# PINK BOLLWORM INTEGRATED MANAGEMENT TECHNOLOGY UNDER FIELD TRIAL CONDITIONS IN THE IMPERIAL VALLEY, CA

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## Abstract

This paper reveiws the history of the pink bollworm pest management project in California with emphasis on the last 4 years in the Imperial Valley. This project uses release of sterile insects, cultural controls, intensive monitoring with pheromone baited traps for adult males and boll sampling, pheromone applications for mating disruption, very limited use of pesticides and, recently, widespread use of genetically engineered cotton. Results indicate good control of local pest populations. A major concern is migration from nearby, heavily infested fields, over which we have no control. Recommendations for future projects are discussed.

## Introduction

### Retrospective: 1994 Through 1996

Sterile insect technology has been used for 25+ years to prevent establishment of pink bollworm (*Pectinophora gossypiella* (Saunders)) as an economic pest in the San Joaquin Valley of California. This has been an exclusion program dependent largely on use of sterile insects over a very large area against targeted, low level populations. With the development of pheromone technology, shifts to determinant cotton varieties (compressed season) and now genetically engineered cotton varieties (a Bt cotton), we have an excellent potential for a completely bio-rational area-wide management/eradication program. We are using the Imperial Valley as a large-area test-site to conduct exploratory programs. Even though this area does not have adequate isolation for eradication, high levels of suppression are measurable. We expect also to answer procedural and operational questions. If data is convincing, we may expect growth to a largely grower funded eradication program. This would provide major environmental and economic impact at the local and regional levels and help alleviate regulatory issues in export of cotton. This paper describes briefly the 1994 - 1996, with some emphasis on 1996. Most of the discussion concerns the past year, 1997.

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In 1994 through 1996, our program used two in-field suppression techniques over cotton grown in an area with a highly regulated growing season (Table 1). All fields received a release of sterile insects 6 days per week using a 7 day projected release rate. Releases started each year in early April and were terminated when ratios of sterile to native insects had no hope of being released at a 60:0 ratio or of influencing control of the populations. Releases were started when cotton was in 5 or less leaf stage of development. Pheromone in the PBW Rope formulation was applied at 6 leaf if a 60:1 sterile: native ratio was not achieved. This application used a hand applied PBW Rope formulation of 30g AI per acre. In 1994, a few fields received sprayable MEC formulation mid-season to release pressure on sterile insect resources. In 1995, a much lower level of sterile insect release was attempted (see Table 1).

Fiber treatment was required after first bloom on more than 1,000 acres and all ratios were lost in mid to late June. In 1996, releases were increased to a higher rate (Table 1). Cotton acreage had escalated from approximately 1,600 acres in the adjacent Mexicali Valley in 1993 to 130,000+ acres in 1996. This resulted in drastic increases in migratory pressure apparent in early spring and late July through the remainder of the season.

In 1996, results were more favorable than in 1995, but still impeded by movement from the Mexicali Valley. Figure 1 illustrates levels of release until termination of release on 20 July. Our release rates were relatively consistent and not influenced as drastically in 1996 by production anomalies as our 1995 releases were.

Pheromone Fiber treatments were required in 11 fields during the fruiting cycle. The PBW Rope was required in 5 commercial fields and used on 3 experimental field locations, because they were difficult to treat with sterile releases (less than 2 acres in any continuous block). At the 350 per acre per day release rate, ratios were more difficult to reach than in 1994 but the program held through the primary fruiting cycle. Figure 2 illustrates native and sterile recapture valley wide, April through July, 1996.

It is apparent that by mid-July ratios in individual fields were affecting relative capture rates overall. Most importantly, however, no conventional insecticide was required anywhere in this valley for PBW and boll infestations were kept low (Table 2). All data are from incubated bolls (held 2 weeks in boll boxes before counting larvae/pupae). Only in mid and late August, as fields reached maturity, were larvae found in the few remaining green bolls. The populations in the Imperial Valley were much lower than in adjacent valleys during the critical growing period of May through July (Figure 3).

### 1997

In 1997, transgenic (Bt) cottonseed was readily available in several varieties suitable and acceptable to Imperial Valley growers. Its efficiency is revolutionary. Table 3 summarizes important issues. Table 4 summarizes expectations.

Taking these factors into consideration, growers in the Imperial Valley and all respective cooperators agreed to a shift in project treatment paradigms. The growers used the maximum amount of Bt cotton possible so long as it fit within individual grower expectations and budgets (not regulated). Our lowest sterile release was 100 steriles/acre/day. Pheromone rope was used on all non-Bt cotton (within legal requirements). Table 5 summarizes the acreage that fell into these categories. Note that sterile insects are not registered as pesticides and may be legitimately released over any cotton.

Important population indicators to date are as follows: spring emergence, April through mid May, in 1997 was unprecedented and higher than any previous year (Figure 4), but was not followed by a subsequent larval population in bolls. Until the 3rd week of July, trap captures of native moths were lower than either 1995 or 1996. Of particular interest were low-level captures in June and July with excellent ratios (Figure 5) through the week of July 16 compared to 1995 and 1996 (Figure 4).

During the week of June 23, all non-cotton trap lines experienced significant population increases. During this first upsurge, captures were highest in the line closest to Mexico (Figure 6). By the following week, the valley overall had very high moth captures in non-cotton trap lines.

During this week we lost ratios in all fields, and sterile release were terminated on August 9. Populations were, however, much lower than in adjacent areas (Figure 7). The larval boll population was higher this year (Table 6) than any preceding year, even given that only 19 percent of the fields were conventional cotton. The date of infestation suggests migration as a contributing factor.

## Conclusions

1. This is a programmatic trial. Results must be evaluation with judgment and knowledge of pest potentials. It is not replicated as in a conventional test. Our results are, however, very encouraging. We must realize that PBW is a long term "tax". Its control does not make money for the industry in that it would be cheaper to not have to deal with it at all. Even in the San Joaquin, where sterile insect programs are run on a low cost/acre/year, the bill for the last 25 years is approximately $125 million (in 1996 dollars). Arizona will continue to pay at least $30/acre/year on 275-300,000 acres unless we eradicate the pest or stop growing cotton.

2. Incorporation of Bt cotton into an eradication format could significantly increase our chances of reducing overall program cost and increasing efficacy. We will gain real advantage if we act quickly before insect resistance develops and decreases Bt cotton's effectiveness.


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Table 1. Imperial Valley 1994 1996 Program Review

| Year | 1994 | 1995 | 1996 |
|---|---|---|---|
| Sterile Release | 250 | 175 | 350 |
| Pheromone Treatment | Rope + MEC | Rope Fiber | + Rope Fiber |

Sterile Release = number of moths per acre per day per 7 days per week average. Insects were released 6-days/week.

Table 2. Imperial Valley Boll Data, 1996.

| Week of | Bolls | Larvae/100 Bolls |
|---|---|---|
| 06/23/96 | 280 | 0 |
| 06/30/96 | 1600 | 0.01 |
| 07/07/96 | 1715 | 0.08 |
| 07/14/96 | 1520 | 0.18 |
| 07/21/96 | 1180 | 0.31 |
| 07/28/96 | 1654 | 0.5 |
| 08/04/96 | 1520 | 0.36 |
| 08/11/96 | 1678 | 0.79 |
| 08/18/96 | 1540 | 3.05 |
| 08/25/96 | 1459 | 4.14 |
| 09/01/96 | 1324 | 4.45 |
| 09/08/96 | 1077 | 3.95 |
| 09/15/96 | 778 | 2.54 |
| 09/22/96 | 600 | 4.52 |
| 09/29/96 | 94 | 0.05 |

Table 3. Issues in Use of Bt Cotton

| |
|---|
| A powerful too for PBW-affects larvae within the boll |
| Resistance is a key issue |
| Completely compatible with pheromone disruption and sterile insect release |
| It is the most suitable new technology for integrated, area-wide eradictaion/control |
| We need to act quickly to take full advantage of this technology |

Table 4. What can be expected with Bt cotton in mixed agro-ecosystems

| |
|---|
| High larval mortality in early instar |
| Late season bolls with high numbers of mines |
| Drastic reduction of population’s biotic potential in areas with a high ratio of Bt to conventional cotton |
| A few larvae survive in late season because: |
| 1% to 3% of plants within the Bt cultivar may be non-Bt |
| Bt toxin is found predominantly in rapidly growing tissue |

Table 5. Imperial Valley Program Treatment Regimes

| |
|---|
| 81% Bt cotton |
| 17.75% pheromone rope treated conventional cotton |
| 1.25% refgia-untreated conventional cotton |
| Sterile insect release at 100 moths/acre/day on all cotton |

Table 6. Inperial Valley Boll Sampling Results, 1997

| | 100% Bt | | Conventional with Rope | | Conventional No rope-Refuge | | Weighted Average | |
|---|---|---|---|---|---|---|---|---|
| Week Of | Bolls Sampled | Larvae/ 100 Bolls | Bolls Sampled | Larvae/ 100 Bolls | Bolls Sampled | Larvae/ 100 Bolls | Bolls Sampled | Larvae/ 100 Bolls |
| 6/22 | 2000 | 0.00 | 1000 | 0.00 | 900 | 0.00 | 1809 | 0.00 |
| 7/6 | 2000 | 0.00 | 1000 | 0.10 | 1000 | 0.00 | 1810 | 0.02 |
| 7/20 | 1990 | 0.00 | 975 | 0.00 | 800 | 0.00 | 1795 | 0.00 |
| 8/3 | 1998 | 0.00 | 995 | 0.10 | 1000 | 0.00 | 1808 | 0.02 |
| 8/17 | 1383 | 0.00 | 280 | 19.29 | 900 | 0.00 | 1183 | 3.38 |
| 8/31 | 1148 | 0.00 | 606 | 38.28 | 400 | 1.75 | 1042 | 6.73 |
| 9/14 | 322 | 0.31 | 519 | 102.12 | 100 | 3.00 | 353 | 18.17 |
| 9/28 | 200 | 0.00 | 203 | 44.83 | 100 | 1.00 | 199 | 7.86 |

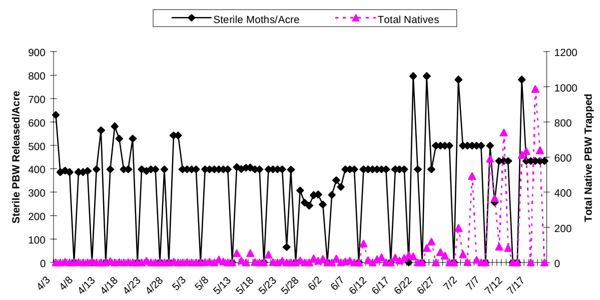


**Figure 1. Sterile PBW Release/acre vs. Natives trapped, Imperial Valley, April - July 1996**

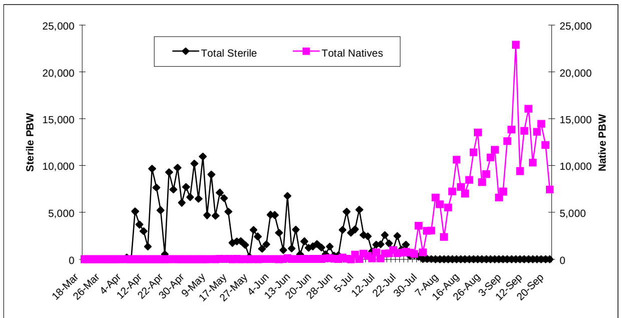


**Figure 2. Total Sterile vs. Native PBW Trapped - Imperial Valley 1996**

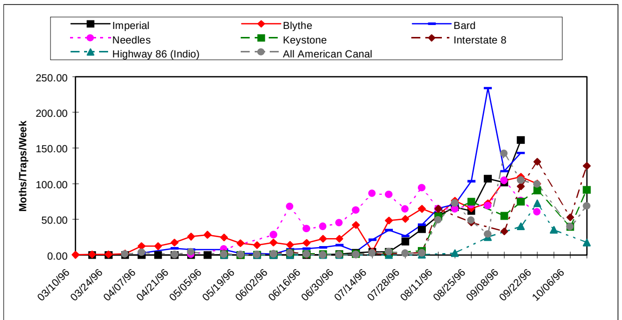


**Figure 3, Comparison of PBW Trapped Southern CA Cotton Growing Areas, 1996**

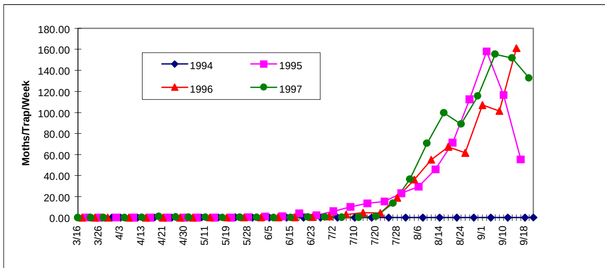


**Figure 4, Comparison of Native Moths Captured per week, 1994-1997 Imperial Valley PBW Sterile Release Project**

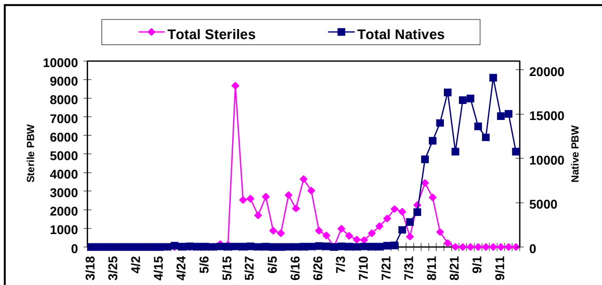


**Figure 5, Total Sterile vs. Native PBW Trapped, Imperial Valley, 1997**

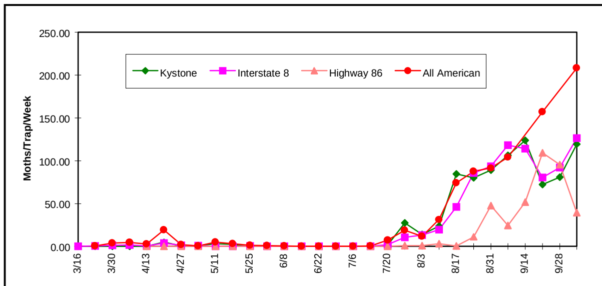


**Figure 6, Comparison of Moths Captured per Week, 1997 Traplines**

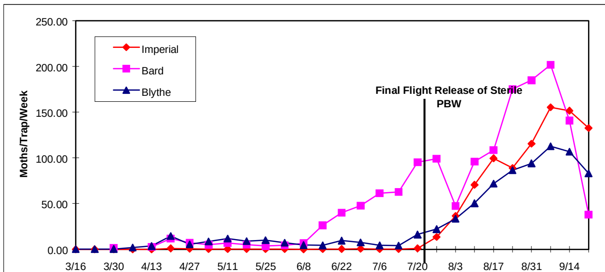


**Figure 7, 1997 Comparison of Imperial, Bard, and Blythe**