AN INTEGRATED APPROACH TO AREAWIDE PINK BOLLWORM MANAGEMENT IN ARIZONA

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Abstract

A multiyear areawide pink bollworm suppression program was conducted in Parker Valley, Arizona from 1990-1995. Two pheromone systems, the Shin Etsu or Mitsubishi PBW Rope and the Ecogen NoMate Attract N' Kill hollow fiber, represented the principal control components along with limited chemical insecticides. Population dynamics were monitored season long utilizing a standardized trapping program of one trap per ten acres of cotton.

Pheromone applications began annually at the six true leaf stage of cotton. During the 1990 and 1991 seasons, one rope application on 50% of the cotton acreage and four fiber/insecticide combinations were automatically applied on a 12-14 day schedule on the remaining acreage. Following 1991, the amount of rope utilized dropped progressively to zero in 1994. Fiber application protocol was modified over time from four automatic applications to treatments based exclusively on trap triggers.

A strict cultural control program of crop destruction and tillage was also instituted to reduce overwintering PBW populations. Weekly grower meetings provided updated program statistics and maintained program continuity. The six year program met or exceeded all stated objectives, namely:

1. Larval infestation rates in bolls were progressively reduced from 23.35 percent pre-program to 0.38 percent in 1995. This demonstrated the efficacy of pheromone technology.
2. The use of conventional insecticides for PBW control in Parker Valley was reduced from more than 216,000 cumulative acres treated per season pre-program to 2,047 in 1995.
3. PBW populations in bolls were maintained far below acceptable economic threshold of 5-10% through out the program.
4. The cost of PBW control was reduced from an historical average in excess of $70.00 per acre to an average of $28.33 per acre for the last three years of the program.

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Introduction

Since 1965, the pink bollworm, *Pectinophora gossypiella* (Saunders), has been a major economic pest of cotton throughout Arizona and southern California. In an effort to combat this insect, growers have been forced to rely heavily upon chemical insecticides to suppress pink bollworm populations and maintain acceptable yields. This process has not only proven to be very costly, but has also produced an array of detrimental side effects:

a. The potential development of resistance to various chemicals, i.e., pyrethroids.
b. Secondary pest problems associated with increased pesticide usage.
c. Increasing environmental concerns related to the use of pesticides.

Further complications have resulted due to lack of continuity produced when growers apply various control methods, (or none at all), on differing time schedules. This allows for pink bollworm population reservoirs to build and regularly re-infest otherwise relatively clean areas throughout the state. The above represents a variety of factors that called for the development of alternate strategies. In support of this, during the fall of 1989, a demonstration program was designed to utilize pheromone technology as the main component in a large scale uniformly managed pink bollworm suppression program in Parker, Arizona. The goal of the program was to reduce pesticide use and grower costs through suppression of pink bollworm populations leading to eradication as technology is perfected.

The time frame for duration of the demonstration program was initially set at three years. A progressive reduction in pink bollworm populations over the period was determined to represent an acceptable criterion for program evaluation. Due to the success of the effort, the program has been continued for six years through 1995. It should be noted that the Parker program was designed to be a demonstration project and not a research effort. Untreated checks or control fields were not to be part of the evaluation process. Rather program assessments were to be made by comparing pink bollworm population trends in Parker Valley over the duration of the three year suppression effort. All comparisons were adjusted to equivalent heat unit accumulations. Preliminary program data has been previously reported. (Staten et al. 1995, Staten et al. 1996 in press) This present report will serve to provide complete documentation of program protocol, data and results to date.

Program Objectives

Initially in 1990-1991, the program set out to demonstrate the effectiveness of pheromone technology, reduce the use of conventional insecticides and provide pink bollworm suppression below economic thresholds on 90% of the fields in Parker Valley through August 15th.

Objectives were modified for 1992-1995 to extend pheromone treatments through September 15th. Initial objectives listed

above including the minimization of cost inputs were maintained throughout the six year program.

Methods and Materials

Due to the dynamic nature of the Parker Program and because of ongoing efforts to analyze and improve technologies, the project was not conducted according to an irrevocable set of pre-established guidelines. Program strategies evolved over the course of the three year demonstration and beyond. As a precursor to full scale program initiation, 1989 was selected as the year to gather baseline data to be used for future program analysis. Forty-five cotton fields averaging approximately forty acres each were randomly selected in subsets of fifteen each from the north, middle and south portions of Parker Valley. An eighty boll sample was taken from each field on a weekly basis beginning the week of July 23rd and running through September 17, 1989. The samples were comprised of forty bolls from each of two diagonally opposed quadrants on week one, (i.e., NE and SW quads) and from the remaining two quadrants (i.e., NW and SE) on week two. The process was then reversed for alternating sampling periods.

The samples, consisting of green bolls which could be depressed slightly with thumb pressure, were taken by walking a loop near the corners of each quadrant. No bolls were taken from the outside four rows of cotton. Only after proceeding further into the field, did field personnel begin harvesting bolls.

All boll samples were then placed in labeled paper bags and returned to the field office where they were cracked and examined by technicians under table mounted 3X florescent ring light illuminated magnifying lenses. Findings of the survey were reported as the percent of larvae recovered from the total weekly boll sample. (Table 1)

Population Sampling

Surveillance activities in 1990 consisted of trapping all cotton fields in Parker Valley at the rate of one trap per field or forty acres, whichever was smaller. Standard Delta sticky traps were used (Foster et al. 1977). Traps were placed and run outside fields until layby, then moved at least fifty feet inside of field edges. Lure consisted of red rubber septa impregnated with 4mg load of gossyplure, a USDA standard.

Traps were serviced three times per week beginning with the week ending April 21, 1990. Multiple weekly servicing was carried through the programs treatment period which ended July 26, 1990. Following final treatments, servicing was reduced to once a week through the week ending September 1, 1990.

Based on trap density tests conducted in Maricopa and Pinal counties in 1991-1992, trap density was increased to one trap per ten acres on fiber treated fields. Trap density on rope treated acreage remained at one trap per field. Traps were moved to field perimeters and servicing schedules reduced to two times per week. (Leggett et al. 1994) From 1993-1995, trap inspection was further reduced to once a week with trap density remaining at one trap per ten acres on field perimeters. Boll sampling for larval infestation rates was conducted annually on 45 randomly selected fields according to the protocol established in 1989.

Pheromone Treatment Program

Two primary control regimens were employed in 1990:

1. The Shin Etsu or Mitsubishi PBW Rope was used where possible on the earliest cotton (first planted) and around sensitive sites where aerial application of pesticides was to be avoided. The Rope is a high rate system. Gossyplure is contained in a 8" polyethylene reservoir sealed at both ends. The gossyplure diffuses through the walls of the reservoir to produce its extended release capabilities at approximately a 28g rate per acre. (Flint et al. 1985) Tests have shown the rope to be effective for up to sixty days. Ropes were hand tied using labor crews on 11,826 acres of cotton at or near six leaf stage before pinsquare at a rate of 400 Ropes per acre on approximately a 10 by 10 foot grid. The majority of the Rope acreage was tied between April 28, 1990 and mid-May. No insecticide oversprays or pheromone fiber applications were made on Rope fields.

2. The remaining 13,174 acres in Parker Valley were provided four scheduled treatments on a maximum interval of 14 days utilizing the Ecogen pheromone hollow fiber ("Attract and Kill", U.S. Patent no. 4671010, Staten and Conlee) and azinphos methyl (an organo phosphate insecticide) either alone or in combination beginning at the six leaf stage. Applications were made by air utilizing standard fiber pods. Swath width was 50 feet. The extent of use of this system has prior review (Baker et al. 1990).

The first and fourth applications were dual treatments of both the fiber at 10 gram rate of formulated material (approximately 0.7g AI) in combination with an overspray of azinphos methyl at the rate of 16oz per acre in an ultra low volume formulation. The fiber was premixed with an adhesive (Biotac) at the rate of 3.5oz per acre. Included also in the Biotac was 0.5oz (formulated material) of the pyrethroid permethrin to complete the Attract and Kill mode of operation.

Second and third applications were made on a 12-14 day cycle thereafter on the same acreage. Both were fiber applications at a 15g rate (approximately 1.05g AI) plus Biotac and permethrin.

The fourth and final application was a dual treatment, identical to the first listed above, the insecticide acting as a clean up on existing moth populations to augment the effectiveness of the fiber.

In all of the fiber treatments previously listed, any individual field trap reading averaging one or more moths per trap per night triggered a reduction of the treatment interval below the 12-14 day target time frame. In no instance were treatments

with fiber made on less than an eight day schedule. Most treatments averaged 12 day intervals. Fiber treatments began in a limited fashion on May 8, 1990 and were completed on July 26, 1990.

Rope versus fiber acreage ratios remained at 50:50 in 1991. Fiber treatment protocol was reduced to two scheduled applications beginning at the six leaf stage, the first a dual treatment (fiber at a 10 gram formulated rate in combination with chlorpyrifos at the rate of 32 oz per acre ultra low volume formulation) and the second a single fiber application 12-14 days later. Subsequent treatments were based on trapping triggers (threshold moth counts) on a field by field basis.

In 1992, the rope/fiber acreage ratio was reduced to 35:65. Fiber treatments were reduced to one scheduled dual application. All additional treatments were based on trap triggers or the presence of known in-field infestations. Rope and fiber treatments covered the date ranges of May 2 - June 15, 1992 and May 2 - September 15, 1992 respectively.

Rope to fiber ratios dropped to 05:95 in 1993. No rope was utilized in either 1994 or 1995. In addition, automatic dual fiber insecticide treatments were discontinued after 1992. Trapping triggers were employed season long to differentiate the need for single fiber or dual treatments.

Standardization was essential to program success. Trapping was carried out on a strict schedule. Moth counts were analyzed by supervisors daily as reported by field personnel and entered into a computerized database. Pheromone and insecticide treatments were scheduled within a window of less than twenty-four hours post detection.

Two way radio communication assured constant contact between supervisors and all field personnel. Regular monitoring of trapping, boll collection activities and commercial application of pheromones maintained program quality assurance at a high level.

The integration of a strict cultural control regimen represented a key component in program success. Agricultural ordinances enacted by the Colorado River Indian Tribes on tribal leased land mandated well defined planting, chemical termination, stalk destruction and tillage deadlines leading to a one hundred percent compliance record on the part of Parker cotton growers. This in turn has assisted in reducing overwintering pink bollworm populations.

Communication between Arizona Cotton Research & Protection Council program personnel, local growers and pest control advisors has also been an essential element in the full integration of community wide activities. Weekly meetings allowed program managers to update growers on pink bollworm population levels, current control strategies and financial status reports. Secondary pest status discussions with pest control advisors minimized duplication of treatment strategies.

Results and Discussion

Results of the six year suppression program may best be analyzed by comparing statistical summary data with stated program objectives, namely:

1. To demonstrate the efficacy of pheromone technology.
Despite the selective use of chemical insecticides, the Parker Program has primarily utilized pheromones to achieve suppression of the pink bollworm. A progressive season long reduction of pink bollworm male moths trapped has been documented over the duration of the program (Figure 1). A dramatic reduction of larval infestation rates has been achieved over the course of program activities. An overall larval infestation level of 23.35 percent in 1989 has progressively been reduced to a season long average of 0.38 percent infestation in 1995 (Table 1). These data indicate that (particularly since 1992) pink bollworm populations have been reduced, establishing a new general equilibrium position which is sustainable.

2. To reduce the grower's use of conventional insecticides.
Parker Valley has a history of heavy pink bollworm infestation levels. During the late 1980's, growers averaged 12-15 insecticide treatments per season for pink bollworm control. Arizona Department of Agriculture pesticide use documents were reviewed for all program study fields for the period of 1990-1992. All grower treatments labeled for pink bollworm (as either a primary or secondary pest) were then summarized and reported as the average number of treatments applied by area growers for each cotton season. This, coupled with the average number of program insecticide applications per season, documents a significant reduction in the use of conventional pesticides for pink bollworm control; from an average of 6.2 applications in 1990 to 3.5, 2.6, 1.1, 0.7 and 0.3 per season in 1991-1995 respectively. These results represent a dramatic reduction in the use of traditional insecticides.

3. To reduce pink bollworm populations below economic thresholds.
Historically, University of Arizona economic threshold recommendations or pink bollworm treatment have ranged from 5-10% infested bolls. Program objectives for 1990 and 1991 were clearly met with 3.6 and 0.1 percent infestation levels documented through August 18th and 17th for 1990 and 1991 respectively on more than 90% of program fields. Modified objectives extending program activities through September 15th produced maximum weekly boll infestation levels of 0.6, 0.0, 0.1 and 0.6 percent for 1992-1995 respectively.

4. To reduce the cost of pink bollworm control.
An historical review of Arizona Department of Agriculture treatment documents verified that Parker growers spent a minimum of $70 per season on pre-program pink bollworm control. Some spent much more. Since ACRPC personnel assumed season long management in 1992, average grower costs per acre for pink bollworm control have been successfully reduced to 55.00, 23.00, 29.00 and 33.00 for the period of 1992-1995. This in turn has resulted in a dramatic reduction of traditional insecticide use from a minimum of 216,000 acre equivalent per year pre-program to 2,047 acre equivalents in 1995 (Table 2).

In conclusion, it is evident that all program objectives have been met or exceeded. Based on the extensive data that has been gathered over a six year period and more importantly, the Parker growers' acceptance and vote of confidence, the program must be considered a success.

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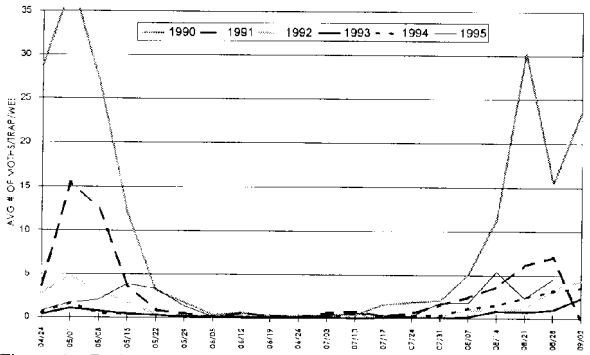

Figure 1: Parker Valley six year pink bollworm trapping history, Lapaz County, AZ 1995.

Table 1: Parker Valley seven year pink bollworm larval infestation summary, Lapaz County, AZ 1995.

Year	Total Bolls Collected	Total Larvae Recovered	Percent Larvae Recovered
1989	26,879	6,282	23.35
1990	34,726	3,442	9.91
1991	35,477	507	1.42
1992	30,064	261	0.86
1993	25,200	0	0.00
1994	16,109	32	0.19
1995	16,520	63	0.38

Table 2: Parker Valley pink bollworm program summary, Lapaz County, AZ 1995.

Year	Total Acres	Program Duration	Cumulative Acres Insecticide Treatments	Seasonal Average Cost Per Acre
1990	24,071	05/05 - 07/26	33,452	48.00
1991	27,111	05/10 - 07/26	27,034	48.00
1992	27,638	04/27 - 09/15	26,722	55.00
1993	28,229	04/26 - 09/10	3,570	23.00
1994	23,650	04/20 - 09/08	5,381	29.00
1995	25,154	05/02 - 09/14	2,047	33.00