northern Rolling Plains and northern High-Plains areas where late 2000 infestations were most prevalent. Apparently there was good overwintering survival in these areas. Early instar larvae were easy to find in seedling cotton but rarely were able to establish in any kind of number. Record levels of natural enemies, especially crab spiders, apparently kept this pest in check. There were some spotty late season damaging infestations in the Rolling and High Plains areas but these were not common.

Bollworms and tobacco budworm numbers were extremely light across the area although a few fields did need treatment in some instances. Cabbage looper were reported in South Texas but were not a problem.

Cotton aphid infestations appeared early in much of the cotton acreage of south Texas and many fields needed treatment before natural enemies took control. Texas requested and received a Section 18 for Furadan 4F, but it was not needed for much of the state. Aphid infestations in the rest of the state were sporadic and appeared in late-September and October. This is later than when they can reduce yield but could have posed a sticky cotton problem. Late season rains appeared to eliminate this potential problem.

Grasshoppers were again a problem in the Rolling Plains and the southern area of the High Plains. Most damage resulted in stand losses with the drought masking any additional yield reductions that could be attributed to this pest.

Bandedwinged whiteflies were reported at unusually high levels in the Northern Rolling and High Plains. These infestations were most prevalent in cotton fields near sunflowers. Commercial sunflower acreage was up this year in the High Plains because of low cotton prices and some replant decisions. While no infestations were thought to be at damaging levels, the absence of research-based thresholds, sampling methods and insecticide efficacy data made it difficult to provide management advice on these pests.

Lower Rio Grande Valley (LRGV). Rainfall was short and fell at the wrong time in 2001 for much of the LRGV, especially for Willacy and parts of Cameron and Hidalgo counties. The first rains of the season actually began in the fall of 2000, when only minor amounts of rain fell to provide deep soil moisture for the 2001 cotton crop. The next significant rain fell in early February prior to planting. However, the amount of precipitation that fell lasted until about mid March and then the fields were left dry again. The small amount of rain left many fields of cotton with poor stands and an even poorer start toward adequate yields for the year.

The next major rain event fell in late-April. It was adequate to make the crop grow and put on good fruit loads. However, again, deep soil moisture was not available and no additional rain fell in many areas until the end of June, long after the crop was matured and yields had been permanently reduced for the season. Rainfall recorded at Weslaco, was not equal at all locations, especially in June. Therefore, individual rainfall amounts from other locations would be needed to adequately interpret individual cropping areas in the LRGV for 2001.

Heat, which usually accompanies low rainfall periods, was in abundance at times and below normal at others. Drought conditions caused low yields despite lower than normal heat unit accumulations early in the season. Other times saw higher than normal heat unit accumulations and that had a yield-reducing impact on the crop in 2001. The drought led to about 90% of the fields in Willacy County to be destroyed without any harvest.

Boll weevils were caught in high numbers in traps in the spring of 2001. Field infestations of weevils were light, however. Low moisture levels along with high temperatures led to dead weevil grubs in squares on the ground. The low numbers of weevils could also be tied to a better-than-average 2000 fall season cotton stalk destruction effort by growers all across the LRGV. Additionally, overwintered weevil applications were made in record numbers in 2001 along with some aggressive applications for weevils during the season. Combinations of all of these events probably led to reduced weevil populations in 2001, which resulted in reduced insecticide applications for all pests. Fleahoppers and Heliothines were very light overall for the year.

Cotton yields were poor when the entire LRGV acreage and yield figures were viewed. However, while yields ranged from 0 to 500 lbs in parts of Willacy and Cameron counties, much of Hidalgo County, especially the mid Valley area, had yields exceeding 3 bales per acre in many fields. However, the yield for the entire LRGV was about 314 lbs of lint per acre based on USDA's Farm Service Agency certified acres of 214,937 in the four county area of Cameron, Hidalgo, Starr and Willacy counties (LRGV) with total harvested bales of 134,940. Actual per acre yields were higher, but because we do not know the actual harvested acres versus those destroyed without harvest, no true per acre figure could be obtained.

Overall, fiber quality was considered good in 2001. Micronaire readings indicated that only 21.96% was 5.0 or higher. Staple length was slightly higher than normal and strength readings were at all time high records. Variety improvements and reasonably good weather conditions probably were the primary reasons for the good fiber quality in 2001.

Coastal Bend (CB). Cotton was planted during the favorable early March period on the lower Gulf Coast but was delayed about 10 days beyond the favorable late March planting dates in the upper Gulf Coast. Early plant growth and soil moisture conditions were the best in many years. About 6 weeks into the season it became obvious that very dry conditions might prevail. The drought was generally much worse in the southern Coastal Bend; conditions generally improved toward the north, although very dry pockets occurred even in upper Gulf Coast areas. Approximately 30,000 acres of cotton had to be destroyed due to the severe drought. On the upper coast about 100,000 acres were subjected to excessive rainfall just at harvest. Fiber Max varieties in the south and Delta Pine varieties in the north accounted for more than 70% of the variety selection. Yields ranged from 0-1700 lb lint/acre.

Thrips infestations were much lower than in 2000 except for isolated pockets on the upper Gulf Coast. Aphids reached treatment threshold on a high percentage of the southern acreage between the 4 true leaf and bloom stages. Aphid numbers rapidly fluctuated up and down much quicker than in 2000. Natural enemies, including the parasitic fungus reduced aphid numbers for the remainder of the season. Cotton fleahopper numbers did not reach treatment threshold until nearly first bloom; one insecticide treatment was generally made for fleahoppers. Looper (cabbage and soybean) numbers increased early, but before treatments were required they declined and were not observed for the remainder of the season. Bollworm and tobacco budworm infestations were low to moderate, although about 50% of the acreage was treated one time; a higher percentage of cotton was treated on the upper coast. No control problems were observed.

Initially it appeared that spider mites might become a severe problem, but their numbers did not persist. Boll weevils were not observed except in pheromone traps and at the edge of the eradication zone. Their numbers in pheromone traps continue to decline. Outside the eradication zone boll weevil numbers were generally low until their numbers exploded following harvest. Trap catches outside the eradication zone were the highest on record in November and December. Brown stink bugs, *Lygus* bugs and cutworm numbers were low. However, treatments were needed for stink bugs on the upper coast.

Cotton stalk destruction for boll weevil control was initially considered good on the lower coast and poor on the upper coast.

Northern Blacklands (NB). Cotton was planted during the optimum window, from the first to mid-April, and weather conditions were favorable for seedling establishment and growth. Thrips were a serious problem in some areas. Fleahoppers infested cotton early, and infestations were intense and prolonged throughout the area. Continued migration of adults overwhelmed treatments and often frustrated efforts to prevent square loss. Boll weevil numbers were light, probably reflecting several consecutive seasons with open, fall weather, which has allowed early harvest, and stalk destruction. Infestations of other pests were very light or absent. Rains in May and June were followed by late summer drought. However, yields were above average. Heavy rains (ca. 8 inches) just prior to harvest caused seed germination and reduced lint quality, resulting in price discounts.

Northern Rolling Plains (NRP). Dry conditions in much of the Rolling Plains delayed planting. However, some areas had adequate moisture due to the results of scattered thunderstorms. Hot temperatures and the lack of rain in June and July limited cotton plant development. Rainfall in mid-August was scattered but resulted in renewed growth. Little rain was received in September and drought conditions were apparent across the entire area. At the Texas Agricultural Research and Extension Center at Chillicothe/Vernon, a total of 11.65 inches of rain was received from January 1 through September 30, 2001, and of this 5.5 inches was received in January and February. The cotton acreage was estimated at 520,000 acres, up about 13 % from last year.

With seedling cotton growing slowly, thrips (mostly western flower thrips) migrated into and damaged cotton from mid-May through mid-June. With the hot dry conditions, these thrips had few hosts to move into when they came out of small grains and cool season grasses.

Grasshoppers damaged developing cotton stands during late June and continued to damage stands into July. Heaviest infestations were on the eastern side of the area. Damage in the western part of the area was limited to field borders. Much of the grasshopper damage was masked by hot dry conditions.

Boll weevil eradication programs are underway in the Central and Northern Rolling Plains Zones, which includes the entire area. This was the second full year of ULV malathion applications in the Northern Rolling Plains Zone and the fourth full year in the Rolling Plains Central Zone. In most of Motley, Dickens and Kent Counties this was the first full year of ULV malathion applications. This cotton acreage was added to the Northern Rolling Plains Zone during 2000. During September an average of 0.0002 and 0.0291 boll weevils per trap week were captured in the Rolling Plains Central and the Northern Rolling Plains Zones. Boll weevils did not damage cotton in the Rolling Plains during 2001.

Cotton fleahoppers increased in fields and were a concern in later planted cotton in late-July. 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 and tobacco budworm moth numbers captured weekly in Texas pheromone traps prior to and during the growing season were below average, however tobacco budworms moth numbers were above average; in Knox County during July. 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, insecticidal applications were limited to one in most cases.

Beet armyworm moth numbers in traps were well above average in May and June but declined during the remainder of the production season. Beet armyworm infestations were light in most of the Rolling Plains. However, during August they damaged cotton in counties on the western edge of the area, where cotton was being treated more frequently to eradicate the boll weevil. Predators and parasites suppressed beet armyworms in most of the area preventing excessive damage. In most irrigated cotton fields with the Bollgard gene, beet armyworms did not require additional control measures. Infestations were most often found in fields where Round-Up Ready® cotton was treated for weed control, and beet armyworms moved off the weeds onto cotton.

In most of the area cotton aphids did not increase until early September, and by then the production season was about over. Where predators and parasites were suppressed by more frequent insecticidal applications in Motley, Dickens and Kent counties, cotton aphid activity did increase during August.

Bandedwinged whiteflies were found in July and were heaviest in cotton adjacent to western ragweed and sunflowers. Heavier whitefly infestations produced large amounts of honeydew. Since most fields were not harvested until after the crop was terminated by freezing conditions, September and October rains washed most of the honeydew produced by cotton aphids and whiteflies from the lint.

Cotton yields are estimated at 220 lbs of lint per acre. Insect infestations were very light and the extremely dry conditions during much of the growing season limited insect damage and cotton production. Rain from October 1, 2000 through February 2001 provided most of the moisture for the 2001 cotton crop. With moderating conditions in August, cotton did mature bolls in the tops of plants, but most of these bolls were small and their contribution to the crop was disappointing. Yields in irrigated fields where producers were able to keep up with the plants' moisture requirements produced 2.5 to over 3.2 bales per acre, but in this area fully irrigated cotton represents less than two percent of the cotton acreage.

Southern Rolling Plains (SRP). The 2001 cotton production season started out with some potential. The 1999 and 2000 seasons were extremely dry but moisture conditions at planting in 2001 were much improved. Moisture started accumulating in December of 2000, and moisture conditions remained fair until early-May. Rainfall stopped in mid-May, and cotton planted in early June went into marginal moisture conditions. Irrigation was limited again in 2001 despite the early spring rains. The irrigation situation was somewhat better than 2000, because producers did not have to do as much pre-watering. Planted acreage declined in 2001 since wheat acreage remained stable. Total planted acreage for the region was 600,000, which is close to the ten-year average. The region plants about 25% *Bt* cotton, and most (95%) of the acreage has 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; however this was the first time in five years that fields were treated for thrips and cotton fleahoppers. The fall and spring rains resulted in numerous wild hosts, and early-planted cotton (planted prior to May 20) received some insecticide applications. Thrips populations were high in the northern counties (Nolan, Jones, Scurry, Mitchell), and some early-planted fields had yield reductions from thrips. Cotton fleahopper populations were consistent but reached high populations only in limited areas. Percent square set remained normal with most fields in the 70-80% range. Only 3 to 5% of the acreage was treated for cotton fleahoppers. The area also had high populations of lubber and migratory grasshoppers. Only field margins were treated, but approximately 13,000 acres were economically impacted with plant stand reductions. The area also had high populations of false chinch bugs and scentless plant bugs, but no damage was evident from these two pests.

Once the rains stopped in mid-May, moisture limited pest populations. The irrigated acreage in Tom Green county and limited dryland acreage in southern Runnels County had high populations of bollworms that required treatment but that was on less than 1000 acres. *Bt* cotton held up well with the high populations since the bollworm population was prior to peak bloom.

Approximately 580,000 acres of the 600,000 planted in the region will be harvested. Harvest is delayed due to late season rains that were helpful to late planted fields. Final yields on harvested acreage will range from 100 lbs. on dryland to 1500 lbs lint per acre on irrigated acreage. Final yield average will be approximately 260 lbs lint per acre.

Far West Texas (FWT). Cotton producers in the El Paso production area generally experienced average spring and early summer temperatures and rainfall in 2001. Temperatures were near normal and rainfall well below normal during the entire growing season for the Trans-Pecos and St. Lawrence production areas. In the dryland production areas, rainfall amounts generally were not high enough for producers to plant 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. Summer temperatures were good for cotton growth, but rainfall through July and August was generally nonexistent resulting in early cutout and low yield potentials for the dryland production area. Cotton yield in the Trans-Pecos and El Paso regions was generally considered normal.

Insect pest populations across the FWT region were sporadic and generally treated on a local basis. Pink bollworm was more of a problem in the El Paso cotton production area where most of the pima cotton is produced. Bt cotton acreage increased slightly in the El Paso/Trans-Pecos area from 2000, primarily because of its effectiveness against pink bollworm and incentives from the Texas Boll Weevil Eradication Foundation. The El Paso/Trans-Pecos eradication zone should be declared functionally eradicated for boll weevil this year. The first year of pink bollworm eradication was underway this year.

High Plains (HP). The 2001 season began with considerable promise due to the excellent soil moisture conditions from winter and early spring rains. Also, a colder winter than those the past four years promised to provide some relief from pests. Unfortunately, from June to September, rainfall amounts were insignificant resulting in extremely dry, stressful conditions. Significant rainfall did not occur again until November, providing mostly ideal conditions for harvest operations. Severe storms, mostly in May, resulted in accumulative acreage losses of over 1.3 million acres that were never replanted. Acres to be harvested dropped to 2.535 million acres from a planted base of 3.85 million acres. Yields from the remaining dryland acres, mainly to the south of Lubbock, lacking any appreciable rainfall through the summer, were reduced to very low levels. Irrigated producers were hard pressed to keep up with irrigation demands with the added problem of low cotton prices and high energy costs. Both disease and insect problems were minimal this year.

Producers opted to reduce pest management costs this year, resulting in less than a 3rd of the more typical 900,000 acres being treated with Temik or a seed treatment for thrips. As it turned out, this was a year of severe thrips infestations with yield losses higher for this pest than any other. However, optimal early growing conditions between damaging weather systems provided conditions that minimized damage from these high thrips populations.

There were predictions of severe problems from cotton fleahoppers and plant bugs (*Lygus hesperus* and *L. elisus*), with early rains and lots of alternate weed hosts as a result of these rains. The absence of further seasonal rains and high heat stress, coupled with unusually high numbers of beneficial arthropods, may have been the cause of the absence of early problems from these pests. Plant bugs did eventually develop to levels of concern later in the season when boll protection was important.

Boll weevil winter survival was apparently reduced significantly due to low overwintering site temperatures associated with our coldest winter in five years. Emerging boll weevil numbers were the lowest observed since this pest invaded the High Plains and became established in 1993. The eradication program starting its second full season of applications was also a significant contributor to reduced boll weevil numbers in the three active zones. The remaining two High Plains zones initiated their programs in the fall, before economically damaging weevil infestations could develop. As a result, the boll weevil was relegated to a minor pest for the first time after six years as a primary pest.

False chinch bug numbers were significantly higher this year with stand losses occurring in some field margins. Once cotton began to square, false chinch bugs could be found beneath the bracts of squares in many fields. Observations by university entomologists and consultants again supported previous observations that this insect does not affect square retention.

Bollworm numbers were very low again this year the lowest observed in over two decades (higher than last year but still at record low levels). Most fields treated for this pest were triggered by other pest problems. The greatly reduced corn acreage in the northern area again significantly reduced the magnitude of bollworm infestations in August.

Beet armyworm infestations were extremely light this season in stark contrast to last year. Early high trap catches and field infestations of beet armyworms initially caused concern, but record levels of beneficial arthropods, especially crab spiders, big-eyed bugs and minute pirate bugs, kept most infestations suppressed all season long.

Cotton aphids were practically nonexistent for much of the season, only developing very late infestations in October after their yield-reducing threat had past. There were no reports of sticky cotton problems this year. A sporadic pest, which caused some concern early during the blooming period was high infestation levels of bandedwinged whiteflies which developed in many fields in late July and August, especially in fields adjacent to sunflowers. Sunflowers appear to be an ideal whitefly host and with higher than normal acreage planted to this crop, higher whitefly problems could be expected. The absence of any research-backed thresholds or insecticide recommendations for this species made it difficult to provide management advice, but the final assessment was that their numbers were not sufficient to cause yield losses.

Overall, weather had the largest impact on harvested acres, final yields and cost of production. 2001 will go into the record books of being one of the lightest if not the lightest insect problem year since 1975.

Virginia

An estimated 103,000 acres were planted in Virginia. Early season cool and dry conditions caused delayed planting in some areas fields. In some areas, dry soil conditions during planting time, followed by intermittent rains, resulted in uneven plant stands, and in many fields, non-uniform seedling emergence. Overall, rainfall was at or just below normal for most of the season, although some areas experienced droughty conditions for much of the season. Rainfall in August revived plants and allowed for growth and compensation for much of the early and mid-season stress. With these challenges, reported lint yields are very high ranging from 800-850 lb/acre in drought-stressed areas to 1000-1200 lb/acre in non-drought stressed areas. The estimated state lint yield average is 900-950 lb/acre.

Estimates of cotton acreage planted to cultivars with the BG gene range from 50-60%, depending on the estimator and area of the state. Most of that was stacked gene RR®/BG cultivars. An estimated 1-2% of the acreage was planted with BG-alone cotton cultivars.

Cool, dry early-season conditions resulted in both heavy thrips populations and slow seedling growth – the worst possible combination for creating the potential for excessive thrips damage. Preliminary data show 200-500 lb lint/acre losses in insecticide-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 1.25 foliar applications/acre. Many producers, especially those with RR® cotton cultivars, elected to tank-mix thrips insecticides with post emergence herbicides. Unfortunately in some cases, 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 and good coverage was achieved and rates were sufficient, thrips control with standard insecticides was excellent. Spot samples of thrips populations did not reveal new species, but predominantly the common species, *Frankliniella fusca*.

Cotton aphid populations were expected based on large outbreaks the previous year but did not materialize as expected. In mid-season (June and early-July), populations did develop in some fields but beneficial populations of wasp parasitoids and lady beetles were very high and quite rapidly reduced aphid populations to less than critical levels. However, populations did develop in some fields (along with whitefly, species unknown) again late in the season (mid-August and September) but not at levels that warranted treatment. Some honeydew collected on leaves and terminals, but no cotton was known to develop sooty mold on open boll lint. No acres were treated for aphids.

Bug-damaged fruit, especially young bolls, became evident in a few fields in June and July. Most damage appeared to be caused by *Lygus* species rather than stinkbugs although stinkbugs were evident in some fields. 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. Because of reduced sprays number, bug problems tended to be worse in fields planted to BG cultivars. An estimated 1000 acres were treated with pyrethroids for bug problems, and this was prior to the initiation of bollworm sprays. Once bollworm sprays commenced, bug problems subsided. There was a small amount of bug damage evident on small top and outer canopy bolls after crop defoliation, indicating that late season populations resurged in some areas after bollworm spray residues diminished.

Bollworm populations were low to moderate as expected, based on mid-July field corn surveys. Percent infested corn ears for the cotton growing counties averaged 26% compared with 55% in 2000. Moth numbers, as monitored with a series of blacklight traps, were also low compared with previous years. However, many fields reached the egg threshold by early-August and most producers made two applications for bollworm in conventional cotton and one in Bollgard cotton, as recommended, based on initiation at egg threshold. Helid tests of field collected Heliothine eggs showed that budworm comprised almost 30% of total eggs collected in both early (9^{th}) and late (21^{st}) August.

A second year cypermethrin and first year spinosad adult vial testing program where 1122 moths were examined from two locations showed survival rates of 8% or less with both compounds. This was low in contrast to survival rates as high as 23% with cypermethrin in the previous year.

Spider mites persisted at low levels in a few fields causing some leaf reddening but no yield loss. Populations erupted on at least two farms causing extensive leaf drop and requiring treatment. An estimated 600-1000 acres were treated for spider mites.

No damage from cutworm, European corn borer and fall armyworm was reported; no boll weevils were trapped.

Research Progress and Accomplishments

Alabama

Alabama may be the only state without an identified cotton insect researcher. However, those with extension appointments (R. Smith, B. Freeman and R. Weeks) are conducting field evaluations with the new chemistry and new technology (Bollgard II®). In addition, Dr. William Moar, research entomologist, is working in the area of *Bt* monitoring and resistance. Fewer county level extension functions are held each year, but more multi-county and regional meetings are conducted. Scouts are trained at three one-day short-courses in early June each year. In-service training of agricultural agents is conducted in two locations. A close working relationship exists between extension entomologists and the 20-25 private consultants working within the state. Private consultants service approximately one-third of the Alabama acreage.

All the new sucking/bug chemistry was evaluated for stink bug control. However, due to marginal populations on research farms, it is not felt that definite conclusions should be drawn from this test. The threshold for stink bugs was changed prior to the 2001 season. The current threshold is one adult or immature stink bug per 20 row feet or 15% internal damage to quarter sized bolls. All new chemistry is being evaluated in Alabama to determine how and where they fit in cotton insect management within the State. **(Department of Entomology and Plant Pathology, Auburn University, Auburn, AL)**

Arizona

Experimental plots of alfalfa, fall and spring cantaloupe, broccoli, cotton, ornamental lantana, and native weeds have been established at three University of Arizona Agricultural Centers; Maricopa, Yuma and Marana to study sweetpotato whitefly population dynamics by bi-weekly sampling of whiteflies and natural enemies to establish whitefly cohorts for life table studies at all sites to examine effects of sub-zero temperatures. Results suggest that several common predators of whitefly 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, and we are examining whether parasitized hosts may represent a better diet for these generalist predators.

Natural enemy conservation plays an essential role in IPM development. We continued toxicological studies with *Geocoris punctipes*, *Orius insidiosus* and *Collops vittatus*, common predators found in cotton. Results indicate that two insect growth regulators (buprofezin and pyriproxyfen) used for whitefly control have little effect on survival of these natural enemies. Results provide further evidence that use of these insect growth regulators is compatible with biological control in cotton. Studies have described the sampling distribution of sticky lint and developed efficient sampling plans for estimating cotton lint stickiness with the manual and high-speed thermodetector.

Sampling tools are essential to monitor sweetpotato whiteflies. We are attempting to improve the efficiency of a trap developed at the WCRL. Insides of CC traps are coated with a sticky material. This increases catches of whitefly adults by 50% and further modifications suggest additional improvement. Wide use of CC traps in greenhouses may occur where parasite releases are used for whitefly nymph control; the CC trap catches large numbers of whiteflies but few or no parasites.

We are equipping yellow sticky card traps with a light to increase whitefly and other insect catches. Increased catches of fungal gnats and in some cases whiteflies have occurred. Widespread use of the modified yellow sticky card trap in greenhouses is predicted when the project is completed.

We protein-marked whitefly parasitoids, *Eretmocerus emiratus*, to measure their dispersal pattern in cotton, melon and okra fields. A total of 1388, 637, and 397 marked and unmarked wasps was captured in suction traps during each of three trials, most between 0600 and 0800 h, and 40% were marked with the traps consistently catching more males. Almost all of the marked parasitoids recaptured in the cotton plot were at or adjacent to the release site; marked parasitoids were recaptured more frequently in distant traps located in the cantaloupe plot rather than in distant traps located in the cotton and okra plots, suggesting that they have orientation mechanisms that selectively locate preferred hosts.

Eretmocerus eremicus a potential biological control agent for the sweetpotato whitefly; its flight activity, and factors that influence the insects' dispersal are of utmost importance in determining their biological control potential. We examined how the parasitoids might respond to simulated skylight and plant cues following their release in a vertical flight chamber. Both male and female parasitoids were capable of sustained flights in excess of 1 hr, 63% of the wasps responded to the plant cues presented shortly after take off, and female wasps were much more likely to actually land on the plant cue than were males; 20% of the wasps exhibited a 'migratory' response, in that they only responded to the plant cue after flying for a considerable time, and males were more likely to exhibit migratory behaviors. These findings could significantly influence the outcome of biological control programs, and differential dispersal by male and female parasitoids should be considered during the parasitoid evaluation process.

A wide variety of protein markers have been used to identify insects for dispersal studies, but most are not useful for marking small parasitoids. We tested a new protein-marking procedure by: a) making comparisons of marking internally; b) marking parasitoids externally with protein, (c) marking parasitoids externally with day-glo dust; and (d) unmarked parasitoids. Parasitoids marked with protein behaved differently than unmarked parasitoids. The day-glo treated parasitoids were less active and spent significantly more time grooming than the protein-marked and untreated parasitoids. The protein marking technique is easier, faster, safer, cheaper and more stable than the currently used techniques for marking small insects, resulting in a significant paradigm shift in the way researchers now consider marking insects for migration and dispersal studies.

Feeding behavior of six predators on whitefly life stages was evaluated by recording feeding, resting, grooming, walking, and probing. Results showed: a) piercing/sucking predators (e.g., big-eyed bugs, *Lygus*, and minute pirate bugs) and the predatory fly, *Drapetis,* fed almost exclusively on adult whiteflies; b) chewing predators (e.g., lady beetles and collops beetles) fed equally on whitefly eggs and adults; and c) none of the predators examined in this study fed on whitefly nymphs. Although *Lygus* bugs can cause damage and reduce cotton yields, information on *Lygus* bugs as predators of whitefly eggs and adults shows the need to further evaluate the capacity of *Lygus* to contribute to the management of whitefly populations under certain conditions (e.g. when it is too late for new fruit to mature, feeding by *Lygus* bugs on whiteflies may outweigh damage to the plants).

We examined the amino acids found in our artificial diet versus those found in the honeydew of the sweetpotato whitefly, comparing total pmol and mol% of individual amino acids found in whitefly honeydew and in artificial diet. Results were: a) nearly all of the same amino acids were found in the artificial diet; except for Cystine, which was lacking in the honeydew;

b) the total pmol of amino acids found in honeydew of whitefly nymphs reared on an artificial membrane was only 3.38% of that found in the artificial diet; c) substantive changes in mol% of individual amino acids occurred between the artificial diet and honeydew of whiteflies for glutamic acid greater in the diet than in whitefly honeydew; d) glutamine was approximately 40 times higher in honeydew than in the diet, alanine 4-4.5 times greater and methionine 3-3.5 times greater in the diet than in honeydew; and e) asparagine, valine, isoleucine, leucine, lysine, arginine and proline were slightly elevated in the honeydew when compared to the diet. These findings provide clues to whitefly amino acid nutrition, and additional studies will be necessary to determine if these findings are relevant to developing an artificial diet and the needs of whiteflies.

Research was undertaken in a Phoenix greenhouse to determine the factors that contribute to female-biased populations of sweetpotato whitefly. It was determined that availability of males to mate with females throughout their adult lifespan was required to promote female-biased sex ratios. The male availability hypothesis represents a novel mechanism to explain variability in population sex ratios often observed in haplodiploid insects.

Sticky cotton is the single most important lint quality concern on a worldwide basis affecting prices, marketability, export markets, and lint processing. We conducted studies to determine the quantity and quality of the major honeydew sugars produced by sweetpotato whitefly adults and nymphs. Results showed that a) adult females lived longer than males, produced more and larger honeydew drops and, in most cases, larger amounts of the measured honeydew sugars compared with males; b) for nymphs, honeydew production began the first day of nymphal life and peaked on day 3 following emergence; c) adults produced more honeydew than nymphs, and trehalulose as a percentage of all sugars measured in the study was greater for adults compared to nymphs; and d) melezitose, as a percentage of all measured sugars, was greater for nymphs compared with adults. The identified sugars produce varying levels of lint stickiness and the results contribute to our ability to quantify and support control technology to reduce honeydew production in cotton systems.

Lygus bugs are serious pests of agricultural and horticultural crops, and yet little is known about the factors that influence their dispersal, which is essential information for development of an integrated pest management (IPM) program. Comparative studies on the flight behavior of *L. hesperus* and *L. lineolaris* are being conducted using a tethered flight system and a free-flight chamber. Results show: a) that *L. hesperus* and *L. lineolaris* nymphs and adults are predaceous on whitefly eggs and nymphs; third, fourth, and fifth instars, as well as the adults, readily consumed eggs and nymphs when offered on cotton leaves; b) most flights for both species are < 5 min, but flights in excess of 400 min have been recorded; c) most individuals took multiple flights (up to 300) in the 23 hr sampling period; d) unlike many other insects, pre-reproductive insects rarely flew; and e) longer flights occurred 2-3 wk after emergence, after most individuals had already mated, and females had begun depositing eggs. Our increasing knowledge of *Lygus* dispersal will result in developing computer models that predict when, where and how far *Lygus* bugs could disperse, as useful grower tools in developing planting schedules and crop selections when considering crop placement.

Anaphes iole is the most important native parasitoid of *Lygus* bugs in the southwest, and understanding its movement after release in the field will help develop parasite release strategies. In three tests in cotton, 50,000 parasitoids were externally marked with a protein, released, and recaptured in fan traps over a five-day period. Approximately 4% of the released parasitoids were caught in the traps. The recovery distances and direction of movement after release are important information in developing more efficient parasite mass release strategies.

In the spring, *Lygus* populations increase on a variety of weeds, and subsequent generations migrate to alfalfa and cotton; however, little is known about the chemical factors that mediate host location as *Lygus* bugs move from one crop to the next. We have completed studies on the response of inexperienced (reared on beans) and experienced (reared on alfalfa) 5th instar nymphs and adult *L. hesperus* to volatile cues associated with con-specifics and alfalfa. Female *Lygus* progressed upwind to flowering alfalfa more often than to vegetative alfalfa, males only responded preferentially to volatile compounds associated with 4- to 6-day-old virgin females and to a 10% clover honey solution, 5th instar *Lygus* responded to all plant or plant/insect combinations for vegetative alfalfa and to several combinations for flowering alfalfa, and previous exposure to alfalfa did not enhance the response of adults or nymphs. Development of a synthetic attractant for *Lygus* could play an important role in managing movement and population control.

Lygus causes significant loss in cotton flower buds and reduced yields. The factors that are involved in host location by *Lygus* are not known, and we are undertaking studies to determine whether host-plant volatiles play a role in the orientation process using a Y-tube olfactometer. Time of volatile releases in vegetative and flowering alfalfa were examined by using a push-pull collection apparatus where headspace volatiles were collected with Super-Q adsorbent traps. We found that a) volatile production for both vegetative and flowering alfalfa was greatest during the 1000-1400 hr collection period; b) most of our olfactometer bioassays were conducted during this period of maximum volatile release; c) many compounds have been identified from headspace collections, with flowering alfalfa having significantly higher quantities and more compounds than vegetative alfalfa; d) *Lygus*-infested vegetative and flowering alfalfa produced larger quantities of compounds thought to be induced by insect feeding; e) plants fed on by adults produced larger quantities of these compounds than plants fed on by nymphs; and f) *Lygus* nymphs and adult females were responsive to host-plant volatile odors. Better understanding the host-location process of *L. hesperus*, as well as the development of a potential attractant that can be used in a monitoring or trapping program are substantial products of this research.

The establishment of the pink hibiscus mealybug (PHB) (*Maconellicoccus hirsutus* Green) in California constitutes a new, invasive pest threat to cotton and numerous other crops. The activity of systemic neonicotinoid insecticides against PHB was investigated on various trees and 1 shrub in the Imperial Valley, CA during fall, 2000. Moderate to heavy infestations of PHB were eradicated from 9 out of 9 trees and 1 out of 1 shrub that were treated with thiamethoxam and from 2 out of 2 trees treated with imidacloprid. The complete elimination of PHB from treated trees helped to reduce the zone of infestation in the Imperial Valley and demonstrated that containment within the current zone and further reduction is possible.

A high percentage of the cotton grown in the southwest contains a gene that mediates production of *Bacillus thuringiensis* protein toxic to lepidopterous insects. Resistance is a potential hazard. Studies were initiated to determine baseline toxicity of the *Bt* protein Cry2Ab to pink bollworm larvae from cotton bolls collected from locations in Arizona, California, and Mexico. Toxicological bioassays using the Cry2Ab and Cry1Ac toxins were performed and probit statistics generated for populations covering a broad geographical area. These data will serve as a baseline comparison for future resistance monitoring studies that seek to determine the susceptibility of pink bollworm to the *Bt* toxins produced in transgenic insecticidal cotton cultivars.

In order to develop optimum use of this new technology, we are investigating the potential effects of *Bt* cotton on the natural enemy complex by examining comparative rates of predation and parasitism on whitefly nymphs and pink bollworm eggs. Results suggest that a) there are no direct or indirect effects of *Bt* toxins on populations of natural enemies; and b) spatial distributions of arthropod predators appear to be consistently less aggregated in *Bt* cotton compared with non-*Bt* cotton. *Bt* cotton gives excellent control of the key pest pink bollworm and is compatible with augmentation, conservation, and introduction methods of Biocontrol for other pests in the complex.

Pink bollworm is the key pest in southwestern cotton production areas, areawide management is suggested, and much overwintering biology information is needed. The number of days that pink bollworm diapausing larvae remained in harvested immature cotton bolls, larval and pupal mortality after exiting bolls, and spring moth emergence under insectary and field conditions was studied at Phoenix. Diapause larvae exited immature bolls sporadically during January, February and early March and peak numbers emerged in late-April, May or early-June. Larval and pupal mortality was highest in January and February, decreased in early-March, and increased again in late-June and July. Larvae remained in immature bolls as long as 319 days after harvest. This information provides target dates for planting, plowdown, and control action activities.

We marked pink bollworms internally by feeding larvae an enriched rabbit protein diet or externally by submerging pupae or spraying adults and then assayed for the presence of rabbit protein by ELISA using anti-rabbit protein. The internal marker was: a) retained in larvae, prepupae and pupae, but not adults; b) rabbit protein was retained on adults that were externally marked as pupae; and c) protein was retained for 6 days in the field from externally marked adults. The rabbit protein marker has potential for implementation in the USDA-APHIS sterile insect release program. **(USDA-ARS-Western Cotton Research Laboratory, Phoenix, AZ)**

Seasonal population and mortality dynamics of whiteflies continue to be under intensive study in a collaborative research project with the USDA-WCRL. Field study areas are now on-going at three climatically different locales in AZ (Yuma, Maricopa, and Marana). 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., *Sonchus* sp. and *Physalis wrightii*). Life tables are being constructed for natural and artificially established cohorts in each host plant area. The 2001–2002 winter seems to already be one of the coldest since the establishment of this whitefly as a pest in Arizona (since 1991). Air temperatures have been as low as 26°F at the Maricopa location, where there have already been 6 days below freezing (by 12/18). 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 were conducted with *Bt* transgenic cottons. Fifteen experimental varieties from three families and including single or multiple combinations of 2 different *Bt* transgenes and the Roundup-Ready® gene were studied in an isogenic transgenic comparison trial. Other studies were initiated with at least two other *Bt* transgenes among varieties of one family of cotton. Also, 57 varieties were evaluated for the presence and expression of Cry1Ac equivalents in various tissues over the course of the season.

Insecticide efficacy screening trials were conducted on various registered, unregistered, and experimental insecticides in 2001. The targets evaluated included whiteflies, *Lygus* bugs, and pink bollworms.

In Arizona's on-going effort to address pest issues that affect multiple crops, the Cross-commodity Research and Outreach Program (CROP) has developed a tool for rapidly communicating with producers and other clientele, and launched a completely integrated Crops Web site. The Arizona Crop Information Site (ACIS; *http://ag.arizona.edu/crops*) houses all of the independent, research-based information that the University produces and provides 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

Work is continuing on a systems test comparing conventional and *Bt*/RR®/Bxn cotton systems at two locations in the state. Researchers are looking not just at pest control, but also economics and agronomic differences in the systems to determine potential benefits to growers in different areas of the state. Work continues on perfecting the COTMAN management system. Further work on insecticide termination, irrigation termination and pre-bloom stress are continuing. Plant bug injury to presquaring cotton and terminals injury was investigated this year. Insecticide screening on cotton pests was conducted by several researchers in multiple locations across the state to enhance current and future recommendations. **(Arkansas Cooperative Extension Service, University of Arkansas and Arkansas Agricultural Experiment Station, Little Rock and Fayetteville, AR)**

California

Trials were conducted to evaluate control products for western tarnished plant bug (*Lygus* bug), spider mite, cotton aphid, and worm populations in SJV cotton in 2001. Natural enemies maintained spider mite and cotton aphid infestations below economic important levels and compromised some of the planned research. On *Lygus*, the pyrethroid products (Capture, Baythroid and Warrior) continue to provide the best control. Provado and Vydate were slightly less effective but still useable products especially under moderate pest pressure. Of the experimental materials, Novaluron provided good control especially with the 7.5 and 9 oz acre rates. The effect of these treatments on natural enemies was generally as expected; a noticeable detrimental impact with pyrethroids and a moderate reduction of natural enemies caused by Provado, the carbamates, and the organophosphates. At rates above 7.5 oz acre of Novaluron, natural enemies were significantly reduced. Spider mite populations did not develop to sufficient levels for meaningful research. Cotton aphid levels increased in late-July. Assail provided very good aphid control. Control with Furadan and Lorsban was slightly less than expected. The effectiveness of Bollgard II® cotton was tested and compared with Bollgard and conventional varieties DP 50 and Maxxa. Beet armyworm populations were very low in this test; there were no differences among varieties in number of natural enemies or in number of *Lygus* bugs.

The application of remote sensing was evaluated in several trials. The possibility of using remote sensing data to facilitate arthropod pest management in California cotton was investigated. Stress or excessive vegetation may help to better guide ground-based sampling and may allow an estimation of the percentage of the field that may be potentially infested. Preliminary research in this area was conducted in 2001 on *Lygus* bugs, spider mites, and cotton aphids. Use of Landsat imagery was evaluated as a tool to improve *Lygus* estimation in non-agricultural areas. Vegetation indices were developed to track host availability across large and inaccessible areas. Geographical information systems were used to understand the role of cropping patterns on *Lygus* buildup and movement.

The management of alfalfa hay in a cropping system can play a major role in *Lygus* movement into cotton. Trials were conducted to evaluate the preservation of habitat by leaving uncut areas of alfalfa. Ten percent and 2.5% areas were left uncut and bordering cotton was sampled for changes in *Lygus* densities.

Peristenus spp. continues to be reared and released by California Department of Food and Agriculture's Biological Control Unit. This wasp is a parasite of *Lygus* nymphs and is being released in alfalfa hay to study its survival and movement. Investigations continued into *Beauvaria* and other fungal pathogens against *Lygus* and aphids. **(Cooperative Extension Service, Kern County, Tulare County, Kings County, Kearney Agricultural Center, Parlier; UC, Davis; and UC, Riverside)**

Louisiana

Several tests evaluated insecticide efficacy against thrips in 2001. In one study, Adage 5FS, Gaucho 4FS, Orthene 90S, and Temik 15G provided effective control of thrips (primarily *Frankliniella* spp.) nymph. A higher rate of Gaucho (12.8 fl oz/cwt) significantly reduced thrips nymphs compared with Gaucho at 6.8 fl oz/cwt. Adage 5FS and Gaucho 4FS reduced tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), damaged squares compared with that in the untreated plots. No differences in plant development based on main stem nodes above white flower data were detected. Plots treated with Adage 5FS (12.8 fl oz/cwt), Orthene 90S (12.8 fl oz/cwt), Gaucho 4FS (6.4 fl oz/cwt) and Temik 15G yielded significantly more seedcotton compared with the Orthene (6.4 fl oz/cwt) and the untreated plots. In an evaluation of Adage 5FS at rates from 2.5 to 8.5 oz AI/cwt, Orthene 90S at 6.4 oz AI/cwt, and Temik 15G at 0.5 lb AI/acre, all treatments reduced numbers of thrips adults and larvae compared with the non-treated plots. There were no differences among the insecticide treatments in seedcotton yield, but all insecticide treatments increased yield compared with the untreated plots. In another test, Adage 5FS (300 g AI/100 kg seed), Temik 15G (3.3, 5.0, 6.5 lb form/acre), Gaucho 4FS (250 g AI/100 kg seed) and Gaucho 5FS (250 g AI/100 kg seed) decreased numbers of thrips nymphs compared with the untreated plots. The seed treatments Adage 5FS and Gaucho 4FS/5FS, and in-furrow treatment of Temik (6.5 lb form/acre) significantly increased seedcotton yield compared with the untreated plots. The Adage 5FS and Gaucho 5FS plots yielded higher than the Temik (3.3 lb form/acre) treated plots. In a similar study, no differences among Adage 5FS (8.0 oz AI/cwt), Gaucho 4FS (7.65 oz AI/cwt), Temik 15G (0.5 lb AI/acre), and Temik 15G (0.5 lb AI/acre) followed by Temik 15G (0.5 lb AI/acre, side-dress application) treatments were observed for numbers of thrips adults or nymphs; cotton aphids, *Aphis gossypii* (Glover); tarnished plant bugs; and root knot nematodes. All insecticide treatments significantly increased seedcotton yield compared with that in the untreated plots.

Studies to evaluate the residual efficacy of at-planting seed treatments against tarnished plant bug were conducted during 2001. Tarnished plant bug adults were infested on seedling cotton from 7 days after emergence (DAE) to 26 DAE at 2-3 day intervals. There was no significant relationship between days after emergence and tarnished plant bug mortality for the standard seed treatments, Orthene 90S and Gaucho 4FS. These products resulted in mean tarnished plant bug mortality across the entire period of less than 10%. There were significant negative relationships between tarnished plant bug mortality and days after emergence for the seed treatment Adage 5FS and Temik 15G, applied in-furrow. Tarnished plant bug mortality for Adage 5FS ranged from a high of 62% at 10-11 DAE to 9.5% at 26 DAE. Tarnished plant bug mortality for Temik 15G ranged from 80% at 7-9 DAE to 33% at 26 DAE.

Other tests evaluated the efficacy of foliar applications of insecticides against thrips on seedling cotton. In general, most pyrethroids applied at Heliothine rates controlled thrips nymphs comparable to that provided by organophosphates. Lower rates of pyrethroids produced inconsistent results in the control of thrips adults and nymphs. Novaluron 0.83EC (0.02 to 0.09 lb AI/acre) also produced erratic results in thrips control and usually was not as effective as Orthene 90S.

In field and laboratory tests several treatments showed consistent results in controlling stink bugs. Centric 25WG, Leverage 2.7 EC, Bidrin 8EC, Orthene 90S, and Capture 2EC were applied to cotton foliage and bolls in the field, and were effective against the brown stink bug, *Euschistus servus* (Say). The adult vial test (AVT) was modified for the brown stink bug and southern green stink bug, *Nezara viridula* (L.). There were no differences in seasonal responses between populations of brown stink bug or southern green stink bugs collected early and late-season. However, there were differences between species to the toxicity of selected insecticides. Brown stink bug adults were significantly more sensitive to technical grade samples of Orthene 90S (acephate) and Capture 2EC (bifenthrin), compared to Karate 2.08SC (*lambda*-cyhalothrin). In contrast, southern green stink bug adults were highly sensitive to bifenthrin and *lambda*-cyhalothrin. The LC_{50} for adult brown stink bug was approximately 51-fold higher than that of adult southern green stink bug to *lambda*-cyhalothrin. However, this difference was only 6.3-fold when southern green stink bugs were tested in the AVT. Southern green stink bug nymphs (4^{th}-5^{th} instar) were significantly less sensitive to *lambda*-cyhalothrin compared to adults.

Preliminary experiments were conducted to determine the impact of brown stink bug feeding on cotton boll abscission and yield. Individual stink bugs were caged for 72 h on first-position bolls of varying maturity according to heat unit (HU) accumulation (0 to ca. 850 HU) beyond anthesis. Corrected boll abscission at 72 h peaked at 60% for bolls infested between 0 and 164.5 HU. Abscission declined to 0% at 172.5 HU (ca. 7.4 days) and no abscission occurred for the remainder of bolls infested. Seedcotton yields were significantly lower for 9 of 16 boll age classes ranging from 0-401.5 HU (ca. 17.2 days). Yields were significantly lower for only 3 of 10 boll age classes infested from 445.5-859.5 HU. Seed weights followed similar trends to those of seedcotton yields.

The influence of insecticide application timing on cotton aphid control and subsequent effects on cotton yield was evaluated in a field experiment. The timing of insecticide applications was designed to target cotton aphid infestations at selected cotton plant growth stages. Treatments were initiated at pinhead-square and applied weekly until 14 days after first flower. Cotton aphid populations increased during June and peaked on 27 June with densities of ca. 100 cotton aphids per plant terminal (all apical growth including first fully expanded leaf) in non-treated plots. The insecticide treatments effectively reduced cotton aphid densities and allowed aphid infestations to persist in the fields for specific intervals. Regardless of application timing, no significant differences in seedcotton yields were detected among treatments.

Area-wide experiments on Panola Plantation in Tensas Parish evaluated the potential of reducing tarnished plant bugs by controlling winter/spring vegetation on the margins of cotton fields prior to planting. 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 were applied to kill broadleaf native hosts in February and March. Tarnished plant bug densities in field borders remained at very low levels during February and March. Tarnished plant bugs in the non-treated areas followed a cyclic pattern and reached peak densities on 19 April and 16 May. Tarnished plant bugs in the herbicide-treated fields margins were lower than that in the untreated area on 9, 19 April and 3, 9, 16 May. Tarnished plant bug nymph populations were not observed until the end of April. Differences between the treated and untreated area were not distinguishable in nymph numbers until 3 May. Tarnished plant bug adults and nymphs in the treated area never exceeded 1.5 insects/25 sweep sample on any rating date. In the untreated areas, tarnished plant bug numbers peaked at 10 and 11 insects/25 sweep sample for adults and nymphs, respectively. Pre-treatment weed counts were initiated on 15 and 20 Feb in the treated and non-treated areas, respectively. Pre-treatment broadleaf weed counts averaged 71.0/m^2 in the treated area and 74.0/m^2 in the non-treated area. Post-treatment weed counts were determined on 25 and 26 April. Weed density in the treated area was zero. In the untreated area, weed densities averaged 23.2/m^2. This was a significant reduction compared to the pre-treatment counts and may be due to the senescence of many weeds and pre-plant burndown herbicide applications by the producer.

Field studies were conducted in Northeast Louisiana to determine if differences in bollworm, *Helicoverpa zea* (Boddie), larval behavior occurred on conventional (cv. Deltapine 5415) and Bollgard (cv. NuCOTN 33B) cottons. Larvae were placed in the terminals either on single cotton plants or on all plants within 1-m row micro-plots. On non-flowering cotton plants, significantly more bollworms moved from the site of infestation (terminal) on Bollgard plants compared to that on non-Bollgard plants. On individual flowering plants, the number of nodes larvae moved from the terminal and number of infested bolls were greater on Bollgard cotton plants. Differences in the percentage of infested terminals and squares were observed between Bollgard and non-Bollgard plants at 48-h after infestation when 1-m rows were infested. In addition, significantly more larvae were observed feeding on white flowers and bolls of Bollgard cotton compared to non-Bollgard cotton. These data will be used to refine scouting protocols for bollworm larvae on Bollgard cotton.

Two separate studies were conducted to determine the levels of fruiting form injury that can occur from bollworm larvae feeding on white flowers. In the first study, bollworm larvae were infested on Bollgard and non-Bollgard cotton plants. Individual larvae were placed in first position white flowers on fifty plants per day for five days during 2000 and 2001. In the second study, bollworm larvae were infested on Bollgard II®, Bollgard, and non-Bollgard cottons. Individual larvae were placed in first position white flowers of 10 plants per day for six consecutive days during 2001. Plants were visually inspected at 72 h and every 48 h thereafter, until larvae were no longer present. In the first study, bollworm larvae damaged a total 46.6 fruiting forms per 50 plants on non-Bollgard cotton compared to only 18.9 fruiting forms per 50 plants on Bollgard cotton. An individual bollworm larva damaged 4.3 fruiting forms on non-Bollgard cotton compared to 2.7 fruiting forms on Bollgard cotton. In the second study, bollworms damaged a total of 25.0, 11.5, and 6.4 fruiting forms per 10 plants on non-Bollgard, Bollgard, and Bollgard II® cottons, respectively. An individual bollworm larva damaged 6.6, 3.5, and 0.8 fruiting forms on non-Bollgard, Bollgard, and Bollgard II® cottons, respectively. These data indicate that supplemental insecticide applications may provide economic benefits in the form of yield protection on Bollgard cotton. In contrast, damage to Bollgard II® cotton was minimal and may not require additional insecticide applications.

Field and laboratory studies evaluated the influence of selected crop hosts on bollworm population dynamics in relation to genetically engineered (Bollgard) and non-Bollgard cottons. Host specific bollworm colonies were initiated with a colony originally collected from sweet corn. The colony was allowed to complete one generation on meridic diet then split into cohorts and allowed to complete one generation on field corn, grain sorghum, soybean, cotton, or meridic diet in individual 29.5 ml plastic cups. During the first part of the study, larval developmental times, pupal weights, and survival were measured. Bollworm survival was higher on meridic diet and grain sorghum than on soybean and cotton. Development of bollworm larvae was faster on field corn than all other larval diets. Also, bollworm required a longer period to complete development on cotton than on the other hosts. Pupal weights were higher on meridic diet than on the plant hosts. Pupal weights of bollworm that completed larval stadia on cotton were lower than on the other larval diets. Neonates (F_1) from each of the host specific colonies (200 per colony) were exposed to Bollgard and non-Bollgard cottons. Mortality of second-generation bollworm on non-Bollgard and Bollgard cottons was measured at 96 h. Bollworm larvae from the cotton colony had higher mortality on non-Bollgard cotton than the other host specific colonies except the grain sorghum colony. On Bollgard cotton, larvae from the corn colony had a higher level of mortality than larvae from the soybean and grain sorghum colonies. These data provide valuable information for evaluating the contribution of cultivated hosts as additional, alternative refugia in Bollgard cotton resistance management plans.

In 2001, 20 pairs of pheromone baited wire cone traps were used to survey species composition of tobacco budworm, *Heliothis virescens (F.)*, and bollworm. The adult vial test (AVT) was used to monitor pyrethroid resistance levels in these species. Over 728 tobacco budworm moths were assayed for pyrethroid (Ammo, cypermethrin) susceptibility from May to Sep 2001 using a discriminating concentration of 10 µg in the adult vial assay. Percent survival in May, Jun, Jul, Aug, and

Sep. was 69%, 47%, 73%, 76%, and 57%, respectively. These data further indicate that pyrethroids are no longer a viable option for tobacco budworm control in Louisiana. Over 829 bollworm moths were assayed using a 5 µg /vial concentration of cypermethrin. Percent survival for May, Jun, Jul, Aug, and Sep was 10%, 6%, 32%, 13%, and 16%, respectively. No field control failures of bollworm infestations associated with pyrethroid usage were reported in Louisiana during 2001. Field populations of bollworm and tobacco budworm were also monitored for susceptibility to Tracer 4F (spinosad) using the AVT. Bollworm survival ranged from 0% to 40% and from 0% to 28% for the 5 µg/vial and 15 µg/vial concentrations of spinosad, respectively from May to Sep. Tobacco budworm survival to the 5 µg/vial and 15 µg/vial concentrations ranged from 3.9% to 19% and 0% to 19%, respectively from May to Sep. Some suspected field control failures of tobacco budworm infestations with spinosad occurred in Northeast Louisiana during 2001. Extensive laboratory testing of collections in topical bioassays from these areas indicate elevated LD_{90} values compared to laboratory reference colonies. **(LSU Ag Center's Northeast Research Station, St Joseph and Winnsboro, LA; Louisiana Cooperative Extension Service, Winnsboro, LA; and Department of Entomology, Baton Rouge, LA)**

Mississippi

Research is continuing to evaluate the potential impact of *Bt* transgenic cottons (e.g., Bollgard and Bollgard II®) on pest management in Mississippi. Laboratory and small-plot data are being collected to evaluate the relative effectiveness of Bollgard II® cotton on various caterpillar pests when compared with Bollgard cotton. ELISA techniques are being used to quantify the concentration of *Bt* proteins in different parts of the plant and in different varieties of cotton.

A significant research effort is being made to determine what value remotely-sensed imagery may have in predicting the occurrence of insect populations in cotton. Imagery was collected from ca. 2,000 acres. Ground-truthing data, including plant development data and densities of arthropod populations, are being compared with this imagery. Hopefully, these data can be used to determine protocols for sampling and managing insect pests in a spatially precise manner. **(Department of Entomology, Mississippi State University, Mississippi State, MS)**

Cotton insecticide efficacy research for compounds thought to be efficacious against tarnished plant bug included cage trials, field trials and ovicide evaluations in the laboratory. None of the compounds tested for ovicidal activity on 24th old eggs laid in gel packs were affective; however Provado 1.6 F resulted in significantly more insects dying during emergence than the other compounds and the water-treated check. In field trials in the delta (Quitman Co.), 5 days was required before efficacy of newer compounds became evident. Orthene and an experimental compound (Novaluron) were effective as a combination at low rates and individually at higher rates. In caged trials using cloth sleeves to cage 4th instar nymphs beginning 2DAT for 48th, Steward, Vydate and Denim provided no control as compared with the water check, although Asana and Assail resulted in moderated mortality.

Evaluations of DRA-034 indicated no efficacy on aphids as tested. Addition of Kinetic, a silicone based adjuvant, may enhance the efficacy of Calypso. Bidrin continues to be an excellent aphicide in the hills of Mississippi. Calypso, Provado and Centric were as effective as Bidrin at the rates tested, and Assail at higher rates was statistically more effective than Bidrin. Thus, substitutes for standard OP's are available for use against aphids on cotton should the others be lost.

Based on yield, Temik applied at planting at rates from three to six pounds indicated that in the absence of nematodes, 3.5 lbs of product appears optimum for the sandy loam soil in experiment station plots for cotton with moderate thrips populations. Thrips control with foliar applications of Centric, Orthene, Bidrin and Karate Z indicated that Centric had less residual than the other products (based on 2 DAT and 7 DAT samples).

The Cotman computer program was evaluated relative to ultra-narrow row cotton in replicated comparison with wide-row cotton. Yield from both planting regimens was equivalent, and data were taken from tagged bolls to determine the location of harvestable bolls in relation to node above white flower. The test was part of a multi-state trial sponsored by Cotton Incorporated, and data will be summarized with that of researchers in other states. Ultra narrow row cotton was also evaluated for thrips control with Temik at different rates. **(Department of Entomology and Plant Pathology, Mississippi State University, Mississippi State, MS)**

Insect control is a major cost in cotton production. The simultaneous effect of the high cost of insect control along with the loss of many pesticides due to environmental pressures means that alternative strategies and tactics have to be developed for cotton pest management. The employment of diverse spatial technologies (e.g., remote sensing, global position systems (GPS), geographic information systems (GIS)) and modern sampling designs are being investigated as tools that comprise a system of insect control that will reduce costs while protecting yield potential and increasing grower profits. Diverse skills are needed to develop and test this novel approach to cotton pest management. Therefore, with major USDA-ARS participation a multi-agency and multi-disciplinary team (along with grower and farm consultants) is exploring the application of these technologies.

Research on the application of site-specific control continues to build each year. The work of the present production season continues to demonstrate that cotton pest control can be impacted by use of diverse spatial technologies ranging from remote sensing imagery, GPS and GIS systems and variable rate-controller technology. Not all cotton pests are directly impacted by these approaches; that is, for aphids, spider mites, thrips, and whiteflies much needs to be learned. However, for insect pests that attack squares, blooms and bolls the trend continues that their control can be accomplished by use of these technologies.

The use of these technologies requires considerable skill and integration of skills across disciplines and public, private and research institutions. While this integration is the strength of this approach to cotton insect control, the program demands the careful orchestration of information and personnel. It was learned this past summer that the lack of key skills in the expansion of the work to additional farms limits the timeliness and effectiveness of this approach to insect control. With this approach timing is everything, and any delays in the acquisition or processing of any data relevant to crop management decision at hand limits effectiveness and reduces opportunities to reduce cost or increase yield.

Before site-specific approached to cotton insect control can be applied on a larger scale, considerable work needs to be accomplished to reduce the labor and time burdens on all participants at any point along the way, and yet maintain clear channels of communication amongst all. **(USDA-ARS, Crop Simulation Research Unit, Mississippi State, MS)**

The beet armyworm parasitoid, *Cotesia marginiventris* has been shown to undergo multiple parasitism within the same host which could have valuable bearing on mass rearing of this parasitoid. It has been shown that the parasitoids can be kept for extended periods of time with appropriate temperature and photoperiod conditions.

Progress has been made in finding improved diet preservation against molds that affect the production of tarnished plant bugs. A less toxic replacement for formaldehyde has been tested and found to improve preservation against *Aspergillus niger.* Improved methods of making artificial diet for tarnished plant bugs have been developed with large-scale synthesis of diet now being possible. This will reduce costs of labor and increase the likelihood of commercial utilization of the artificial diet. Furthermore, automatic packaging for the TPB diet and oviposition packets has been developed.

Extensive research on antioxidants and other nutrients has demonstrated that certain additives will preserve the shelf life of the artificial diet for these insects. We have also identified several components from soy, lima bean and other legumes that can be potential toxins that may be useful against TPB. **(USDA-ARS, Biological Control and Mass Rearing Research Unit, Mississippi State, MS)**

Continued development of a *Bt* protein quantification assay was conducted. Many cultivars and plant parts were examined, especially with Bollgard II® varieties. Experiments were also conducted to examine threshold levels for fall armyworms in *Bt* cotton. In particular, the level of boll injury significant enough to cause yield loss was investigated.

Production of insects for state, private, and USDA-ARS research by the Stoneville Insect 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 165,000 *H. virescens* pupae, 262,700 *H. zea* pupae, 46,769 *A. gemmatalis* pupae, 100,500 *S. exigua* pupae, 97,454 *C. nigriceps* cocoons, 87,557 *M. croceipes* cocoons, 41 million *H. virescens* eggs, 131,335,000 *H. zea* eggs, 10 million *A. gemmatalis* eggs, and 40 million *S. exigua* eggs. Additional research support included mixing, dispensing, and filling 2,900 30-ml cups and 4,357 multicellular trays with artificial diet. Total diet mixed and dispensed in 2001 was 15,000 liters. Several tours were provided to industry and university personnel and children from kindergarten through 12th grade from throughout the Mississippi Delta. Approximately 71 researchers located in 33 states and 3 foreign countries participated in the Insect Distribution Program.

For a third and final year, 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 2001 as in the two previous years; however, trends indicated that tarnished plant bug numbers were again higher in UNR than conventional cotton. The speculated cause for the minor differences is that a denser canopy in the UNR cotton favors tarnished plant bug reproduction (protection from heat, poorer insecticide penetration).

Comparison of numbers of boll weevils captured in 34 traps 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 state-wide boll weevil eradication program when compared to other years. From August-October in 2001, there was another 94% reduction. Before boll weevil eradication (1995-1998), numbers for March through each year averaged

60,500. For the same period in 1999, 2000, and 2001, the numbers were 5,304, 198, and 4, respectively, indicating continued progress toward total elimination of the boll weevil from this part of the state.

Moth traps records in 2001 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 were similar to 1999 and 2000 which were the lightest on record. Bollworms and tobacco budworms have consistently been lower since 1996 (the year *Bt* cotton was introduced) than from 1985-1996.

Results from a 1st year, 3-state, 6-location test to determine the best time to spray for cotton aphids produced inconsistent data due to extremely low numbers of aphids in almost all areas in 2001. The test will be repeated at the same sites in 2002.

First year testing of applications of certain chemicals to stress aphids early in the season to induce the onset of the entomopathogenic fungus, *neozygites fresenii*, were extremely promising. Stress treatments on June 26 and July 6 produced 69% infection on July 9 as compared to 24% in the control. Data have not been analyzed.

A comparison of tarnished plant bugs in nectariless and nectaried cotton showed no difference in 2001. The extremely high numbers in all areas is suggested as the cause of no difference.

All four generations of bollworm and tobacco budworm were again evaluated in spray chamber tests for tolerance to five classes of insecticides. Budworms remained resistant to pyrethroids but reasonably susceptible to all other classes; bollworms were susceptible to all classes.

Adult vial test (AVT) was conducted with pheromone-trapped moths captured throughout the delta. Studies indicated that moths were susceptible to pyrethroid and spinosad insecticides.

In 2001 a large field plot study was carried out to determine the effects of aldicarb applied in-furrow and in combination with a side-dress application with liquid nitrogen and anhydrous fertilizers on early season insects and nematodes cotton. Treatments were: (1) liquid nitrogen, (2) liquid nitrogen and aldicarb in-furrow at .50 lb AI/acre followed by side-dress application at 1.05 lb AI/acre at pinhead square, (3) liquid nitrogen and aldicarb in-furrow at 1.05 lb AI/acre, (4) anhydrous ammonia, (5) anhydrous ammonia and aldicarb in-furrow at .50 lb AI/acre followed by a side-dress application at 1.05 lb AI/acre at pinhead square, and (6) anhydrous ammonia and aldicarb in-furrow at 1.05 lb AI/acre.

Each treatment was replicated five times. Nematode samples collected prior to planting were above economic threshold across the entire field. Nematode samples were counted and analyzed by personnel in Gabe Sciumbato's laboratory (MSU, Stoneville). Nematode counts were up and down throughout the summer, and the one thing that stood out was that neither anhydrous nor aldicarb had a big impact on the reniform population present.

Early season insect pests were low during the first 5 weeks of fruiting, and there were no differences among treatments through June 20. At this time we turned the field back over to the producer for the remainder of the season. Yield data were collected by machine harvesting of eight rows from each plot. There were no yield responses or differences in yield found between the various treatments.

In small plot tests various insecticides were evaluated for tarnished plant bug control in replicated plots of Stoneville 4691B cotton. In the first test Steward was evaluated at four rates (.066, .078, .09, and .104 lb AI/acre). Vydate and Asana applied at .33 and .04 lb AI/acre respectively were used as standard treatments. Populations were sampled both by sweep net and drop cloth. Plant bug populations sampled by sweep net on July 12 in the untreated check averaged 3,638 per acre. Populations in all treatments were considerably lower ranging from a low of 84 to 292 per acre. Plant bug populations sampled by drop cloth on July 12 in the untreated check averaged 20,473 per acre. Treatment populations sampled by drop cloth averaged from a low of 697 to 2,526 per acre. In the second test, Assail was evaluated for aphid and plant bug suppression at four rates (.042, .056, .084, and .112 lb AI/acre). Other treatments in the test were Decis and Assail at .02 and .056 lb AI/acre, respectively, and Regent (fipronil) at .05 lb AI/acre. Tarnished plant bug populations were sampled by drop cloth and sweep net. Populations sampled by sweep net on July 12 in the untreated check were averaging 3,638 per acre. On the same date, populations in the Decis and Assail and Regent treatments averaged 209 per acre. Average per acre counts in the Assail treatments averaged from a low of 627 to a high of 1,588 plant bugs per acre. Populations sampled by drop cloth in July 12 in the untreated check were averaging 20,473 per acre. Populations in all treatments were considerably lower than those found in the untreated check. Assail was also evaluated for cotton aphid control on July 10. In the untreated check aphid populations were averaging 112 per leaf. No aphids were found in the treatment of Assail at .112 lb AI/acre. Populations in the lower rates averaged four to nine per leaf. Regent provided satisfactory aphid control with populations averaging 28 per leaf. Yield data were inconsistent because of the boll rot and shed that occurred in August and early September.

In a large field plot trial in 2001 a study was carried out to compare cotton insect control in conventional cotton with insecticides applied on a 20-inch band and a broadcast application by ground. Five fields were selected for the study. Each treatment (20 inch band and broadcast) was replicated four times. The tarnished plant bug was the major pest throughout the summer. Also present were low populations of bollworm/budworm. Insecticide and rates per acre used were determined by insects present each week. Measure of success was by plant mapping 40 plants from each treatment and field location. Plant mapping showed that there was slightly less boll set in the 20-inch band than in the broadcast treatment. Yield data were also taken but were not reliable due to excessive boll rot from rain that occurred in August and September. Economic analysis is not complete at this time to determine if cost savings of 20-inch band offsets the difference in boll set between treatments.

In 2001 two separate spray chamber tests were carried out to determine mortality of adult plant bugs exposed to various insecticides. In each test, young adults were collected from cotton three days after the field was treated for control. In the first test, the field was treated for plant bugs and bollworms with Orthene at 1.0 lb AI/acre. Three days later large numbers of insects were still present. Young adults were collected and held on green beans over night. Treatments in the spray chamber bioassay were: (1) Regent, Orthene, Curacron, Bidrin, Baythroid and Steward at .05, .5, .5, .5, .033, .11 lb AI/acre, respectively and an untreated check. Forty-eight hour mortality with Regent, Orthene, Curacron, and Bidrin was 100 percent. Mortality with Baythroid and Steward was 33 and 85 percent at 48 hours. Mortality in the untreated check was 20 percent. In the second test the same field was sprayed with Curacron at 1.0 lb AI/acre for plant bugs and worm control. Three days later large numbers of plant bugs were still present. Adults were collected and held over night on green beans. Treatments were Centric, Provado, Orthene, Regent, Vydate, and Decis at .047, .047, .5, .05, .33, and .02 lb AI/acre respectively. Mortality at forty-eight hours was 87, 81, 100, 100, and 38 percent, respectively. Mortality in the untreated check was 7 percent.

Studies begun in 1998 on reproductive diapause in the tarnished plant bug were continued in 2001. 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 decreases, the number of adults produced in diapause increases. Diapausing adults began to be produced in August and by the 3rd week in September in all 4 years, the percentage of nymphs producing diapausing adults reached 90% or higher. Adults broke diapause in 1998-2000 beginning in the first two weeks of December, and by the end of December in 1998 and 1999 over 90% were out of diapause. The winter of 2000 was a cold one and adults could not be collected to dissect after the 7th of December. All adults collected in March 2001 and dissected were out of diapause. The first nymphs were not found in the field until March of 2001 (as compared to January and February in the previous three years). First generation adults were found on April 5, 2001 as compared to mid-March in the three previous years.

A study begun in 1999 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 was continued in 2001. During these three years plant bugs were collected from weeds in the fall, or in the spring and fall, and tested for resistance to malathion with a glass-vial bioassay. The same collection locations have been used each year, and in the fall these included 8 locations in Region 1, 5 locations in Region 2, and 4 locations in Region 3 of the Boll Weevil Eradication Program. Plant bugs from eleven of these locations (3 in Region 1, 4 in Region 2, and 4 in Region 3) were tested in the spring and fall of each year. Comparison of resistance levels from the fall of 2000 to the spring of 2001 showed that resistance to malathion declined at all eleven locations. Resistance ratios for malathion in Region 1 ranged from 2.4 to 7.5 in the fall of 2000 and 0.97 to 3.2 in the spring of 2001. In Region 2 resistance ratios ranged from 3.2 to 30.1 in the fall and 1.3 to 3.2 in the spring. Region 3 had resistance ratios of 1.4 to 4.0 in the fall and 1.4 to 1.8 in the spring. Boll weevil numbers in cotton were low in 2001 and applications of ULV malathion for boll weevil eradication were fewer than in the previous years of eradication. However, plant bug pressure in cotton was high in the Delta in 2001 and ULV malathion was one of the insecticides used to control them. Results found in the fall of 2001 show that malathion and other organophosphates were used extensively for plant bug control, especially in Regions 1 and 2 which are the delta portion of the eradication program. In the fall of 2001 resistance ratios ranged from 8.6 to 13.4 in Region 1; 8.8 to 17.6 in Region 2; and 1.3 to 1.8 in Region 3. The reason(s) for the decline in malathion resistance from the fall of one year to the spring of the following year is not known.

Orthene is an extremely important insecticide that is widely used for control of plant bugs in cotton in the delta. A survey to determine if plant bugs in the delta have increased tolerance to orthene (began in 1998) was conducted again in the fall of 2001. The same 20 locations (4 in AR, 2 in LA, and 14 in MS) were used in all 4 years. Resistance to orthene was determined using a glass-vial bioassay. LC_{50} values obtained at each location were compared to an LC_{50} value obtained with orthene and susceptible bugs from Crossett, AR. The highest amount of resistance found in any of the 4 years was 4.6-fold found in bugs from near Cummins, AR in 1999. This level of resistance could reduce the effectiveness of orthene but should not cause a control failure. The mean resistance ratios for all 20 locations were 1.5, 1.6, 1.9, and 1.8 in 1998, 1999, 2000, and 2001, respectively. This showed a slight trend toward increasing resistance from 1998 to 2000, with a slight reduction in resistance in 2001.

A large experiment designed to evaluate control of tarnished plant bugs in cotton by reduction in numbers of wild hosts available for plant bug reproduction in the spring was conducted for the fourth year in 2001. Four areas (3 in Washington and 1 in Sunflower Counties) each 3 X 3 miles in size were used again in 2001. One area (Tribbett) used in 2000 as a treated area was used again in 2001 as a check area. The other three areas located near Choctaw, Arcola, and Holly Ridge were new areas. The areas at Arcola and Holly Ridge were treated. The treated areas received an application of broadleaf weed killer (Trimec) in March to all margins around roads, fields, and ditches. The two check areas did not receive this treatment. Prior to treatment, wild hosts were sampled for plant bugs in all 4 sites. 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 with sweep nets for plant bugs. 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 four experimental areas. Group IV soybeans were also sampled in one check and one treated area. Soybeans were sampled using a sweep net for adults and a drop cloth for nymphs. These samples were taken in fields at Arcola and Tribbett. There were no soybeans planted at Holly Ridge and only later planted (3-4 weeks later) soybeans at Choctaw. In cotton fields bordered by soybeans, extra samples were taken 100 ft or less from the cotton field border to determine if soybeans influenced numbers of plant bugs in cotton.

In 2001 plant bugs averaged 3.03 per 100 sweeps in the cotton fields in the treated areas during June and July as compared to 3.75 per 100 sweeps in the cotton fields in the check areas. This was a reduction of 19.2% in the cotton in the treated areas. The reduction was statistically significant in the weeks beginning 11 June ($P = 0.10$), 2 July ($P = 0.003$), and 16 July ($P = 0.008$). Data collection from growers on insecticide use to control plant bugs in the 4 areas is presently incomplete. When this dataset is complete, a cost to benefit analyses will be conducted on the experiment by Mr. Fred Cooke, an Economist at the Delta Branch Experiment Station, Mississippi State University, Stoneville, MS.

Tarnished plant bug populations were found in Group IV soybeans at Tribbett and Arcola during May and June of 2001. Populations in Tribbett (a check area) reached as high as 7600 adults and nymphs per acre, while the peak number at Arcola (treated area) was 5800 per acre. The overall mean number (for 8 sample weeks) at Arcola was 1963 per acre per week, while it was 3249 per acre per week at Tribbett. By the end of June the plant bugs had completed one generation and dispersed from the soybeans into cotton and weed hosts.

Ryegrass was the most abundant wild host plant found in all 4 years in the experimental areas treated with the broad leaf weed killer Trimec. Because of the possible importance of this plant species as a host for plant bugs (when it blooms) and a reservoir for beneficial arthropods, ryegrass was sampled in 2001. Sampling began in the last week of April (the ryegrass was beginning to bloom at this time) and continued each week during May. Samples were taken at Tribbett and Arcola from 16 locations in each area. The sample locations were good stands of ryegrass found in marginal areas, and the samples were taken from the same locations each week. Each sample was 25 sweeps with a standard sweep net, and the sweep net contents were emptied into a plastic bag after each sample. The sample bags were taken back to the laboratory where the arthropods captured in each sample were identified. The data from this study are presently unanalyzed. A similar study is also being conducted by Don Sudbrink, Delta Branch Experiment Station, Mississippi State University, Stoneville, MS, using plots planted to ryegrass and/or broad leaf host plants.

Data collected on wild host plant density and plant bug density on them prior to and after the herbicide treatment are presently unanalyzed. Data on the effect of soybeans on plant bug numbers in cotton bordering the soybean fields are also unanalyzed.

Single pair matings of field-collected *Helicoverpa zea* males and laboratory stock females were carried through to the F_2 generation to establish pedigrees. Amplified Fragment Length Polymorphism (AFLP) generated markers were used to identify linkage groups and ordered chromosomes within family lineage. We are using this map to identify loci associated with Cry1Ac tolerance. APN1 has been closed from *H. zea,* and its role in Cry1Ac tolerance is being examined.

The genetic architecture of resistance plays an important role in determining how and when an insect population evolves tolerance to an insecticide. The bollworm, *Helicoverpa zea* (Boddie), is more intrinsically tolerant of Cry1Ac in *Bt* cotton than another major pest of cotton, tobacco budworm, *Heliothis virescens* F. We created F_2 families from full-sib matings using males collected from the field. Survivorship and growth on Cry1Ac diet was recorded to estimate the heritability of tolerance to Cry1Ac in *H. zea*. Differences among families were observed.

Genetic correlations were estimated for the performance of bollworm families on *Bt* proteins. F_2 families resulting from field populations of bollworm and tobacco budworm were monitored for their tolerance to the *Bt* toxin Cry1Ac. Families varied in their survivorship on Cry1Ac.

Unacceptably low hatch of eggs from matings of untreated TPB was a major problem in our first year of research. This year, hatch has been tripled from a former average to a more acceptable rate of 50%. Removing eggs from the gel into which they were oviposited and placing them on moistened filter paper resulted in the higher hatch. Better methods for producing higher hatch are being examined.

Irradiating TPB with 7 to 13 krad continues to give variable results. The large increases in hatch of eggs from untreated insects have been followed by similar increases in hatch from matings between irradiated males and untreated females. Hatch from matings between untreated females and males subjected to 0 to 13 krad cannot be separated. Hatch of eggs from irradiated females and untreated males is consistently at 0% or slightly above.

Matings between F_1 male progeny of TPB treated with 7-10 krad has produced erratic egg hatch. Hatch as low as 0.3% and as high as 22% has occurred in eggs from untreated females mated with male progeny of male parents treated with 10 krad. Hatch of eggs of female F_1 parents and normal males was as high as 44% when parents were treated with 7 krad and as low as 0% when parents were treated with 10 krad.

Unlike the radiation-induced increased in mortality seen in boll weevils and other insects, we have observed no increase in mortality of TPB treated with doses of irradiation as high as 13 krad. If mortality is high in irradiated TPB, it tends to be high in the controls as well; the reverse is also true. $LD_{50's}$ of 7 days to greater than 30 days between replications are not unusual. We hope to work with an insect pathologist to determine if pathogens are the cause of the swings in mortality.

In cooperation with researchers at the University of Arkansas (N. P. Tugwell) and Arkansas State University (T. G. Teague), we continue to examine the effect of TPB feeding on plant maturity and yield. Preliminary results indicate that later instar nymphs cause more damage and that delayed maturity may or may not be compensated for depending upon the type of plant stress and when that stress occurs.

A field study to evaluate parasitism of *Lygus lineolaris* eggs by the parasitoid *Anaphes iole* was completed. Parasitism rates on *L. lineolaris* host plant species indicate that plant species in which host eggs were laid had considerable impact on parasitism rates, which ranged from ca. 10 to 70%. Parasitism rates in spring hosts, such as henbit, cutleaf geranium, and curly dock, were highest (60 to 70%). Parasitism in cotton and alfalfa was ca. 55 and 45%, respectively. Parasitism rates in two common late summer hosts, giant ragweed and marestail, are ca. 50% and 35% respectively. 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. These results suggest that *L. lineolaris* eggs are vulnerable to parasitism by *A. iole* regardless of plant host. However, it also appears that host plant species does influence parasitism rates. Relatively high parasitism rates in spring hosts suggest that inoculative releases of *A. iole* in the spring may suppress *L. lineolaris* densities prior to dispersal to cotton. 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 *Erigeron annuus* and *E. philadelphicus* indicated that glandular trichomes interfered with oviposition by the wasp.

A study begun in 1999 of the population dynamics of *L. lineolaris* and its natural enemies was continued in 2001. Three insecticide-free alfalfa, *Medicago sativa,* fields were monitored in Mississippi from April through October. Densities of *L. lineolaris*, beneficial insects, and plant development were assessed weekly by sweep net sampling. Results indicate that *L. lineolaris* populations peak several times from May through September, and that these peaks are related to cutting hay and drought. The first peak generally occurs before the second cutting in late May-early June. At that time, cotton in the vicinity may be subjected to an infestation of adult bugs dispersing from the cut alfalfa. Generalist predators were common and abundant throughout the growing season. However, parasitoids host-specific to *L. lineolaris* were rarely collected.

Investigations on the importance of adult food to *A. iole* wasps were continued. Objectives are to identify food sources that enhance parasitism of *L. lineolaris* by *A. iole* following inoculative releases. The gustatory response of food-deprived *A. iole* wasps to solutions of 14 nectar and honeydew sugars and a commercial beneficial insect food source was determined. Several carbohydrates showed promise and were subsequently tested in longevity trials. Longevity of *A. iole* was correlated to feeding response. Compared to other insects, *A. iole* accepts a relatively broad range of sugars, many of them at concentrations as low as 1/256 M, or even 1/512 M. This ability to accept a wide array of carbohydrates, coupled with sensitivity to low concentrations may provide a way to select a food source suitable to the parasitoid but not to *L. lineolaris.*

Foreign exploration continued in South America (Argentina and Paraguay) and Eurasia for natural enemies of *L. lineolaris, Helicoverpa zea, Heliothis virescens,* and *Spodoptera* spp. Population dynamics, geographic distribution, and host associations of a previously undescribed braconid wasp, *Leiophron argentinensis* Shaw, have been studied for two years. This wasp occurs throughout much of northern Argentina and southern Paraguay where it parasitizes mirid nymphs on many host plants. *Lieophron 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 and belong to the genus *Erythmelus,* while those collected in South America have unidentified hosts.

Field studies of *A. iole* flight dispersal were continued. Objectives were to assess the impact of environmental and physiological factors on wasp dispersal, and determine if the nutritional state of the wasps affects dispersal. Histological stains were used to label wasps treated with different feeding regimes, thus allowing detection of differences in dispersal patterns. Environmental conditions were monitored for correlation to dispersal. Preliminary data suggest that use of pre-release feeding regimes has potential for manipulation of post-release dispersal of *A. iole*.

A survey begun in 1999 of nymphal parasitoids of *L. lineolaris* was continued in 2001. More than 4000 nymphs were collected in the Midsouth from March through October in alfalfa, marestail, crimson clover, and redroot pigweed. Nymphal parasitoids were infrequently collected. Nymphal parasitoids appeared to be less abundant in 2000 and 2001 than in 1999.

Most insects develop pyrethroid resistance primarily through elevated gene expression of cytochrome P450 oxidases to detoxify insecticides, and through gene modification of sodium channel to become insensitive to pyrethroids. Full sequences of cytochrome CYP6 monooxygenase cDNAs have been verified. A cDNA, cloned from both pyrethroid-susceptible and –resistant strains of *L. lineolaris*, contained a 1548-nucleotide open reading frame encoding a 516 amino acid residue protein, which was highly similar (up to 42% amino acid sequence identity) to several insect CYP6 P450 monooxygenases responsible for reduced sensitivity to pyrethroid insecticides. A total of 48 nucleotide substitutions were revealed between cDNAs of susceptible and resistant strains, 13 of which were observed on the cytochrome P450 protein coding region resulting in 12 silent substitutions and only one amino acid change from SER^{487} in susceptible strain to Ala^{487} in the resistant strain. The amino acid substitution was confirmed by polymerase chain reaction amplification of the specific allele of both reverse transcription cDNA and genomic DNA prepared from individual insects, and was detected from approximately 35% of resistant individuals showing only as a heterozygous genotype. The untreated resistant strain contained 2.1-fold higher P450 monooxygenase mRNA per microgram total RNA than the untreated susceptible strain. Topical treatment with 10 ng permethrin elevated P450 monooxygenase mRNA levels by 2.2-fold for the susceptible strain and 1.6-fold for the resistant strain. Treatment with 10 µg piperonyl butoxide suppressed P450 monooxygenase mRNA levels by 33.3% for the susceptible strain and 35.53% for the resistant strain. Cytochrome P450 monooxygenase mRNA was expressed in tissues of the gut, head and thorax, and abdomen. No significant expression level was detected from the salivary gland complex.

Monooxygenase subfamily CYP4 is another metabolic enzyme responsible for pyrethroid resistance development in insects. Partial CYP4 P450 cDNA was closed from pyrethroid susceptible strain of the tarnished plant bug. Full cDNA sequences of sodium channel have been amplified from both resistant and susceptible stains of *Lygus lineolaris.* Partial esterase cDNA was cloned and sequenced from *Lygus lineolaris.*

Avitin is a glycoprotein found in chicken egg white. Avitin sequesters the vitamin biotin, causes biotin deficiency, and has great potential to be used as a biopesticide against cotton pests. Preliminary lab bioassays indicated that 100-ppm avitin treatment caused up to 100% larval mortality for bollworm, fall armyworm, and beet armyworm. Avitin treatment also caused great larval body weight reduction.

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 an understanding of feeding biochemistry and physiology, and will 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.*

Polymerase chain reaction (PCR) technique was used to develop a specific molecular marker for detection of immature stages of egg parasitoid, *Anaphes iole*, developing within its host, *Lygus lineolaris.* Ribosomal DNA sequences for the internal transcribed spacer 2 (ITS2) were cloned and sequenced from adult *A. iole* and *L. lineolaris*. PCR amplification of genomic DNA using primers designed on the basis of these rDNA sequences, followed by agarose gel electrophoresis, successfully detected eggs and larvae of the parasitoid within *L. lineolaris* eggs. This molecular method is highly specific and sensitive. A 661 bp wasp DNA fragment was consistently amplified from pure DNA extracted from a single wasp, from a DNA mixture prepared from a wasp, and an *L. lineolaris* egg, and from a DNA mixture prepared from a wasp, an *L. lineolaris* egg, and alfalfa tissue. The presence of plant tissue did not hinder detection of *A. iole* within host eggs. With this PCR technique, as low as 5×10^{-6} wasp DNA equivalent (1.2 ng DNA) could be easily detected. The PCR technique provided more accurate and rapid detection of parasitism rates than observed by rearing parasitized host eggs in artificial oviposition packets. Polymerase chain reaction technology shows promise for early and accurate detection and identification of single and multiple species of egg parasitoids in agricultural and natural systems.

Peristenus stygicus is a nymphal parasitoid of *Lygus* spp. Ribosomal ITS2 DNA fragments have been cloned and sequenced from this parasitoid and its host *Lygus hesperus*. Primers for specific detection of the parasitoid were designed based on ITS2 sequence, and PCR conditions were optimized. **(Southern Insect Management Research Unit, USDA-ARS, Stoneville, MS)**

Missouri

Both experimental and registered cotton insecticides were evaluated in four field trials. Test results from an at-planting thrips trial and a plant bug/fleahopper trial are reported here.

An in-furrow thrips trial was conducted at Portageville, and the predominant thrips species present were eastern flower thrips, *Frankliniella tritici* (Fitch) and tobacco thrips, *Frankliniella fusca* (Hinds). Only at 24 days after planting did plots treated with Gaucho (seed treatment) and Temik (0.525 and 0.75 lb AI/acre) have lower thrips infestations than in the other insecticide-treated and untreated plots. The top three treatments with respect to yield (lb seed cotton/acre) were: Temik (0.6 lb AI/acre), Adage, and Temik (0.75 lb AI/acre).

Pretreatment counts indicated low, sporadic plant bug [predominantly tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois)] and beneficial (ladybird beetles and minute pirate bugs were most common) populations were present in a Portageville trial. At 3 and 7 DAT, no differences in total plant bug infestations [adults and nymphs of the cloudy plant bug, *Neurocolpus leucopterus* (Say); the cotton fleahopper, *Pseudatomoscelis seriatus* (Reuter); and the tarnished plant bug] were observed in the insecticide-treated versus untreated plots.

At 3 DAT, the top three treatments with the highest beneficial populations were: Assail (0.05 and 0.1 lb AI/acre) and Steward (0.078 lb AI/acre). At 7 DAT, Assail (0.05 lb AI/acre), Calypso (0.047 and 0.072 lb AI/acre), and Steward (0.104 lb AI/acre) had higher beneficial populations than in the untreated plots. The top three treatments with respect to yield (lbs. seed cotton/acre) were: Calypso (0.047 lb AI/acre)+Steward (0.09 lb AI/acre), Steward (0.09 lb AI/acre), and Steward (0.11 lb AI/acre).

A total of 600 cotton bollworm male moths were collected in pheromone-baited cone traps and tested for susceptibility to cypermethrin and spinosad. These vial tests were held in conjunction with the Insecticide Resistance Action Committee's *Helicoverpa zea* monitoring program. Average survival of moths at the 10µg cypermethrin dose was 8.0%, and 54.0% for the 10µg spinosad dose. Survival in the control vials was greater than 95%.

A state, Cotton Incorporated-funded, COTMAN project was initiated 2001 to look at different insecticide termination dates for late-season pest infestations in southeast Missouri. Yield data among the different termination dates was inconclusive at both Portageville locations because of low insect pressure in the field plots. No significant yield differences were observed among the different dates at either location. **(University of Missouri, Agricultural Experiment Station, Delta Research Center, Portageville)**

New Mexico

Field tests were conducted for a third year to evaluate microencapsulated formulations of malathion for use in boll weevil eradication programs. Results to date indicate that microencapsulated formulations may allow eradication programs to reduce the number of applications by extending residual activity. Those results are reported by Foster et al. elsewhere in the Proceedings.

A study to examine management effects on crop microclimate and insect populations was continued for a third year. A yield-partitioning test was completed in Quay County. A study was also initiated to evaluate the influence of management of alfalfa on predation of bollworm eggs in cotton.

A study also was conducted to evaluate the use of heat to defoliate cotton. The impact of this defoliation on aphid populations was also determined. Results of that study by Funk et al. are reported elsewhere in the Proceedings. **(Cooperative Extension Service and Department of Entomology, Plant Pathology and Weed Science, New Mexico State University, Las Cruces, NM)**

North Carolina
Several insecticide-screening tests were carried out in 2001. 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 dry conditions at this north central NC location. Under these conditions, uptake of Temik 15G at the 5 lb rate was not optimum, and supplemental applications of several foliar materials increased thrips control, lowered stand loss, and increased plant height. Gaucho seed treatment without a supplemental foliar spray again showed approximately the same level of immature thrips as the untreated check after about 3 weeks. Under typical NC thrips populations, seed treatments have not been stand-alone materials. 2) Two early season budworm tests again showed no yield benefit to insecticides applied before bloom, and even a one-time hand removal of 100% terminals and/or squares did not result in a negative yield response. 3) In a 14-treatment bollworm insecticide test, Karate Z at the 0.025 lb AI/acre industry rate sustained somewhat greater boll damage and lower yields than the other pyrethroids. In a 13-treatment aphid test, Assail 70 WP, Calypso 480 SC, Furadan 4 LV, and Centric 40 WG, at standard rates all provided better control of cotton aphids than the present producer standard Provado 1.6 EC.

In a large-scale, late-season insect (bollworms, European corn borers, fall armyworms and stink bugs) boll damage comparison of *Bt* (Bollgard) vs. conventional (pyrethroid-protected) producer cotton fields, 66 Bollgard fields were compared with 66 conventionally treated paired fields. These paired fields were often 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 6 years from 1996 through 2001 (996 total fields). In 2001, the producer-managed Bollgard fields sustained approximately 20% as much bollworm damage to bolls (despite 2.3 late season insecticide applications, compared with 0.99 for the Bollgard fields). However, stink bug damage to bolls in the Bollgard cotton fields was 2-fold greater compared with the conventional cotton fields (4.3 vs. 1.87%). Overall boll damage, which also included European corn borers and fall armyworms, was lower in the Bollgard cotton fields, 5.47 to 7.97%, in 2001.

An annual survey of North Carolina's licensed independent crop consultants working on cotton was continued in 2001 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 23% of the Bollgard cotton was not treated in 2001, while 63%, 12% and 2% of the remainder of the Bollgard acreage received 1, 2 and 3 applications, respectively, with stink bugs and plant bugs becoming an increasingly (in 2000 and in 2001) greater factor in consultants' and producers' Bollgard treatment decisions.

In replicated small-plot tests, Bollgard II® continues to show essentially complete protection from bollworm and European corn borer damage to either squares or bolls.

Adult vial testing for bollworm tolerance to pyrethroids at selected locations showed almost no survival of corn earworm adults at both the 5 and 10 microgram rates in 2001, down considerably from higher 2000 survival levels.

Studies of the effect of conservation tillage on thrips, bollworms and stink bug damage were continued in 2001. Overall thrips levels continue to be significantly lower in various conservation tillage methods compared with conventional tillage. Although not observed in 2001, probably due to light bollworm pressure in the past few years, boll damage by bollworms has been lower in both strip till and no till where the red imported fire ant (*Solenopsis invicta)* has become established. Stink bug damage to bolls appears to be unaffected by tillage method. **(Cotton Extension IPM Project, Department of Entomology, NCSU. Raleigh, NC)**

Oklahoma
Several *Bt* cotton trials were conducted in 2001 to further evaluate the value of this technology under Oklahoma conditions. Prior to the 2001 season, *Bt* cotton provided sufficient bollworm control and increased yields to compensate for rental fees in all entries under irrigation. However, this year 55% of the *Bt* picker variety entries and 50% of the *Bt* stripper variety entries failed to outproduce conventional variety parents, resulting in a monetary loss. Drought limited dryland cotton production, reducing yields dramatically. For the second straight year *Bt* stripper varietal yields failed to compensate for rental fees, increasing the monetary loss compared to conventional varieties.

This was the sixth year that Heliothine infestations failed to reach levels in economic threshold trials to activate insecticide applications. Heliothine pressure remained below 5 larvae (> 3/8 inch long) per 100 terminals. Insecticide protection was 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 long.

Research continued in 2001 to determine the influence of planting date on cotton yield under dryland conditions. Previous research during years with high boll weevil survival indicates planting date is critical, regardless of management scheme, to raise profitable cotton. Yield results favored June-planted cotton. However yields in both plantings were not profitable due to the prolonged drought.

Node Above White Flower (NAWF4) is a reliable method to determine the last cohort of bolls that will contribute significantly to yield and accurate termination of scouting activities. A three-year study began this summer to see if the absence of late-season boll weevil infestations enhanced the value of the top crop. Preliminary results indicated that there was no change in the value of the last cohort of bolls to contribute to yield. **(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 2001, with some individuals surviving cypermethrin at both 5 and 10 µg levels. The numbers of moths that were collected and utilized in vial tests were much higher in the Savannah Valley area than in the Pee Dee area. There was no evidence of increased pyrethroid resistance in either bollworm or budworm vial tests.

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 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; control was very good. 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 were conducted comparing conventional, Bollgard and Bollgard II® cotton varieties. Both laboratory and field studies 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 Endisto Research and Education Center, Blackville, SC)**

Tennessee

Thiamethoxam was evaluated at three rates for control of early season thrips on seedling cotton. No significant adult and nymphal density differences were noted among treated plots up to 32 days after planting, but all were different from the untreated. Significantly more cotton was produced in plots treated with the 200 and 400 gram per 100 kg seed rate compared to the untreated and 300-gram rates. In another test comparing thiamethoxam seed treatment with three rates of aldicarb and two formulations of imidacloprid seed treatment, stand-count, node of first position square and plant height did not differ among treatments or the untreated check. Leaf area was significantly greater and thrips damage significantly reduced in treated plots. Bloom counts did not differ among treatments or the untreated on any of three dates. Adult thrips numbers were generally reduced in thiamethoxam- and aldicarb-treated plots compared to untreated and imidacloprid-treated plots. Lint yields did not differ among treatments. In a third experiment, a dicrotophos-foliar spray was compared to the seed treatments and in-furrow granules for efficacy and plant effects. Results in this test were similar. A fourth experiment compared comparable treatments with similar results.

Plant bug control was evaluated in small plot and caged studies. Two rows of broad leaf mustard were interplanted between eight rows of cotton to attract and produce plant bugs. Dicrotophos produced the highest level of mortality in the sleeve cage studies and all treatments but the lowest rate of Assail were significantly different from the untreated. There were no sweep net, square retention or yield differences among treatments or the untreated plot. In a second experiment, several of the new insecticides were compared to standards for efficacy. Plant bug mortalities did not differ among treatments and the untreated in this test.

Bt cotton varieties were compared for efficacy and yield at three locations. Bollgard II® was evaluated at the Ames Plantation in sprayed and unsprayed situations. No sprays were required to suppress caterpillars. The Bollgard and conventional varieties produced significantly more cotton than the Bollgard II® line. Also at the Ames Plantation, nine *Bt* varieties were compared to four conventional varieties for efficacy and yield potential. There were no significant yield differences and yields ranged from 721 to 921 lbs per acre. Bollworm pressure was low and no sprays were required for the conventional varieties. At the West Tennessee Experiment Station, the same *Bt* and conventional varieties were compared. All of the *Bt* varieties produced over 1000 lbs per acre and were not different from each other. SG 747 and FM 958 (conventional varieties) were comparable to the *Bt* varieties. At the Milan Experiment Station, many of the same varieties were compared, but there was little bollworm pressure and yields did not differ among varieties.

Insecticide termination studies using NAWF=5 and accumulated heat units were conducted at two locations. Bollworm pressure was light, no insecticides were needed, and required heat units could not be validated. Stink bug threshold studies were conducted in small plots, but were terminated due to boll weevil populations and required sprays. **(University of Tennessee, West Tennessee Experiment Station, Jackson, TN)**

Texas

Boll weevils from Lubbock (656 weevils) and Burleson (1097 weevils) Counties were tested for susceptibility to malathion. Collections from Lubbock included 325 adults that emerged from field-collected bolls, and 331 weevils 2-3 days of age that emerged from pupae from field-collected bolls. Collections were at the USDA/ARS Research Farm and from the Texas Tech Campus Research Farm. Collections from Burleson included weevils 2-3 days of age that emerged from squares collected at the Texas A&M Farm, USDA field #14 (Farm Road 50), and weevils collected from traps located at the Texas A&M Farm (Farm Road 60) on the Brazos River Bottom. Weevils were fed boll weevil diet and/or organic apple until tested. Mortality was recorded after weevil exposure in malathion-coated vials for 48 h at 27°C. Control vials were with acetone and mortality of the controls was used for corrections. Probit analysis with the Polo PC program indicated that there was no detectable malathion resistance in these two populations. Lethal concentrations 50 and 95 were comparable to those obtained in 2000.

Diet incorporation assays with Cry1Ac toxin require large numbers of Heliothine neonates. In order to obtain enough eggs from individuals from the field for testing of neonates, attempts were made to capture females of tobacco budworm or bollworm from light traps, but these were unsuccessful. Therefore, larval collections were made.

Larvae of *H. virescens* (approximately 200) feeding on velvet leaf (*Abutilon theophrasti*) were collected in Waller Co. on June 20 and July 6 at the Rohm & Haas Co. Farm. Larvae (about 200) were also collected in Burleson Co., at the Texas A&M Farm, USDA field # 14 during July and August. Both collection sites were on non-*Bt* cotton fields. Some larvae were collected from cotton plants and others from velvet leaf. Larvae were reared to obtain adults, and neonates obtained from them were tested in a diet incorporation assay. Those obtained from Waller Co. (943 neonates tested) were more susceptible to the MVPII formulation than both larvae from Burleson Co. (1132 neonates tested) and the laboratory control colony. Larvae from Burleson Co. were equally susceptible to the toxin as those from the laboratory susceptible colony. The results indicate that at least for the two locations tested, there is no evidence of resistance to the Cry1Ac *Bt* toxin in the field populations. Attempts to collect significant number of larvae of *Helicoverpa zea* in the field for similar bioassays were unsuccessful. **(Texas A&M University, College Station, TX)**

Cotton aphid populations were hindered by the fourth consecutive summer of drought. Aphid numbers built slowly during the season and reached peak numbers of 48 per leaf on October 23. There has been a general trend of aphid populations peaking later in the year for the past 14 years. These late peaks in September and October contribute to the potential development of sticky lint. Thresholds for aphids during boll opening range from 11 to 50 per leaf. Avoiding late irrigations and use of pyrethroids during boll opening reduced the threat of developing sticky lint.

Bandedwinged whitefly numbers have been higher in 2000 and 2001 than in previous years. The whiteflies in the Texas Rolling Plains have spotted wings rather than the usual banding pattern. These whiteflies are capable of causing some sticky lint problems, although rains during the fall months washed whitefly and aphid honeydew from the lint. Populations began a noticeable increase in July and averaged 2.6 per leaf on August 6, but numbers declined thereafter.

Bollworms, tobacco budworms, and beet armyworms were not a problem in research plots in 2001. Cotton fleahopper numbers were higher than usual, and the development of higher population levels may be a result of abundant spring hosts as evening primrose and horsemint. **(Texas Agricultural Experiment Station, Vernon, TX)**

Mathematical equations have been developed to estimate cotton aphid fecundity and mortality as functions of aphid age and temperature. Based on 6-year field data from the Texas Rolling Plains, equations have also been developed to establish relationship between aphid population levels and plant parameters, including leaf moisture and leaf nitrogen; plant parameters have been modeled as functions of plant age (degree-days > 12^{o} C from planting). With an attempt to include the effect of pyrethroid insecticide on aphid population dynamics model, studies are being conducted to quantify the rate of population growth as affected by cyhalothrin (Karate). The rate of population increase, measured as the net reproductive rate, was significantly increased (7% in 2000 and 22% in 2001) when aphids were reared on Karate-treated leaf discs compared to the aphids reared on untreated leaf discs. The effect of solar radiation and predation effect on aphid mortality will be studied in 2002. These functions will then be incorporated into a distributed-delay model to forecast aphid population dynamics. **(Texas Agricultural Experiment Station, Vernon, Lubbock, and Beaumont, TX)**

The cotton entomology program at the Texas Agricultural Experiment Station (TAES), Lubbock, is participating in a statewide cooperative project involving USDA-ARS and TAES to examine the potential for boll weevil survival through cotton harvesting and ginning processes. This includes survivability in harvested fields and moduled seed cotton, and through ginning processes from lint cleaning to bale pressing. The potential for post-harvest weevil survival in the field under different tillage regimes will also be examined. Objectives include: establishment of ginning equipment specifications and operating procedures that insure that no weevils survive lint cleaning, drying, ginning and baling; determining if weevils on the surface of modules in the field are transported to the gin; development of a multivariate statistical model that will predict weevil survival under module tamps under varying weather conditions; and quantifying post-harvest weevil survival in conventional tillage versus minimum-tillage systems and in green bolls on the soil surface.

In a cooperative project with the Texas Agricultural Extension Service, multi-county surveys of boll weevil overwintering habitat continue. Tested sites are located in both active and pre-initiation boll weevil eradication zones of the Texas High Plains region. Following a severe winter (2000-2001), overwintered weevil survival was significantly lower than previous years in which the winters have been very mild. Multi-year comparisons of overwintered weevil populations in active and inactive eradication zones clearly reflect the effectiveness of eradication efforts.

Late season arthropod pest and predator sampling was conducted in mid-May and mid-June planted cotton at TAES, Lubbock using on-plant sampling, beat buckets and sticky traps. Mid-May planted cotton developed larger populations of cotton aphids in October than mid-June planted cotton, with numbers approaching ten per leaf, near levels that could cause sticky cotton. Lady beetle numbers were low throughout the sampling period (?5000/acre), while spiders were found in much larger numbers (up to 30,000/acre). **(Texas Agricultural Experiment Station, Lubbock, TX)**

Wild and cultivated hosts of *Lygus* species were surveyed in the northern Rolling Plains and High Plains areas. Additionally, species determinations were made with the High Plains samples. Both *Lygus hesperus* and *L. elisus* were found, but *L. lineolaris* was not collected. A graduate student initiated studies to determine if there were any differences in feeding damage between *L. elisus* and *L. hesperus*.

We completed the second year of an economic evaluation of Bollgard cotton as a management tool for caterpillar control in the High Plains. Except where prolonged, heavy beet armyworm infestations persisted in 2000, Bollgard variety yield were no different than their Round-Up Ready® counterparts. **(Texas Tech University, Lubbock, TX)**

Research conducted included the following studies: 1) Silverleaf Whitefly efficacy: IGR's (Knack and Applaud) showed good efficacy against SLWF. First data for applaud with good pest pressure in Texas against SLWF. 2) Cotton Aphid efficacy: All nicotinoid insecticides performed similarly against cotton aphids with only minor differences. 3) Spider mite efficacy: Proclaim showed efficacy against spider mites. 4) Bollgard II® variety trial: Lab data showed Bollgard II® controlled beet armyworm very well. 5) Messenger trial: No significant effects of treatment. 6) Herbicidal cotton stalk destruction for management of boll weevils: Trials to determine best timing of herbicide applications to control cotton stalk regrowth and volunteer seedlings to aide in manage boll weevil survival and reproduction in the fall and winter months in the LRGV. 2,4-D applied immediately following stalk shredding (14 hours after shredding) at 1.0 lb formulation per acre provided 100 percent stalk death with no additional squares produced compared to later application timings and/or leaving stalks standing instead of shredding. 7) Lepidopterous insecticide test on "beneficials": Steward and Denim had large impact on many beneficial species. Denim showed good suppression on cotton fleahoppers. 8) Aphid/cotton fleahopper insecticide test on "beneficials": Data collected in this trial showed worst offender to be Baythroid-Provado combination. **(Texas Cooperative Extension Service, Weslaco, TX)**

Results from a study of cotton fleahopper/Lygus bug beat bucket sampling indicated that regardless of pest insect or whether both species were pooled, the beat bucket sampling method required fewer samples and less time/sample to make a pest management decision. Accounting for both time and required sample numbers, the beat bucket sample plan reduced sampling effort in excess of 70% relative to the visual sample plan. Use of the beat bucket sample method would further reduce sampling effort, because it can also be used to estimate natural enemy population densities more efficiently than by visual examination. Based on these results adoption of the beat bucket sampling method could dramatically increase the efficiency of current IPM scouting programs in cotton.

Results from a binomial sampling study were used to develop a fixed precision plan for estimating boll damage by stink bugs. Results from this study indicate that the average time needed to sample 10 bolls across all sample dates was 2 min 32sec. The time required to sample 34 bolls (the required sample number to estimate an economic threshold of 10%) would be 8min 52sec. This sampling cost could be offset if further research indicates that this sampling method could replace the drop cloth method currently used to estimate stink bug population densities. However, until validation of the sampling plan has been performed, stink bugs and cotton bolls should be sampled before a management decision is made. This research will be continued in order to validate the usefulness of this binomial sampling plan in an integrated approach to pest management in cotton. **(Texas Cooperative Extension, Ft. Stockton, TX)**

The impact of conservation tillage on insects and plant growth was evaluated in cooperation with the ARS Integrated Farming Systems Laboratory. The role of fire ants as beneficial predators and their relationship to increases in cotton aphid were evaluated. Research on boll weevil survival in green bolls and cotton modules was conducted in Ellis County in cooperation with ARS at Weslaco and TAES at Lubbock. Several methods for sampling fleahoppers were evaluated. **(Texas Cooperative Extension Service, Dallas, Fort Stockton, TX)**

Research continues on determining movement of natural enemies and pests between crops and non-crop areas. Trials were established in cages to manipulate aphid and lady beetle populations to determine why movement occurs between grain sorghum and cotton. Preliminary work is also starting in looking at other refuge areas (pasture CRP, roadside, etc.) contribution to natural enemies. Insecticide trials included Calypso for cotton aphid control and Assail, Centric, Calypso, Steward and Cruiser for cotton fleahopper control. **(Texas Cooperative Extension Service, San Angelo, TX)**

Cruiser and Gaucho seed treatments and Temik granular insecticides resulted in a 68 lb lint/acre average yield increase across 5 field studies along the Texas Gulf Coast. These results exceed the long-term average increase for these type treatments by 8 lb lint/acre. In a foliar study, Karate, Asana, Baythroid, Capture, Decis, Fury, Bidrin, Orthene, and Leverage all provided control of thrips through 7 DAT, but Denim did not provide control significantly different from the untreated control (UTC). In a foliar study Furadan, Bidrin, Calypso, Assail, and Centric provided effective aphid control by 3 DAT but by 6-DAT aphids had disappeared from all plots. Asana, Orthene, and Vydate provided significantly better control of fleahoppers when compared with the UTC. Steward did not provide fleahopper control different from the UTC.

Bidrin, Vydate and Steward applied as foliar treatments resulted in a numerical (not statistical) reduction in brown stink bug (BSB) numbers. No reduction in BSB occurred where Asana was used. In a cage study, BSB significantly reduced seed cotton weights in bolls up to 21 days of age, which were the oldest bolls evaluated. In a 3-year study on the Upper Gulf Coast, DPL 20B provided a $7.25 per acre more return than did DPL 20. In a heliothine study Asana, Leverage, Tracer, and Steward significantly reduced damaged squares 4 DAT-1, and these insecticides along with Denim provided significantly better boll protection compared with the UTC. Aphids were noticeably reduced in Leverage and Denim plots, and mites were absent from Denim plots. A south Texas study continued to evaluate stink bug puncture vulnerability of bolls in order to develop a function for. **(Texas Cooperative Extension Service, Corpus Christi, TX)**

The GRID boll weevil trapping project was continued into its 7th 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. Results from 2001 clearly demonstrated the impact of boll weevil eradication activities in those zones that have been active. We continued a 7 year survey of boll weevil overwintering sites in 21 counties in the High Plains were evaluated mainly broadleaf litter, consisting mostly of elm. Lower overall numbers were found providing evidence that the eradication effort was working. But there were also lower numbers in sites outside eradication zones indicating that a late season source of food was limited. Survival was greatly reduced, primarily due to the coldest winter in five years. Both of these studies supported field observations where boll weevil numbers were at the lowest in 8 years.

Validation of the COTMAN model continued in the High Plains area. This included evaluations of SQUAREMAN in IPM programs, BOLLMAN as a tool to determine when to terminate insecticide applications for bollworms and plant bugs, as well as when to terminate the crop. The latter study was conducted by a graduate student from West Texas A&M University at Canyon. A SQUAREMAN project was initiated looking at developing a compensation function for pre-blooming square loss in the High Plains area. Six square retention levels were evaluated in a factorial design under a normal and very late planting regimen. Target development curves, box mapping of yield by position, and economic analysis by boll position are being conducted. Preliminary analysis indicates that while some vertical compensation took place, most node replacement occurred out on the fruiting branches. It was also observed that boll retention manipulation may be a better way for a plant to compensate for early fruit loss. Final yields on the first planting date indicated that early square removal was less damaging than late removal and that all removal, treatments resulted in a significant yield increase over the treatment where no squares were removed.

Insecticide efficacy trials were conducted with new and existing insecticides against thrips and bandedwinged whiteflies. Both Temik and Adage (Cruiser) were efficacious while Gaucho and the Orthene seed treatment were not. Foliar sprays of Orthene based on TCE thresholds were effective while applications timed with the Roundup application window were too late. Whitefly control was poor with all treatments in the two tests conducted, especially against immatures. The best treatment was a pyrethroid-Orthene mixture. Centric, Thiodan and Capture were not effective. **(Texas Cooperative Extension Service, Lubbock, TX)**

Field studies were initiated in 2000 and continued through 2001 to characterize the season-dependent morphological/physiological status of trap-captured boll weevils in comparison to that of weevils infesting the standing cotton crop. Dissections of weevils revealed distinct seasonal physiological differences between the two sources of weevils, suggesting that weevils captured in traps did not necessarily originate from adjacent cotton fields. Presence of oocyte and egg remnants in overwintered weevils captured in traps prior to planting of cotton suggested that some weevils had overwintered with eggs. Dissections also suggested that weevils were capable of producing mature eggs on pre-fruiting cotton. Both of these observations are contrary to previous reports. Studies also revealed that weevils were capable of resorbing oocytes and eggs, a phenomenon previously undocumented in the boll weevil literature. Seasonal trends in sex ratios and reproductive/diapause status of trap- and field-collected weevils were observed and are being analyzed.

A field study was conducted to determine the effects of meteorological factors on the pattern of boll weevil emergence from winter habitat (leaf litter), and to compare the physiological condition of boll weevils that emerged from leaf litter and those captured in traps. Temperature, relative humidity, solar radiation, and precipitation were significantly greater, and barometric pressure was significantly less, on emergence dates than on dates with no emergence. Trapped boll weevils had significantly greater reproductive development than emerged boll weevils. This information on the patterns and mechanisms of emergence from overwintering will help to improve predictive models, risk assessments, and pest management strategies for boll weevils.

Sampling efficiency of the Keep-It-Simple Sampler was evaluated in field studies using mark-release-recovery techniques. Efficiencies were examined in cotton at pre-fruiting, pinhead/matchhead square, and third-grown square stages. About 21% of released weevils were recovered during the pinhead/matchhead square stage. Recovery from pre-fruiting and third-grown square stage plants was about 19% and 12%, respectively.

A study was conducted to estimate the extent and time-course of both mortality and escape by trap-captured weevils in traps containing "kill strips" from one of two sources (Plato Industries and Hercon Environmental). Both types of "kill-strip" provided similar levels of mortality at all durations of exposure (1 to 46 hours). By 46 hours, mortality levels in traps with "kill-strips" were > 90%, whereas traps without "kill-strips" had < 5% weevil mortality. Neither type of "kill-strip" significantly reduced the incidence of weevil escape. The mean percentage of weevils escaped from traps with or without "kill-strips" ranged from 5 to 8%.

Field evaluations were conducted during early-season in 2001 between suitable overwintering habitat and a pre-squaring cotton field to determine if relatively low concentrations of spinosad mixed with a feeding stimulant could be used to kill adult boll weevils. Yaupon shrubs in 15-gallon containers were placed in a line adjacent to the overwintering habitat in an equally spaced alternating pattern with Boll Weevil Eradication Foundation traps. Each shrub and trap was re-baited every two weeks with a single 10-mg laminated plastic Grandlure dispenser. Shrubs were sprayed with a mixture of sucrose and spinosad at a concentration of 300 ppm (weight active ingredient per volume). The results indicated that it was possible to kill adult weevils which responded to the Grandlure on the shrubs in numbers similar to those captured in the traps. These results suggest that it may be possible to kill adult boll weevils during early- and late-season when boll weevils are highly responsive to Grandlure by applying a mixture of a feeding stimulant and an insecticide in strips on vegetation in combination with Grandlure in dispensers or in a sprayable slow-release formulation.

Previous observations indicated that boll weevil oviposition is not always associated with sealed punctures, so a laboratory study was conducted to characterize types of punctures and evaluate their association with oviposition. Punctures were characterized as unsealed, wax sealed, frass sealed, or frass/wax sealed. About 2% of unsealed punctures contained eggs. The percentages of wax sealed, frass sealed, and frass/wax sealed punctures associated with eggs were 66, 59, and 70%, respectively. Also, we observed that the waxy nipple usually associated with an oviposition puncture did not appear until several hours after oviposition, and is likely a plant response.

A laboratory study was conducted to examine egg production by overwintered weevils fed vegetative stage cotton. Compared with baseline data, feeding on cotyledon and four-leaf stage cotton significantly increased the total egg complement (oocytes and mature eggs) and the proportion of females containing oocytes with yolk; however, there was no significant increase in numbers of mature eggs. Differences among the treatments in numbers of mature eggs may have been obscured by oviposition before dissection. Such oviposition was documented in a companion study examining longevity of overwintered weevils on pre-fruiting cotton. In this study, weevils were held under controlled conditions and supplied either water alone, cotyledon stage, or four-leaf stage cotton seedlings. Weevils survived an average of 6.7 days on water alone, 81.1 days on cotyledons, and 61.9 days on four-leaf stage plants. Longevities observed on pre-fruiting plants exceeded those previously reported.

Recent efforts to determine the influences of food types and sizes on the boll weevil dormancy response have concentrated on square versus boll diets, and on diets of squares of different sizes. We examined the influence of boll size on the dormancy response using procedures previously developed at this laboratory. The highest levels of dormancy were induced by bolls of 20-25 mm diameter, followed by bolls of 15-20 mm diameter. Differences among boll size classes in the proportions of weevils that became dormant were slightly greater for females than for males, but few weevils of either sex became dormant when fed the smallest boll size (10-15 mm diameter).

A series of laboratory studies examined the effects of diet switching on termination of reproduction (switching from squares to bolls) and subsequent host-free longevity, and the termination of dormancy (switching from bolls to squares). Switching females from squares to bolls resulted in a reduced egg complement (oocytes and mature eggs), increased the incidence of oosorption, and increased the proportion of weevils with hypertrophied fat bodies compared with females maintained on squares. Thus, switching from squares to bolls increased the incidence of morphological characters normally associated with diapause. Host-free survival of these weevils is currently being monitored. Switching females to squares after feeding on bolls for 14 d decreased the proportion of dormant females, but diet switching did not terminate the dormancy of males. When access to squares was delayed for 1 to 5 wk after the boll feeding period, the dormancy termination response of males increased with increasing age while the termination response by females was similar at all weevil ages. However, when weevils were allowed to fly on tethers after the boll feeding period and were switched to squares, a significant termination response was exhibited by both sexes.

Laboratory studies examining relationships between dormancy characters, temperature, and host-free longevity of boll weevils were completed. Longevity increased with an increase in the proportion of dormant weevils primarily because of higher early mortality in groups with low proportions of dormancy. This effect was more pronounced for females than for males. Longevity also increased as temperature was decreased from 85° to 65°F, then decreased as temperature was reduced to 55°F. Longevity at 55°F was similar to that at 75°F, and probably indicates that some chronic low-temperature injury occurs to overwintering weevils at temperatures <65°F.

Cold bath studies were conducted to assess the impact of feeding status and physiological condition on supercooling points of adult boll weevils. Weevils with food present in the midgut had a significantly higher supercooling point (12 ± 3°F) compared with weevils that had no food in the midgut (3 ± 4°F). Reproductive/diapause status, sex, or age of weevils did not have a significant effect on weevil supercooling.

Field studies were conducted to investigate the effectiveness of electrostatic aerial application of bifenthrin in controlling thrips. Electrostatic application increased material deposits by 23.8-206.1% over conventional application of bifenthrin. Although the electrostatic application significantly increased deposition, there was no significant increase in control of thrips on seedling cotton in the three studies conducted. The studies showed that thrips could be significantly controlled with bifenthrin.

Studies were conducted to investigate the influence of crop canopies, such as corn, cotton, and soybeans, on spray deposition and movement from an aerial application. Using a fluorescent dye as a tracer, spray deposits were measured at the top of the canopy, at the ground within the crop canopy, and in a grazed pasture. Significantly higher deposits were measured in the top of the canopy in corn, cotton, and soybeans than in the ground or pasture samples. There were no differences in ground and pasture samples beyond 25 m (82 ft) from the aircraft flightline. Higher deposits were measured at the top of the crop canopy than in the pasture samples out to 120 m (394 ft). Leaf area index (a measure of canopy density) and wind speed were not found to consistently influence spray deposition and movement. **(USDA-ARS-SPARC, Areawide Pest Management Research Unit, College Station, TX)**

Virginia

Nine field trials were conducted to evaluate a total of 76 insecticide treatments for control of thrips and impact on lint yield. Treatments included 11 insecticides applied at different rates and timings (Gaucho 480, Gaucho 600FS, Adage 5FS, Temik

15G, Orthene 97, Karate Z, Baythroid 2EC, Decis 1.5EC, Capture 2EC, Vydate C-LV, and Novaluron 0.83EC). Treatment timings included seed treatment, in-furrow at planting, or as foliar applications at either the late cotyledon-1st true leaf, or 2-3 true leaf stages. Lint weights were higher in all treatments compared with untreated controls and ranged from 72 to 531 lb/acre higher, depending on treatment. Seven field trials were conducted to evaluate a total of 46 treatments for control of the bollworm/budworm complex. Treatments included nine cultivars (DP 50BG, DP 50BGII, DP 50, ST 4793R, ST 4892BR, SG 125BR, SG 125RR, DP 451BR, and DP 425RR) and 15 insecticides (Steward 1.25EC, Asana XL, Tracer 4SC, S-1812 35WP, S-1812 4EC, Orthene 97, V-10101 2.25EC, Karate Z, Baythroid 2EC, Leverage 2.7, Fury 1.5, F 0570 0.8EC, Capture 2EC, Decis 1.5EC, and XR-225). Lint weight increases compared with untreated controls ranged from 30 to 184 lb/acre higher, depending on treatment. In one test, 0, 5, 15 or 20% of all 10-14 day old bolls were systematically removed, 14, 18 or 23 days after first flower. There appeared to be no reduction in lint yields, except in the 15 and 20% removal rates imposed on the latest removal date. **(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 2001 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 2001 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 2001.

State	Pesticide	Target Pest
Alabama	Steward	
	Thiamethoxam (Centric)	
Arizona	Applaud® (buprofezin)	Whiteflies
	Actara® (thiamethoxam)	Whiteflies
Arkansas	Centric	
	Intrepid	
	Steward	
California	Steward	
	Savey 50 DF	
	Leverage 2.5	
Florida		
Georgia	Centric	Aphids, plant bugs, whiteflies
Louisiana	Intrepid 80WP	
	Adage Seed Treatment	
	Centric 25WDG	
	Steward 1.25SC	
Mississippi	Adage Seed Treatment	Thrips
	Centric 25WDG	Aphids, plant bugs, whiteflies
	Intrepid 80WP	Loopers, armyworms
	Steward 1.25SC	Bollworms, budworms, loopers, armyworms
Missouri	None	
New Mexico	None	
North Carolina	Centric 25 WP, 40WP	Cotton aphid, Plant bug
	Cruiser 5FS	Thrips
Oklahoma	Intrepid 80WP	
	Centric	
	Steward	
	Denim	
	Furadan 4F (Section 18)	
South Carolina	Steward	Bollworm, budworm, armyworms, looper
	Intrepid	Armyworms, looper
Tennessee	Thiamethoxam (Cruiser = Adage)	Thrips
Texas	Steward	Beet armyworm
	Steward	Plant bug
	Steward	Bollworm
	Steward	Cotton fleahopper
	Steward	Cabbage looper
	Denim	Bollworm
	Denim	Beet armyworm
	Intrepid	Cabbage looper
	Intrepid	Beet armyworm
	Furadan 4F (Section 18)	Aphids
Virginia	Centric 25WP	Cotton aphid, plant bug
	Steward	Bollworm, plant bug

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

State	Pesticide	Target Pest
Alabama		
Addition	Centric at 0.05 lbs. AI./ac. rate.	Aphids, plant bugs, thrips and whiteflies
	Steward	Bollworm, budworm, beet armyworm, soybean looper
Deletion	Curacron	Plant bugs
Rate Changes	acephate (Orthene) to 0.25-0.5 lbs AI./acre.	Plant bugs
	methyl parathion to 0.25-0.5 lbs AI./acre.	
	Lorsban to 0.25-0.5 lbs AI./acre.	
	Bidrin to 0.2-0.33 lbs AI./acre.	
	Lannate to 0.25 lbs AI./acre.	
Arizona	None	
Arkansas		
Additions	Intrepid	Fall and beet armyworm
	Centric	Aphid, plant bug, fleahopper, whitefly
	Cruiser	Thrips
	Bidrin	Stink bug
	Methyl parathion	Stink bug
Deletions	Lorsban	Fall armyworm
California		
Steward	Beet armyworm	
Georgia		
Additions	Steward 1.25	Beet armyworm, bollworm, budworm, Fall armyworm
	Centric 25 WG	Aphids, plant bugs, whiteflies
	Orthene 97, 90	Stink bugs
	Vydate C-LV	Stink bugs
	Adage	Thrips
Deletions	None	
Louisiana		
Additions	Centric 25WDG	Aphids, tarnished plant bugs whiteflies
	Adage Seed Treatment	Thrips
Deletions		
Rate Changes		
Mississippi		
Additions	Statement on statewide involvement in boll weevil eradication	
	Indoxacarb (Steward)	Bollworm/budworm, loopers, armyworms
	Methoxyfenozide (Intrepid)	Loopers, armyworms
	Pyriproxyfen (Knack)	Silverleaf whiteflies
	Thiamethoxam (Adage)	Thrips-seed treatment
Deletions	All recommendations for grower applied boll weevil control	
	Amitraz (Ovasyn)	
	Endosulfan (Phaser, Thiodan)	
Missouri		
Additions	Centric 40WG	Aphids, plant bugs
	Cruiser 5F	thrips
Deletions	None	
New Mexico		

N. Carolina		
Additions	Orthene 97S 2 (ee) rate (0.375)	Thrips
	Orthene 75S, 97S, (0.5)	Stink bug
	Centric 25 WP, 40 WP (0.047)	Cotton aphid, Plant bug
	Cruiser 5FS (7.65 oz/cwt)	Thrips
	Steward 1.25SC 0.065-0.09	Soybean and cabbage looper
	(0.09-0.11)	Fall armyworm and beet armyworm
	(0.11)	Bollworm
Oklahoma	Intrepid	
S. Carolina		
Additions	None	
Tennessee		
Additions	thiamethoxam (Adage = Cruiser)	Thrips
	methoxyfenozide (Intrepid)	Fall and beet armyworm
	methoxyfenozide (Intrepid)	Looper control
Texas		
Additions	Intrepid	Cabbage looper
	Steward	Cabbage looper
	Steward	Cotton bollworm
	Steward	Tobacco budworm
	Steward	Cotton fleahopper
	Adage (Cruiser)	Thrips
Delterions	Pyrethroids	Tobacco budworm
Virginia		
Additions	Bidrin 8 at 4.0-8.0 oz/acre	Stink bug control
	Orthene 97 at 12.0 oz/acre	Cutworm
Rate Changes	Orthene 97 to 4.1-6.0 oz/acre	Thrips
	The recommended treatment threshold for plant bugs was edited to include the following statement: Post bloom - 10% internal damage to small bolls (up to 14 days old).	
Deletions	Orthene 75S	All recommendations

Table 3. Promising pesticides screened in 2001 for control of cotton arthropod pests.

State	Pesticide (lbs AI/A)	Target Pest(s)
Alabama		None
Arkansas		
	Adage seed treatment	Thrips
	Assail @ 0.05 lb AI/acre	Aphids, whiteflies
	XR-225 0.00974 lb AI/acre	Bollworm/budworm
	0570 0.016 lb AI/acre	Bollworm/budworm
	Centric, 3 oz pr/acre	Plant bug/stink bug
	Centric. 2 oz pr/acre	Plant bug
	Centric 0.05 lb AI/acre	Aphids, whiteflies
	Capture 0.05-0.06 lb AI/acre	Brown stink bugs
	Calypso 0.046 and 0.072 AI/acre	Plant bugs
Arizona		
California		
	Fujimite 5% EC @ 2pts	Spider mites
	Acramite 4L @ 1 – 1.5 pts	Spider mites
	Mibermectin (Koromite 1% EC) @ 12 – 20 oz/acre	Spider mites
	Acarisan 72 WDG @ 28.35 ga/acre	Spider mites
	Ecosmart DR-A-034 @1 qt/acre	Spider mites
	Actara 25 WG @ 3 oz/acre	Cotton aphids
	Calypso 4 SC @ 1.5 fl oz	Cotton aphids
	Assail 70WP @ 0.57-1.15 oz/acre	Cotton aphids
	Ecosmart DR-A-034 @ 1 qt/acre	Cotton aphids
	Novaluron 0.83EC @ 6-9 oz/acre	*Lygus* bugs
Georgia		
	Bollgard II	
	Denim	
	S-1812	
	Assail	
	Calypso	
Louisiana		
	Acetamiprid 70SC	Tarnished plant bugs, thrips, aphids,
	Bollgard II®	Various Lepidoptera larvae
	Denim 0.16EC	Bollworm, tobacco budworm, tarnished plant bugs
	Fulfill 50WP	Tarnished plant bugs, aphids
	S-1812 4EC	Bollworm, tobacco budworm, armyworms, soybean Looper
Mississippi		
	Adage seed treatment	Thrips
	Assail 0.05 lbs AI/acre	Aphids, plant bugs
	Calypso 0.047 lbs AI/acre	Aphids, plant bugs
	Centric 0.047 lbs AI/acre	Aphids, plant bugs
	Bollgard II® cotton	Caterpillar pests
	Novaluron	Plant bugs
	Fulfill 50WP	Aphids
	Denim	Caterpiller pests
Missouri		
	Adage 5F seed treatment	Thrips
	Assail 70WP @ 0.05, 0.1 lbs AI/acre	Plant bugs/cotton fleahoppers
	Calypso 4SC @ 0.047, 0.072 lbs AI/acre	Plant bugs/cotton fleahoppers
	Centric 40WG @ 0.0473, 0.0625 lbs AI/acre	Plant bugs/cotton fleahoppers
	Steward 1.25SC @ 0.078, 0.104 lbs AI/acre	Plant bugs/cotton fleahoppers

North Carolina	
Bollgard II®	Bollworm, budworm, European corn borer, and fall armyworm
Assail 70WP	Cotton aphid
Calypso 480 SC	Cotton aphid
Fulfill 50 WG	Cotton aphid
South Carolina	
Centric	Aphids
S-1812	Budworms, bollworms, looper, armyworms
Tennessee	
Calypso at 0.047-0.072	Plant bug
Assail at 0.05-0.1	Plant bug
Texas	
Cruiser 5FS (7.6 oz/cwt seed)	Thrips
Admire 2F (3.2-6.4 oz/acre)	
Denim 1.6 EC (0.0075 lbs AI/acre)	
Leverage 2.75 SE (0.063 lbs AI/acre)	
Gaucho 600	
Assail 70 WP (1.14 oz/acre)	Bandedwinged whitefly
Capture 2 EC (3.84 – 6.12 oz/acre)	
Capture 2 EC + Orthene 90 SP (3.84 +9.0 oz/acre)	
Karate Z + Orthene 90 SP (2.2 + 9.0 oz/acre)	
Dibrom 8 EC (16.0 oz/acre)	
Thiodan 3 EC (53.0 oz/acre)	
Furadan 4 F (8.0 oz/acre)	Aphid
Assail 70 WP (0.87 – 1.4 oz/acre)	
Centric 40 WG (2.0-2.5 oz/acre)	
Calypso 4SC (0.8 – 1.5 oz/acre)	
Cruiser 5 FS (7.6 oz/cwt seed)	
Admire 2F (3.2-6.4 oz/acre)	
Assail 70 WP (0.85-2.27 oz/ac)	Cotton fleahopper
Calypso 4 SC (1.5 oz/acre)	
Centric 25 WG (1.6 – 3.3 oz/acre)	
Steward 1.25 SC (9.2-11.2 oz/acre)	
Bidrin 8 E (4.0 oz/acre)	Brown stink bug
Asana 0.66 XL (7.8 oz/acre)	
Vydate 3.77 CLV (11.2 oz/acre)	
Steward 1.25 SC (10.65 oz/acre)	
Steward 1.25 SC (0.09 lbs AI/acre)	Plant bug
Bollgard II®	Bollworm/budworm
Tracer 4 SC (0.06 lbs AI/acre)	
Denim 0.16 EC (0.01 lbs AI/acre)	
Steward 1.25 SC (0.11 lbs AI/acre)	
Bollgard II®	Beet armyworm
Proclaim	Spider mites
Virginia	
Bollgard II®	
S-1812 4EC	
S-1812 35WP	
V-10101 2.25EC	
XR-225	
Adage 5FS	
Novaluron 0.83EC	
F 0570 0.8EC	