50TH ANNUAL CONFERENCE REPORT ON COTTON INSECT RESEARCH AND CONTROL

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Foreword

In 1996, there were approximately 13,570,800 acres of cotton (Upland and Pima) harvested in the U.S. with an average yield of 1.40 bales per acre (480-lb bales) amounting to an 18,951,400 bale production (USDA--December 11, 1996 report). Harvested acreage decreased over 14% but total production increased 3.4%, indicating a yield increase of 18% over 1995. Arthropod pests reduced overall yield by 6.61% in 1996 in spite of control measures which cost an average of over $45.00; loss in yield to insects in the 1996 crop was over $44.00/acre, yielding a total cost from insects in the 1996 crop of about $89.68/acre (over $1.18 billion total). The bollworm/budworm complex was still the number one pest in the U.S. with a yield reduction of 2.37%. Seventy-seven percent (77%) of the U.S. cotton acreage was infested with these pests in 1996 requiring 1.3 applications per acre. These numbers are less than 1995 and are influenced by the 1.86 million acres of B.t. cotton planted in 1996. Only 54% of U.S. cotton was infested by boll weevil, yet it remained the strong number two pest at 1.86% yield reduction. *Lygus* (0.68%), aphids (0.48%), and thrips (0.40%) complete the list of top five insects for 1996 (see M. R. Williams, these proceedings).

Crop and Arthropod Pest Conditions

Alabama. Of the approximately 240,000 acres of cotton produced in north Alabama in 1996 about 85% was Bt cotton. Scattered infestations of variegated cutworms required control. No control was achieved with Bt cotton, and an occasional escape was observed behind pyrethroid applications. Thrips populations were above average and a moderate acreage received foliar applications for control of this pest complex. The boll weevil, although not yet eradicated, was not an insect management concern for most producers. Light egg pressure occurred in late May and June and consisted mainly of tobacco budworms; no control was required. Some square loss caused by thrips was sustained in mid June. A minimal number of treatments, were made for this problem. Serious cotton aphid infestations were very rare. Plant bug populations were abnormally low in June, but a combination of cloudy weather and a low spray environment led to high nymphal populations throughout July. These populations were primarily the tarnished plant bug, but clouded plant bugs were not uncommon. Low numbers of stink bugs were observed in July and August. Low to moderate numbers of corn earworms were present during late July and early August. Few controls were applied, but larval survival was observed to be quite good in the middle portion of Bt plants. Low but noticeable populations of fall armyworms occurred during late July and August. All in all, 1996 was a very light year for cotton insect pests. Short periods of drought stress occurred in May and late June, but overall moisture conditions were good. Average yields may well exceed 1.5 bales per acre.

Approximately 364,000 acres of cotton was grown in central and south Alabama in 1996. Both the central and southeastern areas planted primarily Bt cotton (96-4 option). Thrips populations were heavy (believed to be predominately western flower species), but few foliar sprays were used. A two county area of boll weevils remained throughout the season in central Alabama. Multiple applications were made by the BWEP to several thousand acres to clean up this area. Plant bugs were light during the early square period, and no foliar insecticides were required except in the Gulf Coast counties of Baldwin and Mobile. Wild asparagus serves as a good wild host in that area. Budworm populations were light to moderate in June, but no foliar sprays were made either due to Bt varieties or the action of beneficial insects. No widespread aphid problems existed and few fields were treated.

Beginning about mid-July (coinciding with the maturity of corn) a very heavy bollworm moth flight began in the Gulf Coast area. Numerous escaped larvae were observed in Bt fields, almost always associated with dried bloom tags. Three weeks later this activity had spread over the state but in much fewer numbers in the central and northern areas. Fall armyworms also were infesting fields during this same time in the southern and central counties. Damage and distribution of the fall armyworm was the heaviest seen in the past five years. Multiple foliar sprays (tank mixtures) for both bollworm and fall armyworms were required on Bt cotton in the southern coastal plain counties, especially where beneficial insects had been decimated by previous sprays. An additional generation of both species occurred before the season ended; however, little further spraying was done.

Plant bugs, including the clouded species, and stink bugs reached treatable levels in many fields after July. Most growers were so captivated by the number and performance of beneficial insects that no controls were applied. Beet armyworms, loopers, and whiteflies were near non-existent in 1996. Yellow striped and southern armyworms were of concern in scattered fields. Fleahoppers were present season long in a few locations.

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Less than 20% of all acres in Alabama (including both Bt and non-Bt varieties) were treated with a foliar spray in 1996. The statewide yield will likely be above 750-lb which will make it the second highest on record.

Arizona. A warm, dry planting season was followed by strong and persistent winds in much of the state. These winds caused seedling desiccation, stem abrasion, and high rates of early square loss. Hot and dry weather in June allowed fields to recover from earlier losses. Monsoon storms started early this year with hot, humid weather lasting from early July throughout August. High rates of fruit abortion were experienced in many locations in the state where the crop was at peak bloom at the initiation of the monsoon season. Lygus damage may have compounded losses in fruit retention. Overall, this combination of early season winds, excellent growing conditions in June, and a hot, humid July and August resulted in a fair and highly variable crop across the state.

Sweetpotato whiteflies (aka silverleaf whiteflies) became abundant earlier than usual this year. In central Arizona, populations reached threshold levels the first week of July. By the beginning of August, whitefly populations had declined below thresholds. In contrast, *Lygus* bug infestations were experienced later than usual. Many fields required treatment for *Lygus* starting late July through early August. Pink bollworm infestations ranged from light to heavy. Fields were treated sporadically for the pink bollworm starting late August.

Other pest populations were local and sporadic. Reports of bollworms were up, particularly in areas of high corn acreage. Moderate infestations of cotton aphid were present along the Colorado River, but had subsided quickly, well before the open boll period. High numbers of saltmarsh caterpillars were reported from Graham County in mid-September. Beet armyworm infestations were light and sporadic.

New technologies introduced in 1996 were widely used and greatly changed pest management practices in Arizona. In particular, two insect growth regulators were available for whitefly control, and Bt cotton was grown commercially. A Section 18 allowed single use of the insect growth regulators Knack® and Applaud to control sweetpotato whiteflies. This Section 18 also required a minimum interval between use of the two insect growth regulators and required growers or pest control advisors to complete a training session before they could use the new insecticides. Over 700 people attended these training sessions, and insect growth regulators were used on 250,000 application-acres. Whiteflies were effectively controlled by these insecticides, and only 1-3 applications for whiteflies were required compared to 5-7 in previous years. Bt cotton was grown on 20-25% of the cotton acreage. No additional treatments were required for pink bollworm or other lepidopteran pests in Bt cotton.

Arkansas. Early season growing conditions were good with good seedling survival. Areas in northeast Arkansas experienced high winds which caused significant seedling damage. Some fields required replanting due to wind damage.

Overall insect pressure was lighter than in the 1995 growing season. Boll weevil numbers emerging from overwintering habitat were much lower than in previous years. However, there were still sufficient numbers requiring most growers to use a pin-head square treatment. Many growers were able to get adequate control by spraying field borders near overwintering habitat. In some areas in northeast Arkansas no overwintered sprays were required due to lack of weevils. These areas were also lacking in good overwintering habitat and experienced good winter kill. The weevil was not much of a problem for the rest of the season until August.

Thrips pressure was light to moderate in Northeast Arkansas with very few fields requiring a foliar spray for control. Pressure was higher in the central and southern parts of the state. Many growers used an in-furrow insecticide or seed treatment at planting which gave sufficient control. Soybean thrips were observed in some cotton but did not appear to cause as much damage as the tobacco thrips.

Aphid outbreaks were widespread in southeast Arkansas and more localized to the north. A section 18 for use of Furadan was enacted, however, only a few fields were treated. An epizootic of the fungus occurred about the third week of July eliminating this pest as a problem.

Plant bugs were numerous in wild host plants early in the season. However, infestations in cotton were spotty. Numbers increased later in the season with some fields experiencing significant damage to bolls. Effective control with insecticides became poorer as the season progressed.

Spider mites were a problem in July. This problem was aggravated by the dry conditions at the time. Fields that were infested primarily in northeast Arkansas, required 2-3 applications to get adequate control. Some fields required another treatment later in the season as mites resurged.

Bollworm numbers were high in the central and southern parts of the state, and to a lesser extent in the northern part of the state, in July and August.

Tobacco budworm numbers were surprisingly low throughout the season. This insect was not the problem it has been in the past.

Bt cotton was planted on approximately 157,000 acres of Arkansas' 1,000,000 acre crop (about 16% of the crop). It was planted mostly in areas with traditionally troublesome tobacco budworm problems, primarily in southeast

Arkansas. Budworms were not a problem on Bt cotton, but bollworm infestations in the mid canopy at peak bloom caused farmers to spray Bt cotton an average of 1.5 times. Generally, Bt cotton yields were above average.

California. In 1996, 1,183,145 acres of cotton were planted in the San Joaquin Valley with 14% dedicated to Pima. The 1996 season can be rated as good but not exceptional with yields estimated at 1,150 lb for upland. The season began with great promise as the planting season was excellent and open. Cotton was planted in a normal time frame with most cotton planted by April 25. Warm conditions continued through plant emergence and early development. However, temperatures during July and August exceeded 100°F with nighttime temperatures exceeding 70°F. These high temperatures removed much of the optimism for high yields by causing many fruit to shed. Across the Valley, the late fruit retention was poor and weather is estimated to have caused a 10% reduction in yield. For those attempting to recover and set later fruit, early autumn rains caused harvest problems.

Insects were not generally a problem in 1996. However, there were severe localized outbreaks of spider mites, *Lygus*, aphids, and silverleaf whitefly. The winter of 1995-96 was exceptionally mild and thought to be responsible for higher carryover of some of these pests. Areas of Kern Co. experienced severe early spider mites, and multiple applications of miticides were required. Although foothills and range land had completely dried before initiation of fruiting, internal Valley sources of *Lygus* caused localized problems. Heavy sustained migrations were not common, but low populations were thought to cause early and persistent damage. Aphids were not a widespread problem in 1996, but local severe populations developed in Fresno Co. and Kern Co. The section 18 for Furadan was triggered only in Kern Co. Silverleaf whitefly reached its highest density and most widespread distribution since its introduction in 1992. Populations were noted earlier than in any previous year. Mild winter temperatures and warm and hot summer temperatures are thought to have contributed to the silverleaf whitefly severe outbreaks. Silverleaf whitefly was especially severe south of Fresno Co., mostly on the east and south edge of the Valley west side of Kern Co.

Georgia. The 1996 season will not only be remembered for the introduction of transgenic Bt cotton, but also as one of the lightest cotton insect pest seasons in recent times. A continuing trend towards reduced insect pest pressure has been observed since the elimination of the boll weevil as an economic pest in Georgia.

Thrips populations were near normal, and at planting applications of in-furrow insecticides generally provided adequate control. Beet armyworms were found on seedling cotton in late May and June. Populations built to high levels in some areas and triggered an emergency exemption allowing the use of Confirm and Pirate insecticides for control of beet armyworm. Hot and dry conditions persisted in late June and early July which were conducive for a beet armyworm outbreak; however populations crashed. Except in isolated fields, beet armyworm posed few problems for the remainder of the season.

Plants were stressed by heat and drought in June, and square retention dropped in some areas. Plant bug populations were low and did not appear to be the cause of the square shed. Plant bugs were not considered a problem by most producers. Cotton fleahoppers were present in most areas of the state in July. High fleahopper populations were observed in some fields during bloom but damage to the crop was minimal. Aphids never reached economic populations and were eventually controlled by a naturally occurring fungus.

The first tobacco budworm flight occurred in early June and was light (unusually light pressure was also observed on tobacco). The second flight, which is generally expected around July 4 and often is the most difficult to control, did not materialize. Very few tobacco budworm moths were observed or captured in pheromone traps for the remainder of the season. Bollworm pressure increased in mid-late July. Moths appeared to be depositing eggs deeper in the canopy than normal and this behavior made scouting difficult. Control was good with pyrethroids when timely applications were made. Bt cotton performed well in most parts of the state. However, supplemental sprays for bollworm were needed on a portion of the acreage. Increased stink bug damage was observed in some fields, possibly due to the reduction of broad spectrum insecticides applied.

Fall armyworms were reported in several areas, but most problems occurred in southwest and east Georgia. Control of fall armyworm with insecticides was fair at best. Soybean loopers were a problem in a few isolated areas.

The Boll Weevil Eradication Program continued to make progress toward getting Georgia weevil-free. The 1995 outbreak in Brooks County appears to be cleaned up. Minimal spraying was needed in this area during 1996. Weevils were detected in a Dougherty County field in July. BWEP personnel reacted quickly and effectively to this outbreak, intensifying trapping and spraying efforts to prevent its spread.

Overall, Georgia will harvest an average crop of about 749 lbs lint/A on 1,345,000 acres.

Florida. Adequate soil moisture enabled early-planted fields to emerge on time (late April to early May). Dry conditions, particularly during May, delayed crop emergence in some fields until late May and early June. In the western panhandle optimum conditions during most of the season allowed good growth and fruit set. In the central panhandle, dry weather in mid and late July caused considerable plant stress. High humidity and rainfall during late August and early September throughout north Florida resulted in losses to boll rot, particularly in early-planted fields with rank growth and high fertility. Yields in counties in the western panhandle of 750 pounds of lint per acre will be offset by considerably lower yields in the central panhandle, resulting in a state average of 650 pounds of lint per acre.

Thrips populations were at or below normal in 1996. Granular insecticides were used on most fields at planting and provided adequate control. In the western panhandle, plots that did not receive granular treatments averaged 1 to 2 thrips per plant and suffered damage.

Lygus bug populations were very low in 1996, and square retention did not appear to be adversely affected. However in the central panhandle, cotton fleahopper populations were very high (up to 10 per foot of row) at the pinhead square stage. Square retention generally remained above 90% but a few fields had square retention that dipped as low as 70%, resulting in a few fields being treated.

Aphid infestations occurred at low to moderate levels in most fields during July. High infestations accompanied by honeydew buildup and plant stress were generally found in fields previously treated with insecticides. Beneficial insects, mainly ladybird beetles, appeared to be responsible for keeping populations down in untreated fields. The beneficial fungus disease, caused by *Neozygites* spp., decimated aphid populations in most fields by the third week of July.

Tobacco budworm, *Heliothis virescens*, populations were unusually low in 1996. Three (central and eastern panhandle) to four (western panhandle) insecticide applications were made for cotton bollworm, *Helicoverpa zea*, control on conventional cotton varieties that could be treated within the transgenic cotton license agreement. State-wide, approximately 42% of the acreage was planted to the Bollgard varieties Nucotn 33B and 35B. In the western panhandle, more than 90% of the cotton was planted to the Bollgard varieties. Most farmers in Florida used the 100:4 refugia option. The Bollgard cotton provided excellent control of the bollworm and budworm. A few large (>¼ inch) bollworms were found in some Bollgard fields, but numbers were usually below economically-damaging levels. As was the situation elsewhere in the cotton-growing states, bollworm eggs oviposited deep within the canopy on blooms, stems and bracts generally gave rise to the surviving larvae.

The beet armyworm showed signs early of becoming a problem in many fields. Many fields that had a history of beet armyworm losses were treated with Dimilin on a preventative basis. However, late in the season beet armyworm problems failed to develop apparently due to the combined action of parasites and predators.

Fall armyworm infestations were scattered during mid to late season. Infestations first appeared in mid-July and approximately one-third of the Bollgard fields received an application for fall armyworms in the western panhandle. In the central panhandle, multiple insecticide applications to control the fall armyworm were not uncommon.

The southern armyworm was a problem causing defoliation for the second year in the extreme southeastern part of the cotton-growing area of Florida (Putnam County). A number of fields experienced severe defoliation and several hundred acres required treatment. Elsewhere in the panhandle, southern armyworms could be found at sub-threshold levels. The southeastern part of the cotton-growing area of the state also had defoliating populations from the cotton leafworm. The last time the cotton leafworm caused economic defoliation in Florida was 1977.

Stink bugs were present in low numbers throughout the season. In the western panhandle, populations remained low with very few fields requiring treatment specifically for stink bugs. In the central panhandle, stink bug populations were high late in the season with many fields requiring treatment.

Late season pests also included spider mites in the central panhandle and the bandedwinged whitefly in the western panhandle. In the case of spider mites, a few fields required treatment; bandedwinged whitefly parasitic wasps, *Eretmocerus* spp., provided control. The silverleaf whitefly problems experienced in 1995 in the easternmost cotton-producing counties were minimal in 1996.

Louisiana. Most of the 1996 crop was planted between late April and early May and was cutout by mid August; most of the state experienced favorable harvest conditions through October. Louisiana cotton yields are estimated to be approximately 715 pounds of lint per acre on 920,000 acres. In 1995, yield reductions were attributed to weather (56%), insects (40%), and chemical injury (4%).

Early-season insect pest infestations were variable. Extremely high thrips populations covered most of the state. Cutworm infestations were light with most high risk fields receiving a prophylactic treatment for cutworm control. Yellow striped armyworms and saltmarsh caterpillars were present in many fields, but most did not require treatment.

Overwintered boll weevil populations were light. Most fields received at least one pinhead square treatment. After pinhead square, boll weevil populations were light until late-July. From late July to harvest, boll weevils were present at treatment levels in most fields. Boll weevil populations in the Red River Valley were extremely high at this time and resulted in significant yield reductions.

Tarnished plant bug populations were low prior to bloom. Most fields required only a single treatment prior to early July. During late-July and August, tarnished plant bug populations were extremely high. Control of these populations was only achieved when treated on a three- to four-day interval.

Bollworm populations were high during the early-season. Bollworm infestations resulted in significant plant stand reduction in fields where alternate bollworm hosts (henbit and wild geranium) were not adequately burned down with herbicides. In most cases, third to fifth instar bollworms were moving from the alternate host to seedling cotton as the alternate host dried down. Bt-cotton did not appear to provide any control of these populations of bollworm.

During mid and late season, bollworm populations were slightly higher than normal. However, these populations persisted over a much longer period than normal. Most non-Bt cotton fields required 4 to 6 applications of insecticides to control bollworms.

Tobacco budworm populations were generally light during 1996, with heavy infestations developing only in scattered fields. Pyrethroid resistance levels in tobacco budworm populations were similar to that of 1995.

Bt-cotton was planted on approximately 140,000 acres. Tobacco budworm populations were so low that no evaluation could be made on the activity of Bt-cotton on tobacco budworm. Approximately 75% of the Bt-cotton acreage was treated for bollworm. Approximately 1.5 insecticide applications were applied to control bollworm after first bloom. Cabbage looper infestations did develop to significant levels during early September on Bt-cotton.

Mississippi. Mississippi cotton growers planted approximately 1.03 million acres of cotton in 1996, which was down considerably from the 1.45 million acres grown in 1995. Much of this acreage was shifted into corn which increased from 275,000 acres in 1995 to 610,000 acres in 1996. This increase in the ratio of corn to cotton acreage had a significant effect on bollworm populations in cotton.

Approximately 42% of Mississippi's cotton acreage was planted to Bt-transgenic varieties, a significant portion for the first year of commercial availability of this new insect management tool. Bt-cotton was distributed throughout the state, but a relatively higher portion was planted in the Hill region of the state where growers had experienced a severe tobacco budworm outbreak in 1995.

Relatively little cotton was planted in April because of unfavorable conditions. However, excellent conditions in early May allowed growers to establish a very timely and uniform crop that emerged rapidly and exhibited good seedling vigor. Overall thrips infestations were somewhat higher than normal due to dry conditions toward the end of May. Foliar thrips treatments were required on a large portion of the acreage that was not treated with an in-furrow systemic material. Much of the acreage planted with the Gaucho (imidacloprid) treated seed required supplemental foliar treatments.

The winter of 1995-96 was more severe than normal and had a significant effect on survival of overwintering boll weevils through most portions of the state. Statewide pheromone trap captures from May through the early half of June averaged only 10% as high as those for the same time frame in 1995. Consequently, many areas of the state were able to reduce the number of treatments applied to control overwintered weevils and thus conserve beneficial insects. Pre-bloom tarnished plant bug infestations were low to moderate through most of the state, resulting in a reduced number of treatments required to control this pest. Populations of beneficials insects, particularly minute pirate bugs and big-eyed bugs, were observed to be much higher than usual and to persist longer than normal through much of the state.

Pre-bloom infestations of tobacco budworm were much heavier than normal in some areas of the Hill portion of the state. Egg counts in excess of 50% were reported, and a few fields of non-bt cotton sustained heavy early season square loss due to tobacco budworm. However, these infestations were low to non-existent. This is in sharp contrast with the tobacco budworm infestations experienced in 1995, and there seems to be no single explanation for this decrease. Research on the numbers and survival of overwintering tobacco budworm pupae conducted by Dr. John Schneider suggests that this decline was not the result of winter mortality.

Bollworm populations, on the other hand, were abnormally high throughout the season. Early spring pheromone trap captures were observed to be 4 to 8 fold greater than normal in some locations. It is noteworthy that these initially high numbers of bollworms were observed before moths would have had time to complete a generation on corn. In addition, there were a few incidences of bollworms damaging emerging and seedling cotton in reduced tillage situations where larvae were established on weeds that were subsequently destroyed with burn-down herbicide treatments. Overall bollworm pressure was low during pre-bloom because of the preference of corn. However, as corn began to senesce after producing two generations of bollworms, nearby cotton acreage experienced extremely heavy bollworm infestations, with the severity of infestation being somewhat influenced by proximity to corn.

Bt-cotton provided excellent control of tobacco budworms throughout the season. The fact that 42% of the state's acreage was planted to Bt varieties combined with growers' tendency to plant Bt-cotton on fields known to have a history of heavy budworm pressure, must not be overlooked as a possible explanation for this year's unusually low tobacco budworm populations.

Bt-cotton also provided good control of the unusually heavy populations of bollworms that occurred on cotton during July and August. However, supplemental foliar bollworm treatments wee applied to approximately 33% to 50% of the Bt cotton acreage planted in the state (an end of season statewide survey recorded an average of 3.4 budworm/bollworm treatments per acre on conventional cotton vs 0.33 on Bt acreage). Across different areas of the state there was great variability in the portion of Bt-cotton receiving one or more supplemental treatments for bollworm, ranging from near 0% in some areas to as high as 80 to 90%.

Practically all situations in which Bt-cotton received treatment for bollworms were due to survival of larvae occurring in blooms and lower bolls. In most cases, excellent control was obtained against larvae feeding in the upper terminal area, but survival was greatly increased for larvae feeding on pollen in blooms and then moving into bolls. Damaged boll counts as high as 16% to 24% were observed in some fields of Bt-cotton. However, overall boll damage was considerably lower in Bt cotton than in conventional cotton (an end of season statewide survey recorded an average of 2.7% worm damaged bolls in Bt cotton vs 4.9% in conventional cotton), and yields of Bt varieties were slightly higher than those of conventional varieties in most areas of the state.

Although, early season boll weevil numbers were lower than normal due to the severe winter, the unusually low level of tobacco budworm, combined with the widespread adoption of Bt-cotton, resulted in a substantial reduction in the number of foliar insecticide treatments applied to control budworm/bollworm, and this also reduced incidental boll weevil control provided by many of these treatments. Consequently, mid and late season boll weevil infestations built back to normal or above normal levels and high numbers of boll weevils entered overwintering quarters in all areas of the state in the fall of 1996. Surprisingly, season long pheromone trap captures indicated that boll weevil numbers in the Delta portion of the state were somewhat higher than those in the Hill portion of the state. This year's experience with Bt-cotton verified the expectation that wide scale utilization of this technology would allow boll weevils to increase in importance as a pest of cotton.

Mid and late season tarnished plant bug infestations increased in a manner similar to boll weevils, probably for similar reasons. Many areas of the Delta experienced heavy infestations during mid and late season. Control efforts were complicated by the documented occurrence of high levels of insecticide resistance. Multiple treatments applied at 3 to 5 day intervals were required in order to achieve effective control. Heavy plant bug infestations were also observed in some portions of the Hill region of the state that do not normally experience heavy plant bug infestations. As with boll weevil, mid and late season infestations of plant bugs were observed to be relatively more severe in Bt cotton than in conventional cotton.

Many growers and consultants noted that plant bug infestations often appeared to be heavier or more common in cotton that was adjacent to corn. Because plant bugs do not reproduce well on corn and because weed problems are usually well controlled in corn, the increase in corn acreage is not thought to provide an explanation for the high levels of plant bugs observed in 1996. However, it is likely that a general lack of preference for corn by plant bugs could explain the apparent concentration of plant bugs in cotton adjacent to corn.

Overall aphid infestations were somewhat lower than in recent years, but populations did begin building in mid June. By late June and early July some Delta fields had experienced treatable infestations. The *Neozygites* fungal disease began to appear in some fields in early July. Insecticide resistance is a common problem, especially with cotton aphid, but fortunately, relatively little acreage required treatment. Furadan, which was available under Section 18 Emergency Exemption, was used to control aphids on a limited amount of acreage with no reports of human intoxication or damage to wildlife. Of the currently labeled aphicides, Bidrin and Provado were two of the more consistently effective treatments.

Unusually high infestations of beet armyworm were observed in fields of seedling cotton in Eastern Mississippi during May. This early occurrence of beet armyworm infestations, combined with the hot, dry conditions that were prevalent at the time, fostered concern over the potential for a severe outbreak to develop. However, larval collections made from these infestations revealed parasitism rates in the range of 80% to 90%, primarily by *Cotesia*. Apparently, this high level of parasitism, combined with a shift in weather patterns, prevented an outbreak from developing and overall beet armyworm infestations were very low in 1996, with only a few fields requiring treatment. Mississippi had been granted Section 18 Emergency Exemptions to allow use of Pirate and Confirm against beet armyworms in 1996, should an outbreak occur. Fall armyworm was detected at treatable levels in a limited number of fields in the more southern regions of the state, and a few fields of both Bt and conventional cotton required treatment for this pest.

The crop matured earlier than normal, and for this reason late season looper infestations were relatively uncommon. Several occasional caterpillar pests were relatively more common in 1996. These included cutworms, yellow striped armyworms, and saltmarsh caterpillars.

In summary, 1996 was an excellent production year for most of the state. Statewide yields averaged approximately 807 lbs of lint per acre, which is the 2nd highest yield recorded for the state. Primarily because of the unusually low levels of tobacco budworm, total insect control costs were considerably lower than in recent years. Including the $32/acre license fee for that portion of the acreage planted to Bt cotton, total insect costs were estimated at $76.67/acre for the Delta region, $68.83/acre for the Hills, and a state average of $65.78/acre.

Missouri. Approximately 405,000 acres of cotton were planted in 1996. Insect problems in Missouri cotton were notably unremarkable over the 1996 growing season. The winter of 1995-96 was one of the most severe in the last 10 years in the Bootheel. Air temperatures approaching 5°F with little or no snow cover occurred on three occasions; much of the reduction in insect pressure may be attributable to the severity of the winter. Precipitation in early spring delayed field preparation somewhat in some areas. Planting season weather was generally beneficial, although some early planted cotton was hurt by cool weather. Weather during the growing season was unexceptional, although the Delta Center did sustain some minor damage from a tornado in late June. Early development of the crop in most fields was robust, and square retention for the season was exceptionally high.

Thrips pressure was below normal in most areas and much below that observed in 1995, and sandblasting injury was also much reduced from last year.

Overwintering boll weevil numbers were also much lower and relatively little pin-head spraying was done (apart from those made through a state funded suppression program in two counties). In-season applications directed at economic infestations of boll weevils were also rare. Boll weevil populations surged late in the growing season (after most plantings were past economic injury) in the absence of significant in-season insecticide use; we suspect relatively large numbers went into overwintering habitat.

Aphid numbers were very low and economic infestations were virtually non-existent. Plant bug populations were like-wise low in general; scattered plantings experienced marginally economic infestations.

Yield is expected to be near the five year average at approximately 705 lbs per acre.

New Mexico. Agronomically, 1996 was an exceptional year for coton production in most areas of New Mexico. Insect pest pressure overall was lighter than last year. However, boll weevil captures were made in virtually all cotton growing areas of the state by fall. The most damaging insect pests continued to be bollworm and pink bollworm. Aphids and beet armyworm, which can be significant problems, were less prevalent this year.

Pink bollworm pressure was highest in the Mesilla Valley in south central New Mexico and the southern end of the Pecos Valley in southeast New Mexico. There was little control needed in other areas of the state. However, high numbers of pink bollworm near harvest emphasized the need for a mandatory plowdown statewide. NMDA has required plowdown by January 15 statewide.

Bollworm pressure was somewhat lighter than usual but still required 2 applications in many locations. Overall, bollworms caused an estimated 9% loss in infested areas. Beet armyworm infestations were much lighter than last year with the highest infestations in the southern end of the Pecos Valley. Early thrip populations were low. Plant bug and stink bug populations were light again this year.

Agronomically, conditions were very favorable for cotton production. Average maximum temperatures at Artesia in April were about two degrees (F) above normal which helped get seedling emergence off to a good start. However, an exceptionally warm May and June got cotton off to a very rapid start compared to our normal crop. May maximum temperatures were eleven degrees above average with minimums five degrees higher than average. This produced an 87% increase in heat units with 508 degree days (60° base) compared to the average of 271. June also had higher than average temperatures with both the minimum and maximum about five degrees above the average. As a result, cotton fruiting was faster with first blooms at least two weeks earlier than normal. Most producers in the Pecos Valley and Lea County began harvesting before the end of September, which is exceptionally early.

Lea County experienced severe problems with hail damage early in the season. Approximately 3500 acres in east central Lea County were affected out of 13,000 planted in the county. After replanting once, much of that area was hailed out again and 3,000 acres were replanted in sorghum.

Compared to other areas, there was very little Bollgard cotton in New Mexico. Five farmers in the Pecos Valley planted approximately 60 acres each. Bollgard cotton was also planted in variety trials, in some on-farm research trials, and at the experiment stations. Deltapine 33B performed exceptionally well with the highest yields in most locations. The amount of Bollgard cotton planted next year however will likely remain low in most of New Mexico. Insect pressure in many locations is low, and there is some concern about quality losses compared to the Acalas that are grown in much of New Mexico.

The early harvest of the crop has allowed growers to shred and plowdown at an earlier date than usual in many areas. An early freeze in mid-October also terminated the crop and helped with boll weevil control. At that point boll weevil infestations were increasing rapidly. Some fields in south Eddy county had increased from 2% to over 20% infested squares during mid-October.

North Carolina. North Carolina's major insect pest, the bollworm, was on the moderate to heavy side, as evidenced by high moth numbers, moderate to very high egg lay and moderate to high bollworm establishment over much of the state.

European corn borer damage was the lightest since 1985 when we initiated an extensive statewide damage boll survey, with thrips pressure about average and tobacco budworms, cotton aphids, beet and fall armyworms and soybean loopers present at low sub-economic levels.

Plant bug populations remained low throughout most of the state, in keeping with our history of *Lygus* being a very minor problem here. Very few fields were treated for plant bugs in 1996.

Tobacco budworms were low in cotton in the June (second) generation, and did not make up much of the third generation July/August population, as opposed to 1995. In 1996, tobacco budworm levels did not seem to increase their status as a cotton pest in our greatly-expanded acreage, nor did resistance levels to pyrethroids increase in the Southeast. Approximately 7% of the state's cotton acreage was treated for June tobacco budworms, and bollworms constituted 90+% of the bollworm/budworm complex during the major generation. Most bollworm control difficulties arose from very high egg pressure, at times in the 100 to 350 per 100 terminal level, bollworms becoming established under pink and dried flowers, rain-related chemical wash off, and wet soil conditions which at times kept ground spray equipment out of the fields and aerial applicators backed up.

Bollworm populations and their resulting damage to conventional cotton was on the moderate-plus side-4.62% year-end damaged bolls across the state compared with a ten-year average of 3.91%. European corn borer damage to cotton bolls was again very low, with a 1996 statewide damaged boll level of just 0.3%, compared with an 11-year mean of 1.69%.

Boll damage from stink bugs, at 0.75% in non-transgenic cotton, was present at somewhat higher than the long-term average of 0.58%.

The cotton aphid persisted at easily detectable levels in a large number of cotton fields throughout much of the growing season, though the mummifying brachonid wasp parasites (primarily two species) did a good to fair job of holding cotton aphids at sub-economic levels during the mid-season. Our common fungal parasite, *N. fresenii*, appeared to reduce aphid populations very dramatically this past year, particularly once significant cotton opening was underway. We continued to advise cotton producers not to treat for cotton aphids, primarily due to the combination of parasites, fungi, and the presence of multiple insecticide resistance in some of the aphid populations.

Migratory beet armyworms only made their presence felt in a few western Piedmont fields in Anson County. Fall armyworms were present in a number of our state's cotton-growing areas, although they seldom reached treatable levels. Only 0.09% fall armyworm-damaged bolls were uncovered across the state in this year's survey compared with a long-term average of 0.47%.

Soybean looper also was present at very low levels in 1996; loopers were geographically-widespread in North Carolina cotton fields in 1995.

Twenty-seven boll weevils have been found in North Carolina in 1996, one in Halifax County and the remainder within a few hundred yards of each other in Rowan County, a new area of cotton production.

The "acid test" of the efficacy of *B.t.* (Bollgard) cotton to North Carolina's cotton producers began to play out in 1996. Of 116 producer-managed Bollgard fields surveyed for boll damage in 1996, the Bollgard fields sustained just over half as much damage from bollworms 2.30% (vs. 4.62) and 3.03% (vs. 0.75 for conventional) stink bug damage. European corn borer and fall armyworm damage in the Bollgard fields were 1/10 and 2/3 of the boll damage found, respectively, in the conventional fields, although these two pests were present at very low levels on cotton in general in North Carolina in 1996.

An average of approximately 3.0 total applications (except for the at-planting insecticide) was used to control all insects on conventional fields and 0.58 applications used on Bollgard cotton in North Carolina in 1996.

Although weather conditions were very favorable for cotton production in 1996, 2 hurricanes, Bertha and Fran, excessive rainfall (especially following Fran in mid-September), and cool, cloudy conditions hurt yields significantly in some areas. Nevertheless, a number of producers in the less or non-effected areas picked yields of 800 to 1300 lb. lint/acre. Statewide yields are expected to be in the 650 to 700 lb. range.

Oklahoma. Drought delayed planting of this year's cotton crop. A total of 300,000 acres was planted, but weather and insect damage reduced the number of acres harvested to less than 260,000 acres. Heat unit accumulations (2694 hu) lag behind the 40-yr. average because of below average temperatures in August and September. The state production average is projected at 300 lbs. lint/A.

Thrips infestations caused isolated damage because of widespread use of at-planting insecticides and over-the-top sprays. Cotton fleahoppers and boll weevils were targets of many insecticide applications made before bloom. Freezing temperatures in late January reduced boll weevil numbers across most of the cotton-producing area of Oklahoma. However, a late emergence pattern in the Spring insured weevil colonization. Economically damaging populations developed by mid-August. To prevent economic loss, irrigated cotton averaged 4 insecticide applications. Dryland cotton averaged 2 insecticide applications where yield expectations justified treating. Many producers abandoned late-planted dryland fields because of low-yield expectations and poor growing conditions. These abandoned fields became weevil nurseries allowing a large number of boll weevils to enter overwintering habitat with adequate fall reserves to overwinter.

The damage inflicted by the boll weevil in the last five years forced many producers to switch to other crops in 1996. Sorghum and corn replaced cotton on thousands of acres across Southwest Oklahoma. This large tract of sorghum and corn enhanced bollworm development in June, resulting in the heaviest July moth flight in cotton in 15 years. Dryland cotton received 1 to 2 insecticide applications, while irrigated fields were sprayed 3 to 4 times to prevent economic loss.

Cotton aphid infestations exceeded the economic threshold across the State. Heaviest infestations occurred in cotton under intense management. Most of the spraying occurred in Harmon, Jackson, and Tillman Counties in Southwest Oklahoma. Fields averaged two insecticide applications to control aphids. Furadan was the product of choice once counties met the criteria for emergency use under the Section 18 label.

South Carolina. Cotton planting was timely and growing conditions were nearly ideal. Generally warm temperatures resulted in quick emergence and rapid seedling growth. Plant stands were excellent in most fields, so few fields had to be replanted. Some areas of the state received too little rain, but plants compensated unusually well to produce yields that were better than expected.

Growers will harvest more than 280,000 acres of cotton in 1996, with an average yield expected to exceed 800 lbs lint per acre. Thus, this crop has the potentBal to rival the record 819 lbs of lint produced in 1994. The state average yield was 528 lbs. in 1995 on 342,000 acres.

In general thrips were controlled by planting-time applications of insecticides, but delayed maturity from thrips damage was still a problem in some areas. Tobacco thrips appeared to be the most important thrips species in cotton.

Tobacco budworm populations were extremely light in tobacco as well as cotton. There were no problems with this insect in *Bt* cotton. Less than 5% of the conventional cotton acreage had economic budworm infestations. About 600 male moths were tested for pyrethroid resistance and survival at 5 µg cypermethrin per vial was just over 30%.

Economic infestations of bollworm (F_3) showed up on 8 July in many cotton fields. By mid July it became apparent that infestations were higher than usual in some areas of the state. Eggs were being laid further down on the plants, and some larvae were surviving on *B.t.* cotton by penetrating small bolls through the bloom tags. Of some 40,000 acres of *B.t.* cotton, approximately one half was sprayed at least once for bollworms.

A farmer in Hampton County complained about difficulties with bollworm control with pyrethroids. Larvae were collected from two fields in September and reared to adults. From these larvae Dr. Tom Brown obtained 34 healthy moths, which he placed in glass vials treated with 2.5 µg cypermethrin. After 24 hours there was 17.6% mortality of the Hampton County moths in the treated vials compared with 9.1% in the untreated vials. Mortality of a susceptible strain of budworm moths in cypermethrin treated vials was 68.2%. Results of a similar test performed on F_1 moths with cyhalothrin (Karate®) treated vials appeared to confirm resistance. This is apparently the first instance of pyrethroid resistance in bollworm reported from the Southeast U. S.

B.t. cotton was also treated for stink bugs in many cases. Survey information is incomplete as of this writing, but it's likely that 25% may have been treated with insecticide for this purpose. In the Savannah Valley area most *B.t.* cotton fields, and some of the conventional cotton fields were treated.

Plant bugs were not much of a problem in 1996. Both tarnished plant bug and cotton fleahopper populations were light in most fields.

Beet armyworm problems were reported from just a few fields. There did appear to be a relationship between beet armyworm infestations and the malathion applications applied for boll weevil control in Orangeburg and Bamberg County. The cotton fields involved were also in an area of the state which had low rainfall. Fall armyworms infested many cotton fields, but they were not an economic problem in most fields of conventional or *B.t.* cotton.

European corn borer infestations were light. Some cotton was sprayed for aphids, but as has been the case for the last few years, populations crashed following an epizootic of a naturally occurring fungus. The disease was prevalent in most areas of the state.

In 1995 more than 17,000 boll weevils were captured in South Carolina. This year the number captured was reduced by about 90%. A comprehensive trapping program and treatments with malathion to 47,601 cumulative cotton acres did the trick. A few fields should require pinhead treatments in 1997, but boll weevil should be out of the picture by mid season.

Tennessee. The Tennessee cotton crop was planted in a timely manner and with warm growing conditions, the crop got off to a good start and continued throughout the season ahead of the five year average. There were reports of false chinch bugs occurring on no-till cotton in Tipton County in early June. A large portion of the crop was treated with pinhead square applications, but by mid July, applications were being made for boll weevils and aphids. Although aphid populations continued to increase, the pathogenic fungus appeared and controlled the aphid population before much damage occurred. Bollworm moth flights occurred the third week of July and sprays for bollworm, boll weevils, and aphids were applied. The first week of August saw increases in stink bug and plant bug populations, but neither became a serious problem as sprays were applied over the next two weeks. Bollworm populations began increasing the third week of August and became isolated problems. The crop continued developing on a rapid pace and by September 1, one-fourth of the crop had open bolls. Harvesting conditions were excellent in early October, but by mid-month rains began and harvesting was difficult. Estimated yields for the season were 600 pounds per acre with total production down 10 percent to 650,000 bales due to a loss of acreage planted to alternative crops.

Texas. Acreage and yields were generally down across the state mostly due to doughty conditions early in the season and late rains which resulted in late insect and harvest problems associated with heavy regrowth. Cotton acreage of 4.44 million was down 1.3 million acres from 1995 but the 1996 production of 4.42 million bales was only 550,000 bales down from last year. Record yields in the High Plains compensated for much of the lower yields elsewhere in the state.

The 1995-1996 winter provided moderately cold conditions for the first time in five years. This, combined with early dry conditions, delayed significant boll weevil infestation development until late in the season. However, the crop was late in many areas of the state, making it particularly vulnerable to late boll weevil damage.

The Texas boll weevil eradication program took one step backwards but a couple of steps forward in 1996. The Lower Rio Grande Valley had a recall election and terminated their eradication program after one year. Heavy losses to beet armyworms and lack of confidence in the program caused its downfall. The Southern Rolling Plains Program completed its second year and started the 3rd year with the fall diapause program. Both the Coastal Bend and Central Rolling Plains zones initiated their eradication programs with diapause treatments. The St. Lawrence Valley in Far West Texas finally passed their eradication referendum but with no start date established. The High Plains zone completed its second year of enhanced diapause treatments in preparation for full scale eradication in 1998. Poor producer support and rapid boll weevil infestation increases in the area make the 1998 start date hopelessly optimistic. A pending Texas Supreme Court decision on the lawsuit brought by 10 Hale County producers and a looming recall put a damper on producer enthusiasm for the program. Boll weevils have now infested all cotton producing counties in Texas.

Beet armyworms were monitored with extensive use of pheromone traps in response to the devastating problems experienced last year with this pest. In general, damaging infestations failed to develop in the majority of acreage although a section 18 for Confirm and Pirate was triggered for the state in the Lower Rio Grande Valley. While tobacco budworm numbers were greatly reduced compared to previous years in most locations, very high numbers of moths were caught in traps and the resultant heavy egg lay in July produced heavy larval infestations in much of the state's acreage north of the Coastal Bend area. Cotton aphids were not much of a problem except where pyrethroids were used to control the heavy bollworm infestations in July. Section 18's for most of the state were granted for use of Furadan 4F.

Bt transgenic cotton was planted in most areas of the state, if only a limited acreage in some parts. As a whole, these plantings did very well even though there were some instances where heavier than normal bollworm pressure resulted in infestation levels requiring treatment. This was especially true in the Brazos River bottom area of the Southern Blacklands. Even so, fields with Bt cotton generally received fewer treatments for bollworms.

Lower Rio Grande Valley (LRGV). Rainfall during the production season in the Lower Rio Grande Valley was very low in 1996 and was lower than any of the previous ten years. The timing of rain events, particularly in the dryland areas of Willacy county, was better for cotton production there in 1996 than in 1995. Rainfall in 1995, was especially short during the critical square set and early bloom set periods in April and most of May, 1995, but was higher in Willacy county dryland areas in 1996. Timing of rains in 1996 was such that rain fell in the middle of the square/bloom set which improved the agronomic capability of cotton to make a better yield on many farms in Willacy county in 1996 than during 1995. The irrigated areas and the western dryland areas of the LRGV, however, did not experience the Willacy county rainfall timing or amounts and suffered yield damage despite having irrigation available.

Beneficial insects were at all-time high levels. The increased "beneficials" came from lower levels of insecticides used in cotton and the much higher than normal acreage of grain sorghum produced in the LRGV in 1996. Cotton acreage was down to near 200,000 estimated planted acres from a normal planting of near 300,000 acres. Grain acreage was near 600,000 acres, which was approximately triple what it was in 1995 and almost 50 percent greater than the annual average of 400,000 acres. When aphid infestations were reduced in grain sorghum, the "beneficials" moved from sorghum to any plants nearby on which they could seek other insects for food. The supply of "beneficials" overwhelmed most pest infestations in cotton except for boll weevils.

The 1996 cotton season was a very unusual year since pest insect activity was so low. The only major insect concern for cotton producers in 1996 was boll weevils. In most fields, heavy weevil populations occurred so late in the season that the crop produced most of its harvestable fruit before the heaviest weevil infestations occurred. Thus, weevil control was less costly for most producers because they only had to fight the large infestations for a short period of time compared to a normal situation of fighting heavy weevil infestations from the middle part of the fruit setting period. Boll weevil punctured square counts started off the season at very low levels, and the highest punctured square count recorded in 1996 was only about one half of normal. However, weevil activity was rated as very heavy by growers in the Progreso, Rangerville and northeastern San Benito areas due to the intensity of the infestations and lack of apparent control in those areas. Most growers across the LRGV however, did not spend nearly as much on weevil control in 1996 as in most previous years. By the end of the season, actual yields in most fields were higher than expected and thus, boll weevil impact was minimized overall in the LRGV in 1996.

Cotton fleahoppers were at treatable levels in some fields, but on average did not cause economic damage based on observations of early square set in most fields. Infestations ranged from a low of 0 to high of 12 per 100 plants. Bollworm and tobacco budworm infestations and square damage were light in 1996. The highest egg count reported for the entire season was 5 eggs per 100 plants in one irrigated field. The highest worm count for the entire season was 4 per 100 plants. Bt cotton, which was planted in the LRGV in for the first time 1996, was not impacted by bollworms or budworms since there were so few during the season.

Beet armyworms did not cause any significant damage in 1996. One field west of Lyford had as many as 7 "hits" (hatched egg masses) per 100 row feet in early June, (and which triggered the statewide use of section 18 emergency use insecticides Confirm® and Pirate®) but did not result in any economic damage to the field. There were no other significant periods of time during the season when beet armyworms were reported as potential threats to cotton.

Aphid infestations were very light overall in 1996. While some fields suffered from localized aphid infestations, compared to 1995 aphid infestations were almost of no concern during this season. In addition, aphid infestations which started to build in the early stages of cotton production were completely destroyed by parasites and predators in most fields before any damage could be caused, and thus prevented the need for insecticides and saved more "beneficials". Aphid infestations came under additional natural control late in the season when a fungus (species undetermined) developed within the population. By the middle of June, many aphids in cotton and sorghum could be found infected with the fungus.

Silverleaf whiteflies (SLWF) were also very light in numbers in 1996 compared to 1995. In fact, whitefly adults caught on sticky traps set across the LRGV were the lowest recorded since 1991. Infestations in cotton were very slow to develop. Periodic, though very light, rains fell during the season and had a negative impact on the SLWF population. Heavy rains in mid August caused a significant drop in infestation levels. Large numbers of natural enemies (lacewings, *Orius* species and various parasites) were observed feeding or parasitizing SLWF in cotton fields in 1996. Thus, levels of infestation were kept low for most of the production season. Only in cotton grown near old vegetable fields like cantaloupe and cabbage were SLWF infestations higher, and even there, SLWF was not considered a serious threat to the crop as it was in 1995 or 1991 when SLWF first seriously damaged cotton in the LRGV.

Coastal Bend (CB). The spring was relatively cool with almost no rainfall until relatively late in the season which resulted in 25% failed cotton acres, most in the southern and western CB. Thrips populations were generally higher than in past years, and fleahoppers were moderate to low. Aphid populations persisted for 3-4 weeks at more than 50 per leaf and caused substantial damage. A section 18 was approved for Furadan for aphids. Beet armyworm infestations were more widespread in 1996 than 1995 but generally caused little damage. It appeared that *Cotesia* spp. and predators effectively reduced beet armyworm numbers. Pirate and Confirm Section 18's were obtained and used on limited acreage. Boll weevils were generally lower due to the drought conditions, but where some rainfall occurred boll weevil numbers and damage were substantial. Under the dry conditions, leafminers partially defoliated some cotton. Late cotton was attacked by aphids, cabbage loopers and cotton leaf perforators. These 3 pests probably had little affect on yield or fiber quality.

Bt cotton was planted commercially for the first time on about 10% of the cotton acreage. Bt cotton yields were generally very good compared to varieties with similar long season growth characteristics. Some of the Bt acreage required one treatment for bollworms, whereas the nearby non-Bt varieties were treated twice. The Bt cotton varieties generally placed in the top 10% of variety tests.

A malady referred to as "copper top" caused certain varieties to abort most squares along with small to moderate sized bolls. It occurred where the drought was most severe. Heavy rains after a long drought resulted in heavy plant shed, especially where irrigation water had just been applied on the Upper Gulf Coast. A long rainy period on the Upper Gulf Coast delayed harvest up to 8 weeks with a subsequent loss in yield and quality.

The boll weevil eradication program was initiated at approximately 50% open boll. Excellent progress appears to have been achieved in the Southern Coastal Bend; mixed results were achieved on the Upper Gulf Coast. An increase in aphids, cabbage loopers, beet armyworms and cotton leaf perforators were noted after the BWE program was initiated.

Southern Blacklands (SB). The 1996 cotton crop in the Brazos Bottom of the SB suffered from dry weather and hot summer temperatures. The area had 40 days at or above 100°F. A week of rain in late August was a serious problem on about 60% of the crop that had not been harvested. Irrigated yield ranged from 1.3 to 1.9 bales per acre. The Texas A&M University Plantation average yields for cotton for 1996 was 1.78 bales per acre.

Early season pests were not a significant problem except for aphid and fleahopper. Most of the crop was treated for these pests. Mid-season pests problems centered around bollworm and boll weevil. Weevils were exceptionally heavy in the Hearne, Highbank and College Station areas. Bollworm moth trap catches reported by USDA scientists were higher than normal for the season. A large population of bollworms emerged from higher than normal acreage of corn in late June. There was some treatment of Bt cottons for bollworm with 1 to 2 insecticide treatments being applied during the June and July fruiting period. Boll weevil populations continued high in most areas until the crop was mature. Defoliation was a difficult task in September with the rapid regrowth produced from the late August rains.

Harvest conditions in September and October were excellent in the region. Better than normal yields were made on most farms when compared to the low yield of 1995. Irrigation bills for the season were high because of the extended drought.

Northern Blacklands (NB).The cropping year in the NB of Central Texas was dominated by a lack of rainfall during the spring and early summer. However, drought conditions were not as severe as in some other regions of Texas. Late season rainfall in some areas were beneficial and, favorable weather at harvest resulted in average yields for the region.

Cotton aphid infestations did not reach the very high levels early in the season as in 1995. Bollworm infestations were light through June and early July but increased to very high numbers following a weekend of rain in mid-July. Pyrethroid insecticides, rather than ovicides and microbial insecticides, were typically used for these high infestation levels. In other fields, ovicides in combination with large numbers of beneficial insects provided satisfactory control. In many cases, reduced rates of Furadan 4F (approved under a Section 18) or Provado were included with the pyrethroid applications to minimize the risk of subsequent increases in aphid numbers following treatment. This approach appeared successful, as in some cases fields treated only with pyrethroids resulted in increases in aphid numbers.

Transgenic Bt cotton, primarily NuCotn 33B, was planted on about 5% of the acreage. Bollworm control was very good, despite the high (but often short-lived) egg infestation levels, and very few fields required an insecticide treatment for bollworm. The year was unique in the almost complete absence of tarnished plant bug throughout the season, a pest which has been increasing in numbers and damage during the last several years. Lower winter temperatures or the lack of early season weed hosts due to the dry spring were suggested as factors limiting survival of overwintering adults or their increase in 1996.

Fields in the northeastern region of the NB suffered severe late-season boll shed and early defoliation believed to be due to root rot caused by *Agrobacterium radiobacter*. Pheromone traps for beet armyworms were monitored at several locations but no significant field infestations of larvae were reported. Boll weevil numbers increased in late season due to rainfall, but few fields were treated, leaving a large number of weevils for overwintering.

Southern Rolling Plains (SRP). The SRP area went into the 1996 season with minimal subsoil moisture. Rains in March and April made planting conditions good in the southern part of the region, but planting conditions were still dry in the northern part of the region. The crop got off to a good start with minimal insect pressure prior to squaring in the southern area. The northern area was late planted and started poorly with some isolated thrips problems. Temperatures during May and June were warmer than normal, and the crop made rapid progress prior to bloom. Moisture was scattered throughout the area during May and June. Severe storms caused damage on about 10,000 acres but overall moisture was barely adequate during this time frame.

The area experienced a heavy bollworm/tobacco budworm egg lay during the first week of bloom. Trap counts indicated that 50% of the moths were tobacco budworms. Many producers chose not to treat due to minimal subsoil moisture and the threat of going into a prolonged insect fight. The producers that treated achieved good control with high rates of the carbamates, organophosphates or *Bacillus thuringiensis*. Transgenic cotton varieties were planted on mostly irrigated acres and performed well during this egg lay and all season long. After this initial bollworm/tobacco budworm egg lay, insect problems were minimal the rest of the season. The southern part of the SRP had good rains the last week in July and during the month of August which helped the irrigated acreage, because producers kept early season bollworm damage to a minimum. Also, even the irrigated acreage did not have enough water without supplemental rains due to the dry winter. The rain helped some of the dryland acreage but also caused problems. Cloud cover was heavy for a successive ten-day period. The plant did not set fruit for at least three nodes during that time. Plants that did not have a good fruit load experienced heavy regrowth. This regrowth did not have time to mature a crop and contributed to the food source for late season boll weevils. Temperatures started cooling during the later part of August, which limited the ability of the late crop to mature and also stretched the harvest over a long period as even harvestable bolls took longer to open. The regrowth problems also reduced the quality of the crop.

Overall the crop was average or above for most of the area. The dryland acreage in the southern part of the area averaged close to 250 lb/A while the northern area averaged 180 lb/A. Irrigated acreage ranged from 550 to 900 lbs/A depending on water availability. Boll weevil eradication continues with the northern part of the area starting diapause applications for the first time. The southern part is now in the third year of the eradication program.

Northern Rolling Plains (NRP). Dry conditions that started during the fall of 1995 caused the 1996 cotton crop to get a late start. A total of only 2.06 inches of moisture was recorded at Chillicothe from January 1 through April 30. The daily high temperature averaged 87° F during May, but little rain was received through most of the area until the last week of May. In most of the area, rains the last week of May through the first week of June provided the planting moisture that allowed crop establishment. Most of the cotton planted in 1996 was planted or replanted during the second and third weeks of June. Over an inch of moisture was received at Chillicothe from three showers during the first five days of June. Cotton planting continued into the first week of July.

About 24,000 acres of cotton that was pre-watered or was planted on soil that had been fallowed was planted in May and was beginning to square in late June and early July. However, most of the cotton did not begin to square until mid-July or later. About 20% of the cotton acreage did not develop an adequate stand, and another 15% of the acreage was lost due to harsh weather conditions prior to harvest.

Thunderstorms, which provided 2.5 inches of moisture at Chillicothe, kept cotton growing in July; however, most rain events were less than 0.7 inches. August was the wettest month with 6 to 9 inches of rain received, with most of this occurring after August 24. Wet conditions continued into September with another 5 to 8 inches of moisture (rainfall) received. These wet conditions resulted in boll rot in some irrigated fields in Knox and Haskell counties. Cool cloudy weather in August and September along with the late plantings did not allow some cotton to develop adequately. This, combined with the late freeze and damp weather in November, lead to a late crop harvest.

With the dry conditions of May, boll weevil emergence was delayed. Peak numbers of overwintered boll weevils were captured in three traplines in Wilbarger, Knox and Haskell Counties June 18-20. Boll weevils continued to be captured in parts of the area in numbers greater than 4 per trap through the third week of July. Several insecticidal applications were required to control overwintered weevils in fields that begin squaring in late June or early July. With the wet conditions that occurred in August and September, boll weevil populations increased dramatically. These weevils caused heavy damage in parts of the area. In the fall of 1996, boll weevil eradication began in the Rolling Plains Central Control Zone which includes 257,000 cotton acres from the Rolling Plains area. The program began the week of September 15 and by September 29, a total of 406,341 aggregate acres in the entire control zone had been treated. Through November 17, a cumulative total of 2,939,360 acres had been treated. A killing freeze occurred November 23 and 24 in the entire area. This was about 12 days later than average.

Bollworms were a major problem in much of the area during the first three weeks of July. Infestations stripped most of the squares and small bolls from more heavily infested fields. Fields that were making good growth appeared to be most heavily attacked. Beet armyworm moths were captured in the area in numbers of 40 to 80 per trap per week during August and September. Damaging infestations developed only in scattered areas during September and early October. Cotton aphids begin increasing in mid-August. Heaviest infestations occurred in late planted cotton and in areas where repeated applications were being applied for bollworm/budworm and boll weevil control. Cotton yields are expected to be 210 pounds of lint per acre; well below average. Quality is good in most of the area.

Far West Texas (FWT). The 1996 cotton was highly variable. High winds and hailstorms reduced stands and made replanting necessary on a localized basis. Weather was dry and warmer than average from May through July. Because of this, irrigated cotton showed overall increased yields over 1995. However, dryland cotton suffered significant yield reductions and the generally poor crops led may producers to forego insecticide applications altogether. Approximately 60,000 acres of planted cotton were not harvested due to drought. Above average rainfall in September prolonged the season and caused significant regrowth in fields that had previously cut out. The increased moisture and humidity in September also increased incidence of boll rot in pest damaged bolls. An early frost in October caused some premature defoliation in late cotton crops.

The insect pest situation was much lighter overall than 1995. Bollworms, budworms, stinkbugs and aphids were much lighter than have been observed in recent years, although use of Furadan on aphids was authorized in late August and extended through September. Pink bollworm pressure was moderate to heavy and most fields required treatment. Late crops suffered the most severe damage. Bt cotton was planted on a very limited basis but proved to be highly effective against pink bollworm, even under extremely high pressure. Beet armyworms were very light overall and only a few localized infestations required treatment. Boll weevils caused significant damage in the east and northeast parts of the region. Adult weevils were consistently trapped in several new areas in the central region, but no economic impact was observed.

High Plains (HP). The production area got off to another late start with moisture too short for planting much of the rain fed cotton until well into June. Some of this dryland cotton never did get planted or did not come up to an acceptable stand. Severe weather in May involving high winds, blowing sand, and hail wiped out almost 500,000 acres. Much of this was rain fed cotton and was not replanted because of moisture shortages. The total acreage lost during this early period was about 800,000 acres.

Temperatures were nearly ideal for most of the growing season and consequently problems with seedling disease and verticilium wilt was minimal. Most of the acreage lost early was the more marginally yielding dryland cotton. This loss, coupled with warm temperatures, timely rains, and an open fall provided ideal growing conditions, resulting in record yields. Irrigated yields as high as 1750 lbs/A and rain fed cotton yields approaching 920 pounds per acre were reported. Two and one half bale irrigated and one bale per acre dryland yields were the norm rather than the exception. Very little vegetative growth control was needed, and hence little Pix was utilized. Light freezes beginning in early November prepared the crop for harvest, but the absence of an area wide hard freeze until late November resulted in a high percentage of the crop receiving harvest aid applications. The absence of an earlier hard freeze impeded leaf drop and made it difficult to kill the cotton, but overall fiber quality remained high.

Overall, pest problems were lighter than in 1995. Early season thrips and cotton fleahoppers were not much of a problem this year. A large percentage of the irrigated acreage was treated with either Temik, Thimet, or Payload; or the seed was treated with Orthene. Unlike 1995, cotton aphids were virtually absent from stands of seedling cotton. The first cold winter since 1991 reduced overwintered boll weevil survival by 90%. This, in combination with a greatly expanded fall diapause boll weevil control program (aggregate treated acreage=5,000,000), limited early season boll weevils to a few hot spot areas. There was very little insecticide use required for pests until July when a massive bollworm migration into the area, resulting in the heaviest bollworm infestations on record for the month of July. Bollworm oviposition north of Lubbock was absorbed mostly by the corn acreage. The brunt of the bollworm problem was from Lubbock south. These prolonged, heavy infestations required as many as 2-3 applications to maintain adequate control.

These insecticide applications for July bollworms were initially limited to the non pyrethroid choices in an effort to avoid flaring aphids. Eventually pyrethroids were used with the expected aphid population increases occurring within two weeks. These aphid infestations had a high percentage of winged forms, resulting in greater infestation spread and re-infestation following insecticidal control. A section 18 was requested and granted by EPA for the use of Furadan 4F. While Furadan still provided excellent control, it was not as effective as it was the last two years. Cotton aphids re-appeared in the later planted cotton to the east of Lubbock in October. While the earlier light freezes killed the leaves, these infestations were able to develop slowly on stems, square and boll bracts. The amount of honeydew produced was small, but there was considerable concern about the possibility of sticky cotton, especially after the sticky cotton problems of 1995. In fact, the West Texas Sticky Cotton task force was formed in early 1996 to track future problems and to provide management advice to growers to minimize the sticky cotton problem.

The July pyrethroid applications for bollworms probably provided excellent incidental control of boll weevil infestations, further delaying the appearance of economically damaging infestations until late August. While the enhanced diapause boll weevil control program and the harsher winter of 1995/96 reduced number of boll weevils emerging from overwintering sites by 67.2%, as measured through the Grid pheromone trapping program; ideal cotton growing conditions favored rapid increases in boll weevil numbers, resulting in an increase in boll weevil numbers of 39.2% by the fall. This resulted in a greater distribution of boll weevils, with weevils detected in all cotton growing counties in the HP area. There was a considerable number of late season applications required to prevent economic losses from boll weevils in late August and September. Where boll weevils were not controlled, up to 50 pounds per acre was lost from the top crop.

August bollworm infestations were much lighter than usual, with beneficial arthropods preventing much of the egg lay from developing into damaging larval populations. Beet armyworms appeared early in the season but larvae fed mainly on vegetative plant parts, and infestations were limited in most cases by natural mortality agents. Where economically damaging infestations did develop, Pirate, made available through a state wide section 18, provided excellent control. Bandedwinged whitefly numbers were much higher than usual in several fields, causing considerable alarm but minimal insecticide applications. Tarnished plant bugs were unusually heavy in a few fields, necessitating 1-2 applications for control.

The enhanced diapause boll weevil control program for 1996 was greatly reduced due to fund limitations. Producer concern for the referendum recall effort and the pending Texas Supreme Court review of the Hale County lawsuit which could invalidate the Texas Boll Weevil Eradication Foundation assessment mechanism, resulted in less than 50% of the possible assessment being paid for the program. Less than 3,000,000 aggregate acres were treated, with most receiving only two applications. Based on program criteria, as many as 2,000,000 acres warranted 3-4 applications. The marginal program conducted this year, coupled with a mild winter, has put the eradication effort in the HP area in jeopardy.

Research Progress and Accomplishments

Alabama. Research was conducted in several areas ranging from thrips control, Bt cotton, new chemistry, and armyworm control in the Gulf Coast area. The following is a list of findings: 1) Bt cotton must have beneficial insects to prevent economic levels of bollworm escapes in the mid-late-July window; 2) pyrethroids offer very effective economical control of bollworms, probably better than new chemistry such as Tracer and Pirate; 3) no effective controls and/or applications are available for fall armyworms; 4) NuCotn 33B yielded similar to Suregrow 125 and was no later maturing; 5) beneficial species were approximately as numerous in Bt varieties as non-Bt; 6) work is needed on mid-late-season plant bug thresholds; 7) Gaucho failed to perform again, likely due to the western flower thrips species; 8) threshold levels for the fall armyworm are currently too low since the caterpillars do not damage as many fruit per larvae as do bollworms or budworm; and 9) much educational work is needed on stink bugs, survey techniques, and thresholds. **(Alabama Cooperative Extension Service, Auburn University, Auburn, AL)**

Arizona. A commercial-scale whitefly management trial was conducted on 178 A for a second year in cooperation with the USDA-ARS. This trial included 16 treatments replicated 3 times each in approximately 4 acre plots. Treatments included ground and aerial application of insecticide, three thresholds for applications of insect growth regulators, and four insecticide use regimes. Most of the plots were planted in transgenic Bt cotton with the exception of two plots per replicate as a comparison. Whiteflies were effectively managed in all plots using University of Arizona guidelines for sampling and thresholds. Between 2 and 5 sprays were required for season-long whitefly control as well as one additional spray for Lygus bugs. By comparison, in 1995, 6 sprays were required for whitefly control alone. No treatments were required for pink bollworm or other lepidopterans in any of the plots. During the period of most rapid population growth, whitefly levels were slightly lower in ground-sprayed than in aerially-sprayed plots. Either IGR used first or conventional materials can effectively control whitefly populations. Delaying use of conventional materials may benefit natural enemy populations and aid in resistance management. Susceptibility of whitefly populations to danitol and orthene did not change in response to applications of insect growth regulators or non-pyrethroid insecticide mixtures. In contrast, susceptibility to danitol amd orthene declined appreciably in plots after danitol and orthene were applied.

Comparisons of IPM systems for sweetpotato whitefly with and without the use of insect growth regulators were conducted throughout the state (Gila Basin, Marana, Safford, Yuma). Whiteflies were successfully controlled in all treatments. In a couple of locations only one application of an insect growth regulator was used. In all locations no pyrethroids were needed in plots treated with insect growth regulators.

A sampling and threshold protocol was developed for timing the application of insect growth regulators to control sweetpotato whiteflies. This protocol was evaluated in 4 acre plots and disseminated to growers in training sessions, a University of Arizona IPM Series publication, and in-field workshops.

Whitefly preference among 22 Pima cotton genotypes varying in pubescence, leaf shape, leaf size, foliar color and maturity time was studied in the field for a second year, and studies of whitefly behavior were initiated in no-choice cage experiments, both in cooperation with USDA-ARS Western Cotton Research Laboratory. In 1995, linear relationships were found between leaf trichome density and whitefly egg and nymph numbers for the trichome range 0-40 trichomes/in2. Adult whitefly numbers did not correlate significantly with trichome density. The linear relationships between trichomes, eggs and nymphs are being used to locate whitefly non-preference and/or plant resistance originating from sources other than glabrousness.

Research on whitefly overwintering ecology and cold hardiness continued. Whitefly supercooling points and mortality response to cold temperature were evaluated in laboratory investigations. Overwintering whitefly cohorts were followed on four plant species in field studies. Population dynamics were then related to heat unit accumulation.

State-wide resistance monitoring surveys were conducted for both Lygus and whiteflies. Baseline information was collected on whitefly susceptibility to the insect growth regulators buprofezin and pyriproxyfen. Monitoring of pink bollworm susceptibility to Bollgard cotton was initiated.

Pink bollworm and whitefly control in 8,000 acres of cotton were coordinated for a second year in western Maricopa County. This voluntary, cooperative effort was initiated by cotton producers and included 8 growers and 6 pest control advisors. Growers, PCAs and extension personnel met weekly to discuss all cotton management components from an agronomic and entomological perspective. Efforts will continue in 1997.

Three replicated field experiments were initiated on commercial sites in Maricopa County to evaluate Temik for Lygus control when side-dressed at pinhead square growth stage. Lygus counts and plant mapping measurements were made weekly to evaluate Lygus effects on fruit retention. Temik treatments resulted in a significant yield increase of 140 lb. lint per acre.

Molecular markers (esterase electromorphs, mitochondria ribosomal 16S gene and mt protein encoding genes) are being developed for archiving and tracking the global distribution of whitefly biotypes/populations within the *Bemisia tabaci* complex. The transmission pathway of geminiviruses in *B. tabaci* are being defined by in situ hybridization, by polymerase chain reaction (PCR) in time course studies in simulated transmission chambers, and through identification of whitefly proteins that interact with viral coat protein epitopes. The definition of this pathway will contribute to understanding the basis for whitefly-geminivirus specificity and transmission involved in whitefly-mediated transmission of cotton leaf crumple geminivirus. PCR technologies are also being used to estimate relative frequencies of cyclodiene resistance alleles in whiteflies by PASA, and of putatively viruliferous whiteflies harboring cotton leaf crumple geminivirus in the same individual whitefly in Arizona cotton-growing areas. Preliminary data indicate great promise for application of PCR-based technology toward making accurate, rapid predictions about frequencies of insecticide resistance and potential virus vector capacities of *B. tabaci* populations in cotton. **(Department of Entomology, Maricopa Agricultural Center, Maricopa, AZ)**

Laboratory bioassays showed that *Pectinophora gossypiella* (PBW) larvae are highly susceptible to several species of entomopathogenic nematodes. Under optimum conditions, *Steinernema riobravis* infects late instar PBW larvae within 2 hours of nematode application in sand. PBW death occurs between 8-16 hours, and adult nematodes develop after 44 hours. Reproduction occurs after 72 hours and viable infective juveniles exit the cadavers. Temperature assays suggest that the U.S. *S. riobravis*, available commercially, could control *P. gossypiella*, *Heliothis virescens*, *Spodoptera exigua* and *Trichoplusia ni* in most areas of Arizona all year round. Laboratory experiments revealed that diapausing PBW were highly susceptible to entomopathogenic nematodes. Laboratory assays also indicate that F_1 *P. gossypiella* larvae from irradiated parents are more susceptible to nematode infection. Susceptibility increases with radiation dose given (4-12 krads). Several nematode species infected *Bemisia argentifolii*. Low infection levels under optimum conditions discontinued research in this area. Initial analysis of the bacterial symbiont isolated from the nematode *S. riobravis* appears to be a new undescribed species. Field trial results demonstrated effective application and persistence of *S. riobravis*. Application of the nematode at a rate of 1 billion/acre resulted in a significant reduction of infested bolls and higher cotton yields from nematode treated plots.

A predation model was developed that predicts impact of predaceous arthropods on the PBW egg stage. The model integrates results of ELISA, predator population densities and functional response behaviors. Analysis suggests that heteropteran predators removed about 20% of PBW eggs over the season. A new method for immunologically examining predator gut contents was developed. It is based on marking insect prey with rabbit immunoglobulin G and assaying predators by ELISA using goat anti-rabbit IgG. 98.8% of predator species that fed on labeled prey with chewing mouthparts scored positive. Only 29.5% of predators with piercing-sucking predators scored positive. Retention time of antigen varied depending on predator and prey species examined. A new approach for quantifying dot blots using a Minolta Chroma-Meter was developed. The Chroma-Meter was as precise as ELISA spectrophotometer. An immunomarking procedure was developed that can be used to mark thousands of predators for discrimination between commercially-reared predators and their native counterparts. A predator can be simultaneously assayed with multiple ELISAs to test for presence of marker and prey remains in gut using complementary antibodies. Field tests of the immunomarker on adult *Orius insidiosus* showed it to be superior to DayGlo dust marking. Field tests of marked *Hippodamia convergens* indicated that all marked individuals retained amounts of the immunomarker for up to 10 days and a fraction was still marked after 20 days. Cotton leafperforator (CLP) moths occurred in traps in normal versus transgenic cottons. Color of the traps did not influence CLP moth capture.

Most silverleaf (SLW) whitefly predator and parasitoids declined with increasing insecticide use. Whitefly DNA (20 countries) show no clear demonstration of different species. Pink bollworm resistance to Bt transgenic cotton has been selected. Water (150° F) did not affect SLW nymph mortality. Acyl sucrose esters gave 34 to 66% SLW nymph mortality. Air, ground or night and day sprays were not different for SLW control. Elongated epidermal cells on cotton leaves guide SLW nymphs to feeding sites. Minor veins/unit leaf area affect attractiveness. Complex SLW feeding tubes lead to plant veins. No proteolytic enzymes were found in SLW. Complex SLW salivary secretion tubes snake around mesophyll cells. Most predators use a special kind of proteinase called elastase. Vascular bundle depths, lengths per unit leaf volume and leaf thicknesses vary greatly in different cottons. Transgenic cotton had more lygus and nabids than normal cotton. SLW host preference for melons vs. cotton vs. broccoli vs. lettuce was demonstrated. Provisional SLW action thresholds for cotton were developed.

Buprofezin (0.38 lbs./ac) with adjuvant COMATE (1% V/V) gave late season control of a heavy infestation of silverleaf whiteflies at Maricopa, AZ, Yuma, AZ, and Brawley, CA at 24-40% reduction from controls. Buprofezin at 0.25 lbs./ac gave seasonal control with an efficacy of 96% reduction for the last two of 5 applications. Efficacy of buprofezin, 71, 88, and 98%, increased with increased plot sizes of 0.23 ac, 0.115 ac, and 2 ac, respectively. A test comparison of buprofezin with pyrethroid and other insect growth regulators show buprofezin efficacies of 99%. A second comparison of other chemical classes compared to buprofezin showed buprofezin efficacies of 99%, also. These results indicate that the buprofezin can provide excellent control against silverleaf whitefly and be a very useful tool for implementing integrated pest management.

A hydroponic bioassay was developed in cooperation with University of California scientists to monitor responses of whiteflies to imidacloprid. Differences in LC_{50} values were detected among three strains of silverleaf whiteflies. Data showed that the field collected strain (FS) from Imperial Valley had low LC_{50} values (0.16-0.20 mg/ml) compared to the imidacloprid selected strain (IR) (1.32-2.59 mg/ml). The LC_{50} value of the reference strain (GM) was the lowest (0.03-0.05 mg/ml) suggest the method detects susceptibility differences. Field trials were conducted at two sites in the Imperial Valley, CA to evaluate insecticide rotations as a resistance management strategy for whiteflies. Insecticide treatment regimens included continuous treatment plots with single insecticides using bifenthrin, endosulfan, chlorpyrifos and amitraz, rotation plots with the same four insecticides, and untreated control plots. All treatments were applied weekly, and bioassays of whiteflies collected from the respective treatment plots also were conducted weekly. Ten consecutive weeks of bioassay results failed to yield a discernible pattern for either the insecticide treatment regimens (continuous, rotation, untreated) or for any of the insecticides. Significant differences among the various treatments were observed in the densities of preimaginal whiteflies and in cotton yield.

An experiment was conducted in cooperation with University of Arizona, Maricopa Agricultural Center to compare high diversity versus a low diversity chemical use regime (i.e. rotation). Bioassays of resistance levels to Danitol + Orthene were conducted at the UA Extension Arthropod Resistance Management Laboratory during the early, mid and late season. Susceptibility of whitefly to insecticides decreased dramatically over the season, regardless of action threshold, method of application, or insecticide use pattern. This indicates a serious problem in Arizona cotton with cross-resistance between major pyrethroid insecticides. However, using the resistance management recommendation, the high diversity chemical use regime combined with the action threshold of 5 adult whiteflies/leaf slowed the rate at which resistance increased during the season. The results emphasize that: 1) there is a critical need for registration of new insecticide groups for whitefly control, and 2) that choice of action thresholds and insecticide use regimes will demonstrably influence the rate at which resistance to Pyrethroid mixtures build up during the season. **(USDA, ARS, Western Cotton Research Laboratory, Phoenix, AZ)**

Arkansas. Research validating the COTMAN computer based program continues. The program will be in an expanded pilot program for the 1997 growing season.

Boll weevil research includes trap crop and strip spray studies utilizing transplanted cotton and pheromone strips. Habitat mapping and emergence curves utilizing satellite imagery and GIS technology continues into the 3rd year.

Laboratory trials investigating the feeding activities of the tarnished plant bug in response to various insecticides such as imidacloprid continues.

A Bollgard gene equivalency trial was run comparing control, growth characteristics and yield. Bollworm susceptibility to the Bt (Cry IA) protein was evaluated to establish baseline susceptibility levels and screen for resistance development. Vial testing to determine bollworm and tobacco budworm resistance levels to cypermethrin and Curacron was run weekly.

Susceptibility of different varieties to thrips injury was evaluated in two locations in the central and northern parts of the state. Current research shows some varieties, such as Hartz 1215, to be much more susceptible to thrips injury, while others, such as DP20, are much more tolerant.

Insecticide screening trials were run against most of the cotton pest complex including, bollworm, tobacco budworm, cotton aphid, thrips, plant bug, spider mite and boll weevil. **(Cooperative Extension Service, University of Arkansas, Little Rock, AR)**

California. The efficacy of the registered miticides (Kelthane, Comite, Zephyr, and Ovasyn), experimental materials (Alert and Savey), Savey + Zephyr, Savey + Kelthane, and Capture was evaluated at the West Side Research and Extension Center near Five Points. Treatments were applied on 19 June. In terms of motile mites per leaf, Savey + Zephyr, Savey + Kelthane, Kelthane alone, and Zephyr alone head the population for about 28 days; Alert, Ovasyn, Savey (4 oz. Rate) showed activity for 21 days but generally slightly less than that of the more efficacious treatments. Yields were taken from these plots in October.

Predatory mite releases were made in 20 cotton fields in the San Joaquin Valley. Rates and timing of releases were studied.

Resistance bioassays continued. Populations were tested throughout the season using Petri dish assays. Large scale field tests continued to evaluate resistance management programs.

Lygus bug control was compared among 7 treatments in a test at the West Side Field Research and Extension Center. Efficacy with Provado, several pyrethroids (Capture, Mustang, Baythroid), and Metasystox were compared. The pyrethroid products provided the best *Lygus* control (90% + for 21 DAT) with the OPs and Provado giving ~75% control. However, similar results were seen with the effect of these products on beneficials. Large scale field trials to evaluate aldicarb at first square and flower were also conducted.

Insecticide resistance was evaluated for organophosphates and pyrethroids. Susceptibility varied through time and by cropping patterns.

The efficacy of 23 foliar treatments (+ an untreated) was compared in replicated field plots. Applications were made on 8 June to a population averaging ~60 cotton aphids per fifth MSN leaf. AT 7 DAT, 13 of the 23 treatments provided 85% or better control. Residual control with several products held to 28 DAT.

This insect has a long history of developing insecticide resistance and that phenomenon has certainly contributed to the lack of control in some situations. However, other factors also influence aphid control with insecticides. For instance, it has been shown that some insecticides provide greater mortality of cotton aphids on coton in May compared with cotton aphids in August. Cotton aphids growing on melons have a different susceptibility to a given insecticide than cotton aphids growing on cotton. This occurs even with previously-untreated melon and cotton plants growing side-by-side in the field. In controlled laboratory studies, insecticide susceptibility is influenced by environmental conditions and host plants. The influence of the following factors on aphid susceptibility to insecticides was studied in 1996: cotton planting date, cotton nitrogen level, cotton irrigation status, cotton boll load. After allowing the aphids to feed and reproduce on the plants for 2-3 weeks, they were bioassayed to assess insecticide susceptibility. Rapid bioassays were done with discriminating doses for Furadan, Thiodan, Capture, Lorsban, and Provado. Data analyses are underway.

Petri dish bioassays to track resistance to organophosphates, pyrethroids, and chlorinated hydrocarbons were conducted on aphid populations from the San Joaquin Valley. Results indicate some level of resistance to all three classes. Studies to determine the role of plant hosts and stage of cotton development were conducted. Date of planting and levels of nitrogen fertilization were the key variables examined on cotton.

Intensive population studies of aphid susceptibility in specific fields were also initiated. These were designed to look at an aphid population at the field level under normal pest control practices. Resistance to commonly used insecticides was evaluated.

Data continued to be collected from four whitefly trap lines which transect the San Joaquin Valley for the third year. Three of the lines are located in Kern Co. and the fourth traversed Fresno, Tulare and Kings Counties. The former three were placed two miles apart and the latter had traps spaced one mile apart. Traps consisted of 3x3 inch sticky yellow cards which were placed on permanent locations every two weeks for 24 hours. Results were similar to the previous years except that adult catches were much higher and detected further into the Valley. The southern line had the most uniform distribution while the Fresno line had higher populations on the east side than in the middle or in the west. All trap lines captured substantially more adult whiteflies in 1996 than in previous years.

Insecticide susceptibility of whiteflies continues to be monitored with the use of sticky cards and laced with critical doses of organophosphates, chlorinated hydrocarbons, pyrethroids and combinations of various classes. Two sites in the San Joaquin Valley and four sites in the southern desert were monitored. Evidence of resistance to single compounds was noted in the San Joaquin Valley, even though widespread treatments against this pest has not occurred. **(Cooperative Extension Service, Kern Co., Tulare Co., Kings Co., Kearney Agricultural Center, Parlier; UC, Davis; and UC, Riverside)**

Louisiana. A total of 1966 tobacco budworm male moths captured in pheromone-baited cone traps in 17 parishes were tested at the 10 µg/vial discriminating dose for pyrethroid resistance during 1996. The average survival for May, June, July and August was 23, 14, 50 and 43 %, respectively. The mean survival for 1996 was 39%, which also was the mean rate for 1994 and 1995. Resistance to pyrethroids in tobacco budworm appears to have stabilized based on data from 1987-1996. A total of 200 tobacco budworm male moths were tested with profenofos at 10 µg/vial. Survival was 7%, which was similar to that recorded during 1995 (6%) but lower than survival observed in 1993 (34%) and 1994 (12%). A total of 199 tobacco budworm male moths were tested with methomyl at 2.5 µg/vial during 1996. Survival was 7% which was similar to that observed in 1993 (11%) and 1994 (8%). A total of 3030 bollworm male moths captured in pheromone-baited cone traps in 19 parishes were tested with cypermethrin at 5 µg/vial in 1996. Survival during May, June, July and August was 4, 3, 9 and 5%, respectively. Mean survival for bollworm moths during 1996 was 7%, which is similar to that noted during 1991 (5%), 1992 (8%), 1993 (7%), 1994 (8%), and 1995 (6%). However, in 10 out of 99 tests done during July, survival was 20% or greater (up to 40% survival). These data indicate that pyrethroid-resistant bollworms are not uncommon. **(Department of Entomology, Louisiana State University, Baton Rouge, LA)**

Mississippi. Research was initiated to develop a trap crop - refuge crop system for managing *Lygus lineolaris* and preserving susceptible genotypes of *Heliothis virescens*. Literature searches, cage studies, and field experiments resulted in a list of 4 to 8 plant species to be field tested in 1997. This project was supported by Cotton Incorporated.

A two-year project to relate activity of different commercial formulations of *Bacillus thuringiensis* as measured by various bioassay methods to field performance was completed. Regression models describing these relationships are being developed. In addition, the activity of several wild and genetically altered baculoviruses was studies in small plot field tests in comparison with earlier commercial products. These viruses showed good activity.

A large-plot (0.5 acre plots) study was conducted in 1995 and 1996 to test various insect control strategies that include foliar applications of *B. thuringiensis*. Results compared application of *B. thuringiensis* at a high use rate (Dipel ES 2 pt/acre) alone and in combination with traditional insecticides, applied prior to and after bloom, and triggered on the basis of recommended thresholds versus applying scheduled, automatic applications. Some strategies using *B. thuringiensis* were as efficacious as traditional insecticide strategies, but added benefits of using *B. thuringiensis* were not immediately obvious in the data.

Large-plot (0.5 acre) and field-scale (25 acres) experiments indicated the transgenic cotton expressing CryIA© protein was highly efficacious and economical as compared to traditional cotton insect control strategies based on chemical insecticides.

Many field-scale research plots were box mapped at the end of the season to record cotton yield on specific fruiting sites. These data are being compared to within season data collected on fruit retention and insect pest densities to study damage rates by different insects.

A study was completed in the Mississippi delta comparing paired plots of transgenic cotton and transgenic corn expressing endotoxin protein of *B. thuringiensis* to non-transgenic cotton and corn. Seasonal abundance of different insect pests, particularly *Helicoverpa zea*, was closely followed on both crops and other wild and crop plants in the vicinity of the test.

Efforts to improve the Cotton Insect Consultant for Expert Management (CIC-EM) were initiated. A more robust knowledge base is being created from the opinions of multiple experts and the system is being made more compatible with standard computer shells. The Cotton and Insect Management (CIM) model has also been revised and several additional subroutines are being added to make the model useful as a simulator for research.

The path of transmission of *S. marcescens* by adult *Heliothis virescens* to the next generation and the longevity of the infected adults was determined. Our results show that *S. marcescens* can be present on, or in eggs produced by *S. marcescens* infected females. The increase in internal infection of eggs appears to be correlated with dose and duration of the exposure to *S. marcescens*. The highest external contamination of eggs from moths fed an aqueous solution of 10% honey contaminated with *S. marcescens* (2 x 10^8/cc) was 45.0% and internal infection of eggs from the same group of moths was 19.0%. The highest percentage of adult survival at day 10, in bacterial treatments, was 12.5% and in the controls was 85.0%.

We recently found, using ELISA (enzyme-linked immunosorbent assay, TEM (transmission electron microscopy), and BM (bioassay method) that Microplitis-Nonoccluded Baculovirus (Mc-NOBV) also replicated in *H. virescens*, and was present in *Cotesia marginiventris* (Cresson) and *Cardiochiles nigriceps* Viereck. The average percent infection of Mc-NOBV in *H. virescens* was 42%. Virus was detected in 12% of feces from *H. virescens* larvae injected with Mc-NOBV.

Thirty-eight wire-mesh pheromone traps for tobacco budworm moths (TP 50-25) were placed in an 8 km x 10 km area east and north of Sumner in Tallahatchie Co., MS, and checked weekly during the period ca. JD (Julian Date) 158-299, 1996. Nineteen of these traps were located in cotton fields near one of two different boundaries between large blocks of Bt and nonBt-cotton (10 traps associated with one boundary and 9 traps with another). Over the 2-3 km scale of the sets of traps studied, there were no significant trends ($p>0.05$) in numbers of male budworm moths caught with distance around the boundaries (boundaries = 0) in the F_1, F_2, or F_3 generations (analyzed separately). The range of the average number of males caught per trap per night wts 0-8 with an average of ca. 2.

Twenty-six of the thirty-eight traps were associated with cotton fields, and 10 of the traps were associated with either soybean fields or uncultivated areas. The remaining two traps were at the boundaries between these two types of areas and were excluded for this comparison. Through the F_1 and F_2 generations (JD 160-230), the numbers of male budworm moths caught per trap per night in the soybean/uncultivated group of traps was ca. ¼ that caught in the cotton group of traps. For the remainder of the trapping period, the numbers caught in the two groups were similar.

From 27 January through 20 April, ca. 9,800 m of row were dug for tobacco budworm pupae (5 cm deep x 23 cm on either side of the stubble) in a total of 22 randomly-chosen fields south and east of Hamilton in southeastern Monroe Co., MS. An average (SE) of 321 (67) had were found. About 5% of the pupae found were dead on any given sampling date. There was neither a significant reduction in population density of pupae over time nor increased mortality associated with the occurrence of the lowest temperature of the winter: -15°C on 4 February. There was differential mortality by pupal sex which caused a shift in sex ratio from 0.92:1 to 1.76:1 (male:female) around mid-February. This shift was not associated with an increase in the number of dead female pupae found. The major source of mortality appeared to be spring tillage: 90% of fields were tilled by 22 April by which time <1% of the F_0 generation males eventually caught had been caught in six pheromone traps (TP 50-25) located throughout the study area and checked weekly.

The characteristics of vitellogenin (Vg) and the relationship between Vg production and egg production in the tobacco budworm, *Heliothis virescens*, are being studied. The relationship between Vg production and juvenile hormone (JH) and the impact of mating on Vg and egg production are also being investigated. Vg appears in the hemolymph of *H. virescens* about 6 h after moth eclosion. Vg may be separated into two apoproteins (ApoVgI and ApoVgII) on Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE). The molecular weights were 156,065+800 for Apo Vg-I and 39,887+323 for ApoVg-II. SDS-PAGE analysis revealed that the female hemolymph Vg polypeptides appear to be identical to those from eggs, but are absent in male hemolymph. Vg concentration was significantly higher in mated females (16.8 mg/ml) than in virgin females (10.6 mg/ml) of the same age at 48 h after emergence. Rates of egg production increased as Vg production increased; rates of egg production in mated females were significantly higher than those of virgin females at 48, 72, 96, and 120 h post emergence. Vg production is dependent on JH, because hemolymph from decapitated females lacked Vg while that of decapitated females treated with synthetic JH had Vg at levels comparable to similarly aged, normal *H. virescens* females. Hemolymph JH titers in mated females were significantly higher compared with those in virgin females at all sampling periods. The high JH level in mated females may explain the high Vg and egg production in mated *H. virescens*. Future studies are aimed at explaining the dynamic nature of the JH mediated reproductive activities in this species and how it relates to sex pheromone production.

Results of the large plot (field size) evaluation of production strategies indicated that the NuCotn33 transgenic cotton tended to out-yield conventional cottons planted in 2 hill and 3 delta locations. Treatments within this trial included NuCotn33 receiving three early season applications of acephate at 0.33 lb (AI) per acre beginning at the fourth true leaf stage followed by insect control according to the Cotton Insect Control Guide (Bt-aggressive early season), and conventional cotton (conventional-CIC) and NuCotn33 receiving treatments for all insect pests according to the Cotton Insect Control Guide (Bt-CIC). Averaged across the five locations, Bt-aggressive early season, Bt-CIC and conventional-CIC treatments produced the following respective lint yield: 857 lb, 881 lb, and 827 lb. Estimated per acre cost of foliarly applied insect control applications was $32.15, $28.46, and $46.12, respectively, including $15.00/acre for the volunteer boll weevil program in Ittawamba County. Cost of licensing the transgenic cotton would increase costs for those two treatments by $33.00 per acre raising total insecticide costs for Bt cotton above that of the conventional cotton in 1996. This is primarily a result of very low tobacco budworm densities in Mississippi during 1996. At some locations, Bt cotton required additional insecticide treatments directed toward plant bugs and boll weevils, and bollworms required treatment with insecticides in the transgenic cotton at one test location.

Small plot research included strategies to determine application regimen for Imidacloprid for aphid control, strategies for reducing insecticide spray costs by judicial choice of materials based on cost and efficacy, and strategies for possible elimination of in-furrow insecticide for thrips control for late plantings. In addition, the Cotman program was evaluated for accuracy in predicting the last date for effective insecticide applications for heliothine control in cotton; however there were too few insects in any of the 28 fields monitored to provide adequate data for evaluation. Numerous small plot pesticide efficacy evaluations were made for heliothines, aphids, thrips, and tarnished plant bugs to provide information for state recommendations.

A fully functional, computer operated, tractor mounted, small-plot spray system has been developed and tested during 1996. The system has promise for producing a small plot application system using multiple spray containers mounted on the tractor and eliminating all direct contact of the operator with spray materials, valves or containers. This would allow use of a single operator in an air conditioned, protected environment with complete electronic control of all spray operations. **(Dept. of Entomology, Mississippi State University, Mississippi State, MS)**

The period of time required for boll weevils to develop the diapause syndrome was studied as part of a State-Supported Cotton Incorporated Grant. Weevils originated from punctured squares collected in fields between July and September. Squares were placed in computer controlled cabinets to induce diapause. On emergence, adults were held under 8 constant temperatures, fed squares daily, and dissected at different times to determine the amount of fat accumulated with age. Fat development was used as an indicator of how long diapause-induced weevils would have to feed before leaving the field in search of overwintering quarters. Data are being analyzed and simulation models will be derived to estimate the duration of diapause intensification under various late-season environments. The models should provide the best information available on windows of opportunity for killing weevils before they leave fields, thereby optimizing the timing of diapause control applications. Cooperative research between ARS and University of Texas was also conducted to better understand the physiological mechanisms involved with diapause induction in the boll weevil. Results of this research are being analyzed.

Efforts continue on assessment of speech recognition technology for collecting information valuable for cotton management. Of several speech engines available, work has continued with the IBM product, Voice-Type Application Factory (VTAF). With this toolkit, C++ can be used to write customized applications. The initial application for cotton plant mapping has been improved by building a utility that permits any user to name their own fields. Progress has been made in mapping positions from the original rate of twenty words per minute to a current rate of forty words per minute. The major limitation for wider use of the software is the fact that for different users, some people can use it without error, but for other people, numerous errors result. This result means that the system needs to be customized for each user by adjusting several system parameters. Several ideas to automate the process of system calibration are being considered. When this difficulty is solved, it is anticipated that a software product will be ready for release.

The scouting protocol developed has been confirmed to be feasible for use under commercial applications, but needing more work in developing training procedures. The rule-base in rbWHIMS needs to be revised since the transgenic cotton varieties are now released for commercial use.

Several non-replicated factorial procedures have been developed to explore simulation model performance and behavior for two to six system parameters, at several settings (or levels) simultaneously. The value of this work is that methods of testing simulation models are now available similar to the traditional analysis of variance.

Field observations indicate a persistent concern that plant bugs are becoming increasingly difficult to control with currently available materials. Field observations would suggest that ULV Malathion (12-16 oz/ac) is still effective in late-August cotton for at least 2.5 days after application, if rain or heavy dew falls have not occurred. (**USDA, ARS, Crop Simulation Research Unit, Mississippi State, MS**).

In preliminary laboratory studies, tarnished plant bugs were irradiated with 0.5 Krad of ^{137}Cs irradiation and outcrossed to normal bugs. There was 19.7% progeny from treated male crosses and 10.8% progeny from treated female progeny as compared with 66.4% progeny produced in the control. Progeny of T♂ X U♀ matings outcrossed to normal plant bugs resulted in a 40% increase in sterility from F_1 ♂ X U♀ crosses and no change in F_1 ♀ X U♂ fertility as compared with the parent mating. Progeny from T♀ X U♂ matings resulted in 70% decrease in sterility from untreated F_1 ♂ matings and a 46% decrease in sterility from untreated F_1 ♀ matings. Controls averaged about 68% of emergence of adults. Collection of egg samples averaged about 200/mating.

Tolerance of natural enemies to residues of insecticides that may be used for boll weevil control in the Eradication Program was determined. Mortality 24 h after treatment was high for all the natural enemies for all insecticides when the insects were immediately exposed to cotton leaves sprayed with an insecticide. Malathion at 16 oz/A resulted in 92.5, 100.0, 100.0, and 100.0% mortality for *Geocoris punticeps*, *Cardiochiles nigriceps*, *Bracon mellitor*, and *Cotesia marginiventris*, respectively. Similar results were obtained for malathion EC at 1.0 lb/A. Fipronil at 0.05 lb/A resulted in 77.5 and 85.0% mortality for *G. punticeps* and *C. nigriceps*, respectively. Cyfluthrin at 0.033 lb/A resulted in 95.0 and 80.0% mortality for *G. punticeps* and *C. nigriceps*, respectively.

Incidence of parasitism of tobacco budworm larvae associated with tobacco nurseries in cotton plots was determined. Percent parasitism by *Cardiochiles nigriceps* was highest in the tobacco nurseries, 47.9% and similar in cotton plots with a nursery, 10.0%, and cotton plots without a nursery, 28.6%. The tobacco nursery served as a sink for the pest and a place of refuge and population increase for the parasitoid. Further research needs to be conducted to determine if the tobacco serves as a source of the parasitoid for the cotton. These results do indicate that a tobacco nursery could provide a protective habitat for this natural enemy when insecticides are sprayed in the cotton field for control of pest species.

Field comparisons of the effectiveness of 8 and 12 oz. per acre of technical malathion, aerially applied, confirmed the effectiveness of both rates. A rate of 4 oz. per acre also resulted in significant kill of boll weevils, but the 4 oz. rate was not as effective as 8 or 12 oz.

During 1996 we have advised the Mississippi Boll Weevil Management Corporation in the use of the Geographic Information System (GIS) that we developed and named Geosys. Geosys has been used to monitor boll weevil infestations in the states of Mississippi, Tennessee, and Missouri. During the coming year it will be used as part of the Boll Weevil Eradication Program in Mississippi. Satellite images will be used to locate cotton fields, and these images will be placed in the GIS along with trapping data to monitor the eradication effort.

The computer software, Exporters, is being developed for use in remote sensing. We are using six spectral light bands composing the satellite images to identify the fields planted in cotton when a satellite recorded the areas of interest. Results look very promising and optimum image rendering is expected within six months. The data derived from this type of selective imagery is of use in the Boll Weevil Eradication Program and to aid in the placement of cotton pest field traps. **(USDA, ARS, Integrated Pest Management Research Unit, Mississippi State, MS)**

A transition year study designed to further investigate large area pest management techniques was conducted. This study required the organization and planning for treating a 25,000 acre test area 2 times with a formulation of nuclear polyhedrosis virus (NPV). In that test, the application coverage on the target plants was monitored, larvae collected from plants were examined to determine the incidence of infection, and the insect emergence was examined through the use of field cages. Although the cage areas that received 2 applications of virus resulted in no adult moth emergence, the very low numbers of tobacco budworms and cotton bollworms emerging produced inconclusive results regarding the field cage data since the emergence was too low to be of significance. Although larvae were difficult to find on early season plants, 65% of those that were collected and examined were infected by the virus.

Due to the devastating population of beet armyworms in Texas cotton in 1995, a large-plot field trial was planned and organized in cooperation with other ARS, APHIS, and Texas Boll Weevil Eradication Foundation scientists, designed to evaluate the effectiveness of the beet armyworm NPV for use in the control of that pest within the boll weevil eradication program in Texas, as well as the evaluation of its use in Mississippi cotton. The incumbent planned the test and arranged for the materials and equipment for the study. Although the populations were carefully monitored and the trapping data used in various reports at both locations throughout the season, the numbers of beet armyworms needed for field testing did not occur.

The first year of a two-year field test to study the activity and incidence of beneficials in Bt cotton as compared to non-Bt cotton was begun in 24 field sites in Washington County, MS. Field collections were made weekly. The first season's data are being summarized for analysis.

Laboratory studies were conducted on a lepidopterous larval parasitoid *Campoletis flavicincta* (Ashmead) (Hymenoptera: Ichneumonidae) imported from Argentina. Laboratory studies on the biology of this parasitoid were conducted to evaluate its effectiveness as a potential biological control agent for *Heliothis virescens* (F.), *Helicoverpa zea* (Boddie), and/or *Pseudoplusia includens* (Walker). Tests were conducted to evaluate host range, fecundity, and longevity of the parasitoid at 27°C, 60% RH, and a photoperiod of 14:10 LD. Results from the studies are currently being tabulated for analysis.

Production of insects for USDA-ARS research by the Stoneville Insect Rearing Unit required maintenance of seven insect species: *Heliothis virescens, Helicoverpa zea, Anticarsia gemmatalis, Pseudoplusia includens, Spodoptera exigua, Cardiochiles nigriceps,* and *Cotesia kazak*. Support of USDA-ARS scientists at Stoneville, Tifton, GA, Mississippi State, MS, College Station, TX, and Weslaco, TX, as well as state and industry scientists required production of 155,700 *H. virescens* pupae, 285,000 *H. zea* pupae, 141,000 *P. includens* pupae, 98,100 *A. gemmatalis* pupae, 146,000 *Spodoptera exigua* pupae, 146,000 *C. nigriceps* cocoons, 40,502 *C. kazak* cocoons, 106,049 *H. virescens* eggs, 38,925,000 *H. zea* eggs, 36,203,000 *P. includens* eggs, 895,800 *A. gemmatalis* eggs, and 36,650,000 *S. exigua* eggs. Additional research support included mixing, dispensing, and filling 99,570 plastic cups and 714 3.8 liter multicellular trays and artificial diet. Total diet mixed and dispensed in 1996 was 12,060 liters. Several short courses in insect rearing techniques were given to employees of: Abbott Laboratory, Chicago, IL and BASF, Greenville, MS. Approximately 150 researchers located in 37 states, England, Canada, and Japan participated in Cotton Foundation and United Soybean Board Insect Distribution Programs.

A second-year study of boll weevil emergence and movement of the boll weevil in the mid-delta of Mississippi showed that (1) boll weevils suffered a high degree of winter kill in 1995-96 in that numbers of emerging overwintered weevils were much lower in 1996 than in 1995; (2) these low numbers increased rapidly, however, in generations 1-3 to the point of high numbers in late season similar to 1995; and (3) as in 1995, considerable movement of overwintered and first generation weevils occurred after bloom as detected by pheromone traps, especially 1-3 miles from the closest cotton. Samples of weevils were retained from all traps for sex determination and pollen examination for host feeding detection.

Results from a test of two insecticide treatments (7 days apart) for cotton aphid on NuCotn 33 and Sure-Grow 125 at three different growth stages (pinhead square, full-grown square, first bloom) showed that (1) all 3 treatment stages in NuCotn 33 yielded more cotton than an untreated check, but bloom treatment was best; (2) no treatment of Sure-Grow 125 yielded significantly higher than the untreated check; and (3) NuCotn 33 yielded 197 lb lint per acre more than Sure-Grow 125. Sure-Grow 125 was treated once for bollworm/budworm; NuCotn 33 was not treated for worms; and both varieties received 6 treatments (2 at pinhead square; 4 in August) for boll weevil and tarnished plant bug. The test will be repeated in 1997.

Furadan at 0.25 lb AI/A and Provado at 0.047 lb AI/A provided significant reduction in cotton aphid numbers at 2, 5, and 7 days after treatment when samples were taken in the top and middle portions of the plant. Capsyn at 1 gal/50 acres (3300 Capsyn heat units) provided no significant reduction in aphid numbers when compared to an untreated check.

Data analyses are incomplete in a study comparing two biological insecticides (Javelin and Gemstar) applied at pinhead square to 3 fields each inside and outside a 7-mi circle treated early with Gemstar virus in an area-wide management program for bollworm/budworm. Weekly samples for all insects were made in 24 total fields (inside and outside virus area -- 3 reps each of Javelin, Gemstar, no treatment, and Bt-transgenic cottons). Data will be analyzed during the winter, and similar or slightly modified studies will be repeated in 1997.

Moth trap records in 1996 compared to 1995 data collected at the same trap sites showed that (1) beet armyworm numbers were 60% as high, (2) cotton bollworm numbers were over 3 times higher, and (3) tobacco budworms were 33% as high as 1995 numbers. The higher numbers of cotton bollworms and lower numbers of tobacco budworms beginning the season and increased corn acreage are two contributing reasons for higher cotton bollworm and lower tobacco budworm numbers during the 1996 season.

A large field plot study to compare sampling (sweep net, drop cloth, and visual) and economic thresholds for tarnished plant bug control that are currently recommended in the Insect Control Guide were evaluated in Stoneville 474 cotton. Extremely low populations of plant bugs occurred in test field in 1996 prior to initiation of bollworm sprays.

Spray table tests were conducted with Fipronil (Rhone-Poulenc) on resistant tarnished plant bug populations. Two formulations of Fipronil (commercial formulations) showed excellent activity on resistant plant bugs.

A large field plot study to study the effects of seed treatments, in-furrow and sidedress treatments on early season insect populations and yield were evaluated in Bt and SureGrow 501 cotton varieties. Populations of early season insects were low in 1996 and were not influenced by any particular treatment. Although tarnished plant bug numbers were low, higher populations occurred in the Bt cotton. Treatments with in-furrow applications of Temik and Admire and sidedress Temik applications had higher yields than Gaucho and Orthene seed treatments.

A small plot cage study was conducted to determine the efficacy of Guthion 2L, Guthion 3F, Vydate, Methyl Parathion, and Fipronil on the boll weevil. Sleeve cages were used to hold weevils on treated cotton plants. When compared to an untreated check there was no difference between treatments when weevils were caged immediately after treatment and mortality read after 24 h exposure. The highest mortality at 48 h of weevils that were caged 1 day post treatment occurred in the Fipronil, Guthion 2L, Guthion 3F, Vydate, and methyl parathion treatments, respectively.

Populations of the tarnished plant bug were studied in DES 119 nectaried and DES 119 nectariless cottons. Low populations of plants bugs were observed through July in both cotton plantings. Higher first pick yields were observed in the 119 nectariless cotton. There were no differences in total yield.

Several Federal and university scientists in the northeast United States conducted cooperative greenhouse studies in 1996, evaluating the Egypt strain of *Encarsia formosa.* Collectively, our results and the results from these greenhouse studies have led to an effort to develop a CRADA between APHIS, ARS and private industry. This effort is currently in progress.

Several studies (1995-1996) evaluated the effect of host plant on parasitoid efficacy. These studies included four strains of *E. formosa* (Greece strain, Egypt strain, Commercial strain, Beltsville strain), and a diverse group of economically important host plants (cotton, cabbage, tomato, bean, cantaloupe, hibiscus, poinsettia). Parasitoid biological parameters measured included adult longevity, life long fecundity and percent parasitism, as well as parasitoid developmental rate and percent emergence. While *Bemisia argentifolii* 3rd instar nymphs were evaluated, whitefly eggs and early instar nymphs were also provided since these life stages are utilized as food by adult parasitoids. Host plant leaf area and hair density were measured as potential factors which may affect searching efficacy of the adult parasitoids, and therefore the various biological parameters. Data analysis is in progress.

Currently, a cooperative effort is focused on the evaluation of interspecific interactions among parasitoid species being considered for utilization in the suppression of the silverleaf whitefly. A grant proposal is near completion and will be submitted.

In concert with parasitoid evaluations, and as a prerequisite to subsequent field evaluation and release programs, a survey of the whitefly and associated parasitoid species in Mississippi was initiated in 1995 and expanded in 1996. Similar surveys have been conducted or are in progress in other states in the southern U.S. Much effort was made to establish and coordinate collection of whitefly infested plant samples from throughout the state, with APHIS, the Mississippi State University Agricultural Extension Service, and private industry. In 1995, 179 samples were collected and four whitefly species tentatively identified (greenhouse whitefly, bandedwinged whitefly, sweetpotato whitefly and silverleaf whitefly. Whiteflies were found infesting a wide variety of ornamentals (17 species), vegetables (10 species), cotton (various varieties), soybeans (various varieties), and various weed species extending across 17 counties. Parasitoids were collected from 72% of the 179 samples. Results from the 1996 survey are currently being tabulated and analyzed. To date, however, a total of 271 samples have been collected from 25 counties in 1996. Samples have been collected from a total of 48 plant species, including cotton, soybean, 6 vegetable species, 26 field ornamental species, and 14 greenhouse ornamental species, representing 45.4%, 11.1%, 7.7%, 18.5% and 17.3%, respectively, of the samples collected. Whiteflies were found infesting 68.3% of the plant samples collected, and were found in all 25 counties. Whitefly identifications (based upon nymphal morphology and the expression of the silverleaf symptoms in zucchini) indicated that the same 4 whitefly species found in 1995 were again present in 1996. Whitefly-infested plants were predominantly bandedwinged whitefly (55.7%), followed by sweetpotato whitefly (22.7%), greenhouse whitefly (11.9%), and silverleaf whitefly (9.7%). In particular, silverleaf whitefly was collected from: tomato (greenhouse), hibiscus and pansies (greenhouse), and henbit, creeping lavender lantana, candlelabra tree, hibiscus (Lord Baltimore), native rudbeckia, night shade, pansies, rudbeckia hirta, and tropical soda apple (field ornamentals). Finally, parasitoids emerged from only 11.4% of the whitefly-infested plant samples collected. The majority of the parasitized whiteflies were bandedwinged whitefly collected from cotton and soybean fields. The low overall incidence of parasitization is likely due in part to low whitefly density levels, as well as the differing pesticide use patterns in the various cropping systems. Parasitoid identifications and continuation of this survey will be performed during 1997. A detailed discussion of the results will be prepared following a more thorough analysis of the data (including comparison with 1995 data). With assistance and training from Dr. Greg Evans (whitefly parasitoid taxonomist at the University of Florida, Gainesville) during 1996, identification of parasitoid specimens collected during both years are in progress. This survey will continue through 1997.

Efforts were continued in the development of collaborative research with Dr. Regina Vilarinho de Oliveira (EMBRAPA, CENARGEN, Brasilia, Brazil), where the primary object is to explore for and evaluate New World parasitoid species in Brazil for control of *B. argentifolii*. A grant proposal, authored by Dr. Oliveira, was submitted to EMBRAPA and CNPQ following our joint meetings at the SICOMBIOL held in Brazil during June 1996.

A survey of the Arkansas, Louisiana, and Mississippi Delta was conducted again in the spring (April-May) and fall (September-October) of 1996 to determine how widespread pyrethroid resistance was in tarnished plant bug populations in the Delta. The study was a repeat of the survey conducted in 1995 and used the same collection locations and time periods in both years. At least 50 adult tarnished plant bugs from each of 71 locations (6 in Louisiana, 17 in Arkansas, and 48 in Mississippi) were tested for pyrethroid resistance in the spring and fall. The bugs were exposed in glass vials (2 adults per vial) treated with a discriminating dose of 15 μg of permethrin for a 3-h period after which mortality was determined. Susceptible populations (mortalities >90%) were about the same in number in the spring with 30 and 32 of the locations having susceptible populations in 1995 and 1996, respectively. In the fall only 11 and 6 locations in 1995 and 1996, respectively, had susceptible plant bug populations. These results showed that pyrethroid resistance was widespread in the Delta and was increased in both years from spring to fall by selection pressure with pyrethroid use in cotton. The decrease in resistance seen in both years from fall to spring was due to the resistance being recessive and the production of 3-4 plant bug generations on wild hosts out of cotton during September-November and April-May of the following year.

A colony of plant bugs having unusual bright red eyes was reared through 1996 in the laboratory and the inheritance of the red-eyed trait was studied. The trait was found to be due a single recessive gene which was not sex-linked. To determine the occurrence of the red-eyed trait in nature, all adults and nymphs collected in the resistance survey of the Delta (discussed above) during the fall of 1995 and in the spring and fall of 1996 were examined for the red-eyed trait. A total of 15,697 adults and 8,904 nymphs were examined, and no red-eyed individuals were found. Fitness of the red-eyed bugs in the laboratory (egg production, percent egg hatch, nymphal developmental time, nymphal survival) was found to be the same as normal eyed bugs.

A large plot field test designed to evaluate treatment thresholds currently recommended by the Mississippi Cooperative Extension Service for the control of tarnished plant bugs in cotton, was conducted on a growers farm near Indianola, MS. Unfortunately, plant bug numbers found in the plots during June and July were too low to properly evaluate the test.

A study was conducted in cooperation with the University of Arkansas to determine the effect of certain plant hosts of the tobacco budworm and cotton bollworm the Mississippi Delta on virus persistence. A commercial formulation of the baculovirus from the cotton bollworm (Gemstar) was applied to crimson and white clover, and to cutleaf wild geranium. Tobacco budworms feed on white clover collected at 0, 1, 3, and 6 days post-treatment with virus produced virus-induced mortalities of 77, 31, 13, and 2 percent, respectively. Mortality due to virus did not differ significantly from the control after 3 days. Virus-induced mortality on treated wild geranium indicated 73 percent mortality on day 0 and 38 percent on day 3. These results did not correspond well to earlier studies where 47 percent mortality was demonstrated 9 days after application. Since the virus preparations were different, further studies will have to be conducted to evaluate not only the persistence, but the virus formulations and products as well. **(USDA, ARS, Southern Insect Management Laboratory, Stoneville, MS)**

Missouri. The third year of a study on the distribution of overwintering boll weevils was completed. A 4 mile X 4 mile grid similar to that used during the 1995 growing season was established over the entire southeastern Missouri cotton production region. Overwintering boll weevil numbers were much lower than the preceding year but distribution across the region was similar. There appeared to be some contraction of weevils from marginal areas. The Missouri Department of Agriculture conducted an intensive trapping effort in the two counties with histories of high boll weevil populations. The results of both these studies are discussed in greater detail elsewhere in these Proceedings.

Winter temperatures in boll weevil wintering habitat were monitored at seven sites across the Bootheel. Low air temperatures down to 5°F were observed at several sites; the lowest temperatures under native leaf litter approached 10°F for short periods.

The second year of a three-year study on the impact of warm season grass wind erosion control strips on cotton insects was completed. The trials consisted of five treatments: conventional cotton with insecticides as needed; conventional cotton with no insecticides; cotton with a four-row rye strip every 24 rows; cotton with a four-row switch grass (*Panicum virgatum*) strip every 24 rows; and cotton with a four-row strip of switch grass and broad-leaved forbs every 24 rows. Thrips numbers appeared to be higher in those plots with rye strips than in other treatments in one of the two test locations. Of plots with a vegetation strip, ant numbers were highest in rye strip plots and lowest in switchgrass-forb plots. While it had no bearing on the cotton crop, stalkborer damage to the switchgrass was much more severe in switchgrass-forbs plots than in pure switchgrass plots. Few other differences in pest insect abundance were observed this year.

Registered and experimental insecticides were evaluated in 6 trials; however, generally low insect pressure reduced the rigor of the tests. **(University of Missouri Agricultural Experiment Station, Delta Center, Portageville, MO)**

New Mexico. With the recent incursion of boll weevil into New Mexico, testing has been initiated to collect basic information to help direct control efforts. Trapping programs are being run throughout the state with responsibilities for those programs being assumed by personnel from NMSU extension service and the New Mexico Department of Agriculture. Funding is through NMSU, NMDA, and voluntary bale assessments by farmer cooperatives. Testing to evaluate boll weevil overwintering success and influence of habitats has also been initiated this fall. During 1996 a collaborative project with USDA Methods Development Lab (Phoenix) was initiated to evaluate the impact of bait sticks to reduce spring establishments in cotton fields. Boll weevil populations were too low to detect differences among treatments until October. At that point results were somewhat variable but promising enough to continue testing this spring.

Research on pink bollworm included field evaluations of the nematode, *Steinernema riobravis*, in the Mesilla Valley. A plowdown test was also initiated this fall to evaluate differences among plowdown dates, plowdown methods (chisel vs. moldboard plow) and the influence of fall irrigation in the Pecos Valley where pink bollworm has been an increasing problem in recent years.

Field tests were also conducted to evaluate activity of new insecticides, including Tracer and Confirm, and their effect on non-target arthropods. Results analyzed to date indicate that Tracer kills beet armyworm faster than Confirm, but Confirm has longer residual activity. Non-target data are being processed.

The effect of Bollgard cotton on insecticide susceptibility in beet armyworm is also being examined. Initial results indicate that prior feeding on B.t. cotton can enhance insecticide susceptibility. A study to evaluate the impact of tiger beetles on pink bollworm mortality in the Pecos Valley was also initiated this season. **(Cooperative Extension Service and Department of Entomology, Plant Pathology, and Weed Science, New Mexico State University, Artesia and Las Cruces, NM)**

Boll weevil has been well established and highly destructive in cotton fields throughout the southeastern U.S. for nearly a century. More recently it wreaked havoc in cotton in the extreme southwestern U.S. and northern Mexico but it had never successfully established itself in New Mexico until the 1990s. Following the surge in boll weevil populations and dispersal from the Texas Panhandle/High Plains area in the early 1990s, adult boll weevils were detected in sentinel pheromone traps posted in southeastern New

Mexico as early as 1992, with sharp, 3 to 18-fold increases in trap captures in 4 southern counties by 1994.

In 1995, the New Mexico Department of Agriculture, the Cooperative Extension Service (New Mexico State University) and USDA-APHIS-PPQ worked cooperatively to monitor pheromone traps for boll weevils in most of the cotton producing counties of the state. The three agencies posted 1,468 traps at varying densities in cotton fields scattered over 8 southern and eastern counties in New Mexico; in addition, USDA-APHIS-PPQ in El Paso trapped cotton production areas in adjacent El Paso County, Texas. After servicing the traps from May through November, results showed total captures of 4,761 boll weevils in Dona Ana County, 7,516 boll weevils in Chaves and Eddy Counties, 2,276 boll weevils in Roosevelt County and 42,210 boll weevils in Lea County; a single boll weevil captured near Tucumcari, Quay County, was a new county record and also the farthest north record for the pest in the state. Boll weevils were not detected in traps in either Luna or Hidalgo Counties.

In 1996, the same agencies resolved to trap again for boll weevils, dividing the acreage surveyed in 1995 a little differently, adding some new counties, and bringing in (to one report) results compiled by other cooperators from Mexico (USDA-International Services) and west Texas (USDA-APHIS-PPQ in El Paso and the Texas Agricultural Extension Service in both El Paso and Ft. Stockton). The resultant report drew together boll weevil surveyors and their results plus cotton producers from contiguous areas to provide a forum for discussion and planning as well as an improved picture of the pests' threat to the entire area of New Mexico, West Texas, and the Juarez Valley of Mexico.

Traps were established and baited in all areas in April and May, 1996; trap densities varied from 1 trap/2A in parts of Dona Ana County, New Mexico where boll weevil captures were highest in 1995 to approximately 1 trap/40A where the pests were not detected in 1995. Trap densities were supplemented when boll weevils were detected in new areas as resources permitted.

Traps were serviced weekly in Dona Ana, Chaves and Eddy Counties of New Mexico plus the "hot spots" found in west Texas in 1995. Other trap lines were serviced every other week or as resources permitted in more remote areas. By season's end, 33 people participated in servicing boll weevil traps somewhere in the region; all captured at least one boll weevil during the project.

Samples of specimens were taken from the traps and forwarded to designated identifiers at the New Mexico Department of Agriculture, USDA-APHIS-PPQ, El Paso, or Texas A&M University, as appropriate. Trap counts from all cooperators were scanned or electronically processed through a computer data base maintained by NMDA; data were summarized and disseminated weekly via electronic mail or FAX from May 17-November 15, 1996 to a list of over 50 cooperators and cotton producers (through their local gins). Also, in the Mesilla Valley, once boll weevil captures were verified daily, daily trap-by-trap email reports were made to selected local cooperators in charge of making pest control decisions or to those needing to be aware of pest interceptions on a timely basis.

Two trends in boll weevil captures were observed again in 1996: Lea County, New Mexico traps were consistently productive from the onset of the trapping season although trap captures did rise dramatically toward the end. This was observed to a lesser extent with traps monitored in Pecos, Ward and Reeves County, Texas. Other sites in New Mexico, west Texas and Mexico produced few or no boll weevils during the spring or early summer; trap captures were extremely abundant at most of these sites by late fall. In the end, the only trap line anywhere in the region that did not produce any boll weevil captures was for the Virden Valley area of north Hidalgo County, New Mexico.

While Lea County consistently produced boll weevils with every trap check throughout the season, the dates for first captures in other New Mexico trapping areas varied (proceeding from western counties to eastern and north); Hidalgo--September 6; Luna--September 17; Dona Ana--April 3 through May 1 for the first 3 specimens of the year and August 25 for the beginning of the late summer emergence and dispersal season; Otero migration line (see below)--September 19; Chaves and Eddy Counties--May 1; Chaves and Eddy County migration lines (see below)--August 22; Roosevelt--July 12; Curry--October 4; and Quay--October 15.

In west Texas, the dates for first captures of boll weevils in pheromone traps were: Pecos County--May 9; Ward County--May 22; Reeves County--June 17; El Paso County--October 2. For the Juarez Valley trap lines the one and only capture of a boll weevil was reported on October 18.

To gain a better appreciation of boll weevil dispersal flight dynamics, two trap lines were established in remote, desert-like, non-cropping areas of New Mexico in late summer: a north-south trap line through Loco Hills with 27 traps in Chaves County and 48 in Eddy was established in mid-August; a second north-south line from Tularosa to Newman (Highway 54) in Otero County was established in mid-September with 54 traps. Despite being 30-50 miles in any direction from the nearest cotton fields, both lines produced boll weevils shortly after establishment, suggesting that dispersal flights in excess of 30 miles were possible for these pests.

Trap lines were removed in remote areas beginning in late October, after a killing frost, and in remaining areas in mid-November. **(New Mexico Department of Agriculture with New Mexico State University, Las Cruces, NM)**

North Carolina. A statewide damaged boll survey, initiated in 1985 to determine the temporal (year to year) and spatial impact of late-season bollworms/budworms (*Helicoverpa zea/Heliothis virescens*), European corn borers (*Ostrinia nubialis*), fall armyworms (*Spodoptera frugiperda*), and stink bugs (mostly *Acrosternum hilare*) was expanded in 1996. A total of 404 fields from 28 counties was surveyed: 115 Bollgard fields, 115 paired conventional fields (selected either adjacent to the Bollgard fields or with the same producer), and the remainder conventional fields. Additionally, late-season aphid ratings and plant heights were taken. In the conventional paired cotton fields, bollworm/budworm boll damage, at 4.44%, was higher than the 10-year average of 3.91%, while the Bollgard fields averaged 2.3% bollworm/budworm damage. European corn borer damage, at 0.29%, was the lowest in the 10-year survey history which averaged 1.68%; the Bollgard fields averaged about 1/10 this amount with 0.03% damaged bolls. Fall armyworm damage was extremely low in both Bollgard and in conventional fields in North Carolina in 1996. Total caterpillar damage for the paired conventional fields was 4.83%, less than the 11-year average of 6.14%, while the larval damage in the Bollgard fields averaged 2.30%. Stink bug damaged bolls in the paired conventional fields was 0.75%, while stink bug damage in the Bollgard fields was about 4.5-fold higher, at 3.03%.

A survey of North Carolina's licensed independent crop consultants working on cotton was conducted in 1996 to gather data on how both second generation (June and early July) tobacco budworm populations and about how Bollgard cotton was being assessed and managed by these individuals. Twenty-one of the 22 consulting firms contacted responded to the survey, representing 267,530 acres. A high percentage of the acreage was scouted for early budworms (87%). All but 5 of the firms advised some treatment for these early budworms on a total of 16,703 acres (or 7.1% of the acreage monitored for budworms). For tobacco budworm control, 97.1% of the acreage received a pyrethroid and the remainder was either Larvin, a Larvin plus pyrethroid tank mix, or Pix plus Dipel (on a few fields). North Carolina's crop consultants managed approx. 7,500 acres of Bollgard cotton: 3,288 was not treated, 3895 was treated a single time, and 235 required 2 applications, for an average of 0.588 applications per acre. Their non-Bollgard cotton was treated an average of 3.06 applications, essentially all for bollworms.

Two early-season tobacco budworm management tests were conducted in 1996 in southern North Carolina. One of the tests evaluated pyrethroid alternatives, including a carbamate (Larvin), a naturalite at 2 rates (Tracer), a pyrrole (Pirate) a pyrethroid check and an untreated check. Of interest was that the Tracer at both rates (O.045 and 0.067 lb [AI]/acre) was very similar to or numerically superior to the pyrethroid comparison in all parameters tested (terminal damage and budworms, square damage and budworms in squares, boll load in late July, and yields). This closely parallels last year's results. The second test contained biologically-oriented options (Ovasyn), a Karate check, and various fruit removal treatments which simulated moderate to severe early season budworm damage. As has been the case previously, neither the pyrethroid or the Ovasyn increased maturity or yields over the untreated check (numerically, each was less than the check in both categories). A 100% square and terminal removal rate, at the time of second generation budworm establishment, was the only fruit loss treatment (a 50% square and terminal, and a 3 large square removal treatment were also evaluated) that showed a significant yield decrease.

A 12-treatment late season bollworm/budworm and fall armyworm screening test was conducted in southeastern North Carolina near Goldsboro under extremely high caterpillar pressure. All pyrethroids evaluated (Baythroid, Capture , Decis, Fury, Karate, Scout X-tra) performed well against the bollworm (96.5% of the bollworm/budworm complex) population, with final damaged bolls in the 2 to 5% range. The high rate of Tracer (0.089 lb (AI)/acre) sustained numerically the same damage (7%) as the pyrethroids, while the lower rate (0.067) had 23% damaged bolls. In our early-season tests, the 0.067 and the lower 0.045 rate of Tracer were numerically superior to a candidate pyrethroid against budworms. The Pirate treatment, traditionally very weak against bollworms in previous tests here, showed boll damage of 38%, while the check sustained 66% bollworm damage and 71% overall larval damage. This excellent beet armyworm material will need to be mixed tank mixed with a pyrethroid for beets if bollworms are also present. The yields from the check, Pirate and the lower (0.067) Tracer treatment both confirmed the high bollworm pressure and paralleled the damaged boll levels.

A 14-treatment, at-planting and foliar insecticide screening test for thrips control was also conducted near Goldsboro. With thrips levels low to moderate and rainfall plentiful and related plant compensation high at this location in 1996, very few significant differences (in adult or immature thrips numbers at 3, 4 and 5 wk, stand establishment, plant height, July 30 boll load, or yields) between treatments were observed between treatments.

Three *Bt* transgenic cotton tests were evaluated in 1996. The first, a threshold evaluation trial carried out in Laurinburg, compared a protected, a protected preceded by an Orthene (0.75 lb AI/acre) over spray, an unprotected NuCOTN-33b and the same line with pyrethroid protection at 4 and 8% square damage with a standard unprotected and protected DP-5415 line. The selected treatments were evaluated throughout the season for bollworm egg deposition, caterpillar establishment and damage to bolls and squares, stink bug damage, and yields. Instar number was recorded for each caterpillar found. The highest boll damage was recorded on standard untreated DP-5415, at 31% boll damage on 26 August. On the basis of 4 averaged sampling dates, 3, 12, 18 and 26 August, over spraying the B.t. line with Orthene just prior to the initiation of the major moth flight raised the damaged boll level from 1.25% to 4.75% and lowered yields from 1084 lb lint/acre to 922, showing that a single disruptive spray had a marked influence on susceptibility of Bollgard cotton to bollworms, as was the case in a similar test in 1995. Such a disruptive spray just prior to the major bollworm moth flight would be almost unheard of under North Carolina conditions. For the second year, only the lower 4% square damage threshold was met, and was treated once. Although not significant, the single-treated, 4% threshold treatment yielded 130 lb higher than either of the non-treated NuCOTN-33b plots (the un-treated Bollgard check and the 8% threshold, which was not met) . Fall armyworms and European corn borers were extremely light at this location in 1995, paralleling the light fall and ECB damage found in the remainder of the state. Yields resulting from the various treatments were in keeping with previous small plot evaluations, with the pyrethroid-protected DP-5415 yielding statistically the same as the NuCOTN-33b untreated. This year the NuCOTN-33b yield was 217 lb greater numerically.

The other 2 *B.t.* cotton tests were carried out in Goldsboro under high bollworm pressure. The first test was part of a regional set of evaluations of new Stoneville lines, 3 untransformed and 7 Bollgard lines of unknown (to us) parentage. This test was divided into treated and pyrethroid-protected halves (each treated and untreated half was randomly-assigned to one side or the other), for a total of 20 treatments, and replicated 4 times. Each of the 3 unprotected, Bollgard varieties succumbed to considerable bollworm damage and yield reduction- approximately 50%, while the untreated Bollgard varieties averaged approx. 7% boll damage on the final August 21 assessment. All of the protected non-Bollgard lines yielded numerically better than the protected Bollgard lines, despite these Bollgard lines being protected by both pyrethroid and the endotoxin. Apparently, the unknown non-Bollgard lines were agronomically superior to the Bollgard lines tested under the conditions of this test (late planting and harvest). Unfortunately, the parentage of the tested lines were note disclosed, so that the value of this test to our knowledge base is limited.

The 3rd test looked at bollworm damage and agronomic aspects of Hartz/Paymaster line HZ-1220 in the untransformed, Roundup Ready (RR), *B.t.*, and RR + *B.t.* expressions, pyrethroid-protected and without protection. This test established that the RR and the RR + *B.t.* lines were competitive agronomically and apparently expressed the endotoxin at a level similar to the Bollgard only line, as expected. Additionally, this unprotected HZ-1220 Bollgard line out yielded the adjacent Stoneville Bollgard lines by an average of approximately 250+ lb., most likely a result of its early maturity. **(Cotton Extension IPM Project, Department of Entomology, North Carolina State University, Raleigh, NC)**

B.t. cotton (NuCOTN 33B) trials examined the effects of natural enemy conservation versus disruption and early versus late planting dates on bollworm larval populations, fruit damage, and yields in BT and non-BT cotton. In addition, the impact of treating as needed with a pyrethroid for bollworm control was examined in selected plots. Disruption of arthropod natural enemies with a single application of organophosphate insecticide just prior to the bollworm moth flight increased larval numbers and fruit damage, but disruption did not negatively effect yields in untreated BT cotton or in BT or non-BT cotton that was treated with a pyrethroid. Although no significant differences were detected in bollworm egg deposition, larval infestation, and damaged fruit between early-and late-planted cotton, yields were higher in early-planted cotton due to lower than normal late season temperatures. BT cotton protected with a pyrethroid as needed yielded higher than untreated BT cotton and untreated non-BT cotton. Larval populations, damaged fruit, and yields in untreated BT cotton were comparable to pyrethroid-treated non-BT cotton at one test site where bollworm populations were lowest. At the second test site, bollworm populations were higher and yields were lower in untreated BT cotton than in pyrethroid-treated non-BT cotton. Yields in BT cotton were increased by 11% and 23% at two test sites when pyrethroids were applies as needed (3X) for bollworm control.

In an insecticide screening trial conducted during late June against tobacco budworm, Tracer performed comparable to pyrethroid and carbamate standards; however, in a trial against bollworm later in the season Tracer was not as effective as any of the pyrethroid standards. In this test yields in Tracer treatments were ca. 65-85% of that harvested from the better pyrethroid treatments, confirming that Tracer's performance is better against tobacco budworm than against bollworm. Pirate applied alone at 0.35 lb ai/a was ineffective against bollworm as Pirate produced only ca. 57% of the yield produced by the better pyrethroid treatments in a test where the yield in the UTC was reduced by 80% by bollworm.

Field studies were conducted in NE North Carolina to evaluate the effects of early season terminal bud and square removal on yield of cotton. Up to 30% of terminal buds were removed in early July without an effect on yield. First position squares were removed as sequential groups at 4, 8, and 12/row ft. on three different dates in early July to simulate tobacco budworm injury. Yields were unaffected by these square removals indicating that cotton plants fully compensated for the loss of early first position squares. Plant mapping data revealed a greater percentage of fruit was set at second position or at higher first positions in the plant fruiting profile when early first position squares were removed.

Thrips control tests conducted on organic soils (8-20% OM) in eastern NC demonstrated all the soil-applied, at-plant insecticides to be less effective than when used on mineral soils at comparable rates. A desired level of thrips control was achieved only with the highest labeled rates of soil-applied insecticides, through the combination of soil and foliar insecticides, or through multiple foliar applications. **(Deptartment of Entomology, North Carolina State University, Raleigh, NC)**

Oklahoma. During the fall of 1991, Oklahoma State University personnel developed a petri dish technique to assess resistant trends in cotton aphids to four insecticides commonly used for aphid control. Field evaluations begin in 1992 and continued in 1996. This technique continues to accurately predict insecticide performance to the products tested.

A crop termination study was initiated in 1992 and continued into 1996. Favorable weather in 1996 allowed bolls to be tagged and plants mapped. The NAWF (nodes above uppermost white flower) method has proven to be an accurate and precise method of terminating the crop eliminating unneeded insecticide applications, without jeopardizing yields in irrigated cotton. Weather influences on dryland cotton reduces the reliability of NAWF to predict the uppermost bolls to contribute to yield. Under growing conditions experienced in 1995 and 1996, no bolls above 7 NAWF were harvested.

Several Bollgard trials were initiated in 1996 to determine the value of this technology under Oklahoma conditions. Bollgard cotton provided excellent bollworm control, was slightly slower in starting to fruit, retained more 1st position fruit and had the greatest number of bolls/acre in all tests (sprayed and unsprayed). Bollgard cotton out-yielded standard cotton varieties regardless of the spray regime. **(Oklahoma Cooperative Extension Service, Altus, OK)**

South Carolina. A field study was conducted to determine the performance of Bollgard cotton against insect pests. Bollgard and cotton cultivar 'DPL 5415' were evaluated untreated and treated as-needed with a pyrethroid insecticide for control of lepidopterous pest species. The efficacy of Bollgard cotton which received no insecticide applications against a relatively heavy infestation of bollworms (*Helicoverpa zea* [Boddie]) was comparable to that of DPL 5415 treated as-needed with Karate.

A field study was conducted to determine the residual activity of foliar applications of Karate 1EC, Karate CS 2.09EC, and Larvin 3.2AF at 0.034, 0.034, and 0.28 kg(AI)/ha, respectively, against bollworms and tobacco budworms (*Heliothis virescens* [F.]) in cotton. Both formulations of Karate were the most effective treatments, providing excellent 1-day and 3-day control of predominantly *H. zea* eggs.

Larvicidal rates of Asana 0.66EC, Baythroid 2EC, Decis 1.5EC, FCR 4545 1EC, Fury 1.5EC, Karate 1EC, Karate CS 2.09EC, Larvin 3.2AF, Pirate 3SC, Scout 0.9EC, and Tracer 4SC were evaluated as foliar applications in cotton during July and August against a heavy population of bollworms. All treatments except FCR 4545 and Pirate provided excellent control. Larvin and Tracer were less disruptive to *Geocoris* spp. than the pyrethroids.

Selected rates of Tracer 4SC, Intrepid 80WP, and Proclaim 5SG were evaluated as foliar applications in cotton against a heavy infestation comprised predominantly of bollworms. Tracer was the most effective of the three new insecticides, providing efficacy which compared favorably with Karate. The impact of these three insecticides on beneficial arthropod predators was minimal compared with Karate and Pirate.

A field study was conducted to determine the relative efficacy of combinations of four classes of insecticides (pyrethroids, carbamates, organophosphates, and pyrroles) against insect pest species in cotton and the impact of these treatments on beneficial arthropod predators. Karate 1EC, Larvin 3.2 AF, Curacron 8EC, and Pirate 3SC were applied alone at 0.034, 0.84, 0.98, and 0.45 kg(AI)/ha, respectively, and in all two-way combinations at half these rates. Larvin and Karate were more effective against a heavy population of bollworms than Curacron and Pirate. In most instances, tank mixes of reduced rates of these insecticides were as effective as the full rates of materials applied alone. Larvin was less disruptive to *Geocoris* spp. and Neuroptera than the other insecticides. **(Clemson University Pee Dee Research and Education Center, Florence, SC)**

Tennessee. Under ideal emergence conditions in the 1996 season, cotton treated with Gaucho emerged quickly, bringing insecticide-treated seed coats to the surface. Without the systemic insecticide in the root zone, thrips damage was higher and yields lower than in previous years. In nine experiments evaluating control of thrips on seedling cotton, no significant total yield differences were detected, although significant differences were noted in the efficacy of insecticides to reduce thrips numbers and thrips damage and increase bloom counts and leaf area. Imidacloprid applied as a foliar spray for control of tarnished plant bug increased square retention, but did not increase yields. Significant differences were noted in the efficacy of insecticides to control the cotton aphid, but yields were not affected by the late-season infestations. Transgenic cottons containing Bollgard Bt or Bt/BXN genes were efficacious against the bollworm/tobacco budworm complex, but yields from Bt/BXN lines were generally less than those of the recurrent parent. Bollgard Bt lines produced yields comparable to or above the recurrent parent. **(University**

of Tennessee, West Tennessee Experiment Station, Jackson, TN)

<u>Texas</u>. A publication was developed and produced as a TAES Bulletin B-1, "Concepts in Managing Bollworm, Tobacco Budworm and Cotton Fleahopper on Cotton in the Lower Gulf Coast of Texas". Approximately 200 copies were mailed to consultants, extension specialists and growers across Texas. Two additional manuscripts are in development on the use of treatment thresholds and management tactics on *Bt* cotton. (One peer reviewed and one requested by Cotton Incorporated for distribution to mid-south cotton consultants and producers.)

The insect pest simulation Model, TEXCIM, has been combined with the plant-soils simulation model GOSSYM. This combined model will be published as ICEMM, "Integrated Cropping Systems Management Model". The ICEMM code has been given to the USDA Crop Simulation Laboratory. It is hoped they will continue to develop and use the model. A peer reviewed paper is in development using ICEMM to simulate and evaluate (using biological and economic data) various insect management strategies with transgenic *Bt* cotton and biological control.

Six years of field, greenhouse and laboratory evaluations of transgenic cottons producing insecticidal proteins have been conducted, summarized and published. Breeding lines and varieties evaluated were from Monsanto, Calgene, Agracetus, Hartz, Deltapine and Stoneville. The first commercial production of *Bt* cotton took place this 1996 season. There were some surprises but the project appears to be cost effective and reduced insecticide applications for bollworm, tobacco budworm (especially insecticide resistant populations) and pink bollworm.

Collected all literature on beneficial insects in cotton and have developed a peer-reviewed publication on the key parasites of bollworm and tobacco budworm in cotton, corn and grain sorghum. A bibliography of this literature has been produced and mailed to colleagues across the U.S.A. We have assembled a large data base on the literature for insecticides that are selective for target pest insects and harmless to beneficial insects. This data base is being shared with colleagues across the cotton belt. A publication is being developed on selective cotton insecticides and how to use them in crop management.

Validated COTMAN plant mapping and insecticide management system for use on the Texas Gulf Coast. Growers, extension personnel, and consultants have shown an interest in using it to manage their cotton crop. Validated COTMAN termination rules for insecticide at 350 to 450 HU's after plant cutout which works well for boll weevil, is less clear for bollworm, and needs one more year of validation. Worked with J. Landivar to write and publish a TAES bulletin through the Center at Corpus Christi, to manage cotton production using plant monitoring systems such as PMAP and COTMAN. Mailed more than 300 copies to extension entomologists, growers and consultants. **(TAES, Corpus Christi, TX)**

Relay intercropping is being investigated as a method to increase predator abundance in cotton. Crops planted in the fall (canola, wheat and vetch) are compared to crops planted in the spring (grain sorghum, forage sorghum, and canola). All relay intercrops enhanced predator abundance in cotton, but fall crops supported higher numbers of predators than spring crops. However, the best relay crops were grain sorghum and vetch. Cotton aphids were reduced in the relay intercropping systems, but bollworms were not affected.

Boll weevil cold tolerance was investigated during the winter of 1995-1996. Boll weevils lost their tolerance to -7.5^0 C within 2 months (by January) of being placed in field cages. The reasons for this rapid loss of tolerance to freezing temperatures was not determined, but the winter was fairly warm, with almost no freezing temperatures in the litter recorded until early February. Maintenance of cold tolerance may require periodic reinforcement with freezing temperatures. **(TAES, Vernon, TX)**

Relay strip cropping is being tested as a method of building beneficial arthropods for control of cotton aphids in cotton. A large population of *Hippodamia convergens* developed in Canola planted in the fall. A strip of grain sorghum served as an intermediate transfer crop between canola and cotton. Large numbers of *H. convergens* developed in cotton when aphid populations began to build. Plants which were caged to keep out lady beetles developed heavy aphid infestations and suffered heavy yield loss compared to uncaged plants which were fully exposed to the field environment.

Overwintered boll weevil mortality on the Texas High Plains is being measured by means of a series of dig up overwintering cages. A sample of 6 cages is removed at 3 week intervals and examined for live and dead boll weevils. Sampling will continue at regular intervals until June. Samples inspected in late November showed an approximately 70% survival rate. Dissections made before the weevils were placed in overwinter cages indicated that approximately 30% of the test weevils were not in diapause. Therefore, the late November sample indicates that little if any mortality occurred among diapausing boll weevils during the first 3 weeks they were in winter habitat. **(TAES, Lubbock, TX)**

Mortality of boll weevil and persistence of ULV malathion are not affected by applications on dew-laden cotton canopy. Effectiveness of malathion is reduced by hydrolysis of the active ingredient when it is applied in water-based sprays. Concerns were raised by Boll Weevil Eradication Program officials over possible similar results with ULV malathion applied on dew-laden cotton foliage.

Aerial applications of ULV malathion on both dew-laden and dry cotton canopies at College Station, Texas in 1996 followed by boll weevil mortality bioassays and chemical persistence analyses showed that weevil mortalities and malathion persistence were essentially the same for the two application conditions. These findings will permit Boll Weevil Eradication Program applications of ULV malathion on dew-laden cotton canopies, thus extending operational hours and making applications more timely.

Low volume aerial electrostatic sprays control whiteflies as well as conventional aerial sprays and higher volume ground applications. Spray carrier rate per acre is a significant component of the overall cost of spray applications. Even though the spray carrier is usually water, costs result from the time required for mixing and loading being taken away from field application time. Large scale, season-long aerial and ground applications of insecticides at Maricopa, Arizona, in 1995 and 1996, showed that both aerial and ground applications gave satisfactory control of whiteflies, and that low-volume aerial electrostatic applications gave the same level of control as the standard aerial and ground applications. These findings will permit growers and applicators to use the most cost-efficient methods available to them without sacrifice of whitefly control efficiency.

A new portable pneumatic sampling device was developed to aid field scouting of row crop insects. Farmers, crop consultants, and entomologists must perform in-field sampling to determine the presence of both pest and beneficial insects in order to make informed pest management decisions. Such sampling is conventionally done with manual sweep nets or by visual examination of individual plants which is very tedious and labor intensive. We modified a conventional engine-driven leaf blower by adding a metal frame to support an insect collection net in front of the blower outlet nozzle to form a Keep it Simple (KIS) insect sampler. In field operation, the KIS sampler is hand-carried along a row of plants with the blower outlet positioned so that the plants pass between the blower nozzle and the inlet of the insect net. High speed air at about 150 miles per hour from the blower dislodges insects from the plants and carries them into the collection net. Insect collection efficiency of the KIS sampler is high, and with it use, the efficiencies of field scouting for insects can be increased by more than ten fold.

Most scientists believe that adult boll weevils forage only on cotton and a few other species of plants. We examined overwintering boll weevils in Uvalde, Texas, for pollen. A total of 2,271 grains were counted in the boll weevil samples. Pollen representing 44 plant families, 86 genera, and 14 species were identified in the samples. More pollen types from the plant family Fabaceae (bean family) occurred in the samples than any other family. Our research shows that overwintering boll weevils have a wide range of alternative foraging resources and do not just forage on cotton.

Effective feeding attractants and stimulants for adult bollworms and other pest species had been previously identified, but for these to be useful, insecticides that are effective in killing the adults and do not interfere with feeding are needed. Studies evaluated the feeding response and resulting mortality to mixtures of 18 different insecticides and a feeding stimulant. A number of potentially useful insecticides were identified which do not interfere with feeding and kill the adults quickly at very low concentrations. These results indicate that adult moths can be killed using attracticides with very low insecticide concentrations, especially when compared to the concentrations needed when applications are directed at the larval stage. Reductions in the amount of insecticides used should decrease the cost of production, as well as food and environmental contamination.

Last year, the beet armyworm was a major pest in many cotton-growing areas in Texas and it became evident that a means was needed to monitor its activity as an early warning system. Considerable technology (traps of different designs and colors, and three different lures) was commercially available, but the best trap and lure combination was not known. Intensive evaluation led to the identification of an effective trap and lure combination that was used by the Texas Boll Weevil Eradication Foundation to monitor beet armyworm activity in areas of the state where active eradication programs were in effect.

Methods are needed to predict infestations which result from long distance migrations of corn earworm moths. Corn earworm moths were captured in pheromone traps across South-Central Texas in February and March 1994, and examined for citrus pollen contamination, which occurs when moths feed on citrus nectar. Contaminated moths were captured as far as 661 km from the nearest source of citrus production in the Lower Rio Grande Valley (LRGV) of southern Texas and northeastern Mexico, and capture dates were well correlated with estimated moth flight trajectories from the LRGV. Successful incorporation of this information into predictive migration models will alert producers, regulatory agencies, and others for more effective defense against pest insect infestations.

Methods are needed to provide areawide surveillance of pest insect flights between cultivated and non-cultivated habitats. NEXRAD doppler weather radar data from three locations in South-Central Texas were analyzed to determine the capability to detect the concentration and velocity of flying insects over a wide area. Results show that the NEXRAD volume measurements compare well with USDA entomological radar measurements and wind velocity profile measurements. These results will aid in the development of methods to adapt and interpret the

NEXRAD data products for estimating the aerial abundance and movement of pest insects.

Aerial electrostatic spray charging technology has been carried to the point of limited practical usage. Specifically, for several years electrostatically charged cotton pesticide sprays have been applied to research cotton plots. Spray deposition analysis from the cotton plants was provided by use of dual-side leaf washers developed at this laboratory. Some discoveries made about aerial electrostatic charged sprays were: deposition was enhanced, underleaf deposit and plant canopy penetration were improved, and efficacy was equally as good or better for whitefly control as was the conventional spray protocol. **(USDA, ARS, Southern Crops Research Laboratory, College Station, TX)**

Conservation tillage experiments were conducted in 1996 comparing a moldboard plow system with no-tillage and ridge-tillage cotton production systems. Boll weevil, beet armyworm, tobacco budworm/bollworm complex, aphids, and whiteflies were monitored in each tillage treatment throughout the growing season. This is year 4 of this research, and insect populations and damage in the conservation tillage plots have always been equal to or less than that of the moldboard plow system. This indicates that in the subtropical semi-arid environment of South Texas crop residue on the soil surface or tillage has little or no effect on any of the insect populations or plant damage caused by them. Conservation tillage cotton production costs for the four years of the study have been $20 - $50/acre less than cotton production using a moldboard plow system. Net returns were greater in all four years in the conservation tillage due to reduced tillage costs and/or increased yields when compared to the moldboard system.

An improved tractor mounted insect sampler was constructed and evaluated. Sampling efficiencies for boll weevils varied with plant phenology and ranged from 20 to 40%. Effects on beneficial arthropods of early season pesticide applications for boll weevil control were evaluated in large (1-10 acre) plots. All materials including fipronil and ULV malathion temporarily reduced population levels of beneficial arthropods, but long term impacts were prevented by immigration from surrounding areas. Small plot and leaf bioassay tests indicated efficacy of fipronil against boll weevils was similar to that of guthion, except fipronil demonstrated greater residual activity. Regardless of material, adequate control was not achieved with application intervals longer than three days. Leaf disk bioassays comparing duration of exposure and time of exposure lfter application indicated exposure times of <12 hours provided poor efficacy regardless of material except when exposure was immediately after treatment application. Beet armyworms and boll weevils have been captured at each of the 18 trapping locations in Tamaulipas and adjoining states of Mexico regardless of proximity to cultivated crops. Beet armyworm population trends in small (1-2 acre) cotton plots were distinctly different from trends noted in the previous season. Although pheromone traps detected continuous flight activity of beet armyworm moths, densities of immature forms on cotton foliage remained at innocuous levels throughout the production season. Mortality of immature beet armyworms within untreated plots was extremely high (>99%) and differed only slightly from that occurring within plots subjected to routine applications of ULV malathion. This trend was attributed to continuous immigration of a diverse natural enemy complex into the plots.

Strains of the tobacco budworm, *Heliothis virescens* (F.), and bollworm, *Helicoverpa zea* (Boddie), collected in Mississippi were evaluated in bioassays to four classes of insecticides. High and intermediate levels of resistance were found to cypermethrin and thiodicarb, respectively, in *H. virescens.* No increased tolerance was seen to profenofos in *H. virescens* and no increased tolerance to any insecticide tested was detected in *H. zea*. Significant resistance to *Bacillus thuringiensis* Berliner was not observed in either species during the season. The effect of the addition of piperonyl butoxide, phosmet, and propargite, singly, to a pyrethroid for control of a *H. virescens* resistant strain was studied. No synergistic effects were demonstrated. Multiple resistance in *H. virescens* is still evident and resistance to pyrethroids appears to be stabilized. Metabolic resistance may or may not be present.

Commenced studies of insecticide tolerance of *Catoloccus grandis*. A residual film, vial bioassay was refined and preliminary dose ranges for ten insecticides were established. Further studies will be initiated soon.

An experiment was conducted to compare the mortality and suppression of boll weevil populations in the field by *Catolaccus grandis* reared on boll weevil *(in vivo)* or on an artificial diet *(in vitro)*. Each treatment of parasites was released twice weekly for six weeks at a rate of 250 females/acre/release on two fields of 10 acres each. Life tables of boll weevil cohorts monitored in control and treatment fields showed weevil survival from egg to adult was 88.7, 0.4, and 3.0 percent for the control, *in vitro*, and *in vivo* treatments, respectively, from 16 May-30 May. Weevil survival from egg to adult was 74.5, 4.3, and 11.9 percent for the control, *in* vitro, and *in vivo* treatments, respectively, from 07 June-20 June. This indicates that a cheaper food source (artificial diet) produces high-quality parasites which further advances the implementation of needed technology that is cost-benefit competitive with that of other means of boll weevil control.

An *in vitro* system for large scale rearing of *C. grandis* was developed. The system consists of chemically stimulating oviposition devices, manual deposition of parasitoids eggs on wells containing artificial diet, diet dispensing, emergence cages, and packaging system for release. Approximately 100,000 parasitoids were produced during 1996. The cost of diet to produce 100 females was dropped from $8.75 to $5.75 by the use of substitutes. A semi-mechanized process for the above rearing system is in the process of being developed with the goal to produce 500,000 females for the 1997 cotton season. **(USDA, ARS, Subtropical Agricultural Research Laboratory, Weslaco, TX)**

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 1996 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 1996 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 1996.

State	Pesticide (lbs AI/A)	Target Pest
Alabama	Furadan	Aphids
	Confirm	Beet armyworms
	Pirate (Emergency label for 1996)	Beet armyworms/ Tobacco budworm
Arizona	Applaud (Section 18)	Sweetpotato whitefly
	Knack R (Section 18)	Sweetpotato whitefly
	Decis R	Sweetpotato whitefly
	Bollgard cotton	Lepidopterist pests
	Bollwhip	Cotton pests
Georgia	Decis	Cotton pests
California	Furadan 4F (Section 18)	Cotton aphids
Louisiana	None registered for use during 1996	
Mississippi	None	
Missouri	No new registrations except for Bt cotton	
New Mexico	Confirm	
North Carolina	None	
South Carolina	Confirm	Beet armyworm
	Pirate (Section 18)	Beet armyworm
	Decis	Bollworm/budworm
Tennessee	None	
Texas	Confirm (Section 18)	Beet armyworm
	Pirate (Section 18)	Beet armyworm
	Furadan (Section 18)	Aphids

Table 2. Changes in state recommendations for treatment for arthropod pests of cotton for 1996.

State	Pesticide	Target Pest
Alabama		
Additions	Deltamethrin (Decis) 1.5 EC (0.019-0.03)	Bollworm/ cutworm
Deletions	Sulprofos (Bolstar)	
	Chlorpyrisfos (Lorsban)	Beet armyworm
	Profenofos (Curacron)	Cotton aphids
	Phorate (Phorate/Thimet)	Cotton aphids Seedling thrips
Arizona		
Additions	Applaud (once per season)	SPWF
	Capture + Metasystox-R	SPWF
	Danitol + Metasystox-R	SPWF
	Endosulfan + Lorsban	SPWF
	Endosulfan + Metasystox-R	SPWF
	Knack (once per season)	SPWF
	Vydate + Bolstar	SPWF
	Vydate + Ovasyn	SPWF
Arkansas		
Additions	Gaucho seed treatment	Thrips
	Di-Syston 8EC (0.19-0.56)	Thrips
	Fyfanon	Boll weevils
	Fury 1.5 EC (0.033-0.045)	Boll weevils
	Decis 1.5 EC (0.019-0.03)	Bollworms
	MVP II & Dipel ESNT	Bollworms
	Tracer 4E (0.075-0.09) (contingent on EPA registration approval)	Bollworms
	Decis 1.5 EC (0.03)	Budworm
	MVP II & Dipel ESNT	Budworm
	Tracer 4E (0.06-0.09) (contingent on EPA registration approval)	Budworm
	Pirate 3SC (0.35) (contingent on EPA registration approval)	Budworm
	Provado 1.6F (0.047)	Plant bugs
	Ovasyn 1.5EC (0.5-0.75)	Spider mites
	Zephyr 1.5EC (0.0093- 0.0188)	Spider mites
	Pirate 3SC (0.15-0.2) (contingent on EPA registration approval)	Spider mites
	Provado 1.6F (0.047)	Cotton aphids
	Pirate 3SC (0.2) (contingent on EPA registration approval)	Beet armyworm/ Fall armyworm
	Tracer 4E (0.06-0.111) (contingent on EPA registration approval)	Beet armyworm/ Fall armyworm
	Confirm 2F (0.125-0.25) (contingent on EPA registration approval)	Beet armyworm/ Fall armyworm
Deletions	Cythion RTU	Boll weevils
Changes	Increase rate of Bidrin 8E to 0.3-0.5	Plant bugs
	Increase rate of Orthene 90S to 0.3-0.5	Plant bugs
	Increase rate of dimethoate to 0.3-0.5	Plant bugs
Georgia		
Additions	Decis	Bollworm/
	Bollgard	budworm
Deletions	Ambush	All Uses
	Pounce	All Uses
	Baythroid	Soybean looper
	Scout X-TRA	Soybean looper
Louisiana	No significant changes in insecticide recommendations expected for 1997	
Mississippi	None	
Missouri	No significant changes	
New Mexico	None	
N. Carolina		
S. Carolina		
Additions	Tracer will be added if labeled in time	
Tennessee	Recommendation changes are pending	
Texas		
Additions	Decis 1.5E (0.019-0.03)	Bollworm/ budworm
	Provado 1.6F (0.047)	Aphids, fleahoppers
Deletions	Orthene 90S (1.0)	Bollworm/ budworm
	Orthene 90S (0.5-1.0)	Aphids
	Di-Syston 8E (0.1-0.2)	Aphids
	Metasystox-R 2E (0.125-0.25)	Aphids

Table 3. Promising pesticides screened in 1996 for control of cotton arthropod pests.

State/Pesticide (lbs AI/A)	Target Pest(s)
Alabama	
EXP61169A 2.5EC (0.05)	Tarnished plant bug common predators
EXP60720A 80WG (0.05)	Tarnished plant bug common predators
Tracer 4SC (0.06)	Non-Bt cotton for bollworm/budworm
Tracer 4SC (0.044)	Bollworm/budworm
Tracer 4SC (0.09)	Bollworm/budworm
Furadan 4F (0.25)	Cotton aphid
RH-2485 80WP (0.25)	Bollworm/budworm
RH-2485 80WP (0.35)	Bollworm/budworm
RH-2485 80WP (0.25) + Larvin 3.2F (0.45)	Bollworm/budworm
FCR 4545 125SC (0.014)	Bollworm/budworm
EXP61196A 2.5EC (0.025)	Thrips
EXP60720A 80WG (0.025)	Thrips
AC303630 (Pirate) (0.2-0.35)	Bollworm/budworm fall armyworm
MK-244 (Proclaim) (0.0075-0.01)	Bollworm/budworm fall armyworm
RH-2485 (Intrepid) (0.10-0.35)	Bollworm/budworm fall armyworm
NAF-85 (Tracer) (0.045-0.09)	Bollworm/budworm fall armyworm
Arkansas	
Furadan 4F (0.125, 0.25)	Cotton aphid
Reldan MC (0.062)	Cotton aphid
Reldan MC (0.125, 0.25, 1.0)	Cotton aphid
Reldan MC (0.5)	Cotton aphid
Karate 2.09 CS (0.025)	Cotton aphid
Karate 2.09 CS (0.03)	Bollworm
Karate 2.09 CS (0.025)	Bollworm/plantbug
Pirate 3 SC (0.35)	Bollworm
Pirate 3 SC (0.1 foliar)	Thrips
Pirate 3 SC (0.15)	Spider mites
Tracer (0.06)	Bollworm
Tracer (0.07, 0.08)	Bollworm
Regent 2.5 EC (0.025)	Plant bugs
Regent 2.5 EC (0.038, 0.05, 0.068)	Plant bugs
Regent 2.5 EC (0.1, 0.15 in-furrow)	Thrips
Regent 2.5 EC (0.025, 0.038 foliar)	Thrips
Regent 80 WDG (0.05)	Plant bugs
Intrepid 80 W (0.25, 0.35)	Bollworm
Proclaim (0.0075, 0.01)	Bollworm
California	
Alert	Spider mites
Savey	Spider mites
Gaucho seed trt	Spider mites
Regent	Lygus
Aphistar	Cotton aphids
Furadan 4F	Cotton aphids
Louisiana	
Intrepid 80WP (0.05-0.15)	Beet armyworm, soybean looper
Tracer 4SC (0.067)	Beet armyworm, soybean looper, bollworm, budworm
ProClaim 5SG (0.0075-0.01)	Bollworm, budworm
Missouri	
New Mexico	None

Table 3. Continued

State/Pesticide (lbs AI/A)	Target Pest(s)
Oklahoma	
Decis	Bollworm
Tracer	Bollworm
Ovasyn	Cotton aphid
FCR-4545 1EC	Bollworm/boll weevil
Exp61196a	Boll weevil/ cotton fleahopper
Mpo62se	Bollworm
Tennessee	
EXP 80667A (.025-.038)	Cotton Aphid
Aphistar (.062-.125)	Cotton Aphid
Fipronil (.15)	Thrips
Fipronil (.05)	Tarnished plant bug
Counter (1.0)	Thrips
Texas	
Pirate 3SC (0.2)	Beet armyworm
Tracer (0.033-0.1)	Beet armyworm
Confirm (0.125)	Beet armyworm
Pirate 3SC (0.188-0.375)	Tobacco budworm
Tracer (0.033-0.1)	Tobacco budworm
Confirm (20-40 grams)	Tobacco budworm
Tracer 4SC (0.015-0.06)	Bollworm
Intrepid 80W (0.1-0.35)	Bollworm
Proclaim 5SG (0.0075-0.01)	Bollworm
Decis 1.5E (0.025)	Bollworm
Regent (0.025-0.5)	Boll weevil
Thiodan 2CSO (0.5)	Boll weevil
Gaucho 480 seed trt (8 oz/cwt)	Aphids
CGA215944 50WP (0.71-1.42)	Aphids
Furadan 4F (0.5)	Aphids
Pirate 3SC (0.188-0.375)	Spider mites
Provado (0.02-0.04)	Cotton fleahopper
Provado (0.02-0.04)	Plant bug
Gaucho 480 seed trt (8 oz/cwt)	Thrips
Regent (0.8 oz ai/cwt)	Thrips
Regent (0.025-0.038)	Thrips