Combining gossyplure and insecticides in pink bollworm control

C. A. Beasley □ T. J. Henneberry

Benefits have to be weighed against possible adverse effects on beneficial predators

Gossyplure, the pink bollworm sex pheromone, has been used commercially since 1977 to suppress pest populations by disrupting mating in cotton crops. Two slow-release systems for gossyplure are commercially available: NoMate PBW fibers and Disrupt flakes, suspended in the sticker Bio-Tac or Phero-Tac, respectively, and applied aerially with special equipment. The addition of small amounts of pyrethroid insecticide to the sticker has been suggested to kill male pink bollworm moths attracted to and contacting the pheromone-sticker combination (point source).

To determine the effectiveness of such treatments, we conducted tests in cooperation with growers and pest control advisors in southeastern California's Palo Verde Valley. Catches of male pink bollworm moths (*Pectinophora gossypiella* [Saunders]) in gossyplure-baited traps, rosetted blooms and boll infestations, and numbers of beneficial predators were compared in fields treated with: (1) Disrupt with and without the pyrethroid insecticide permethrin in Phero-Tac; (2) NoMate PBW with and without permethrin in Bio-Tac; and (3) insecticides only (trichlorfon). Some decisions to treat or not to treat were made jointly by the chemical representatives, grower, and pest control advisors. Others were made routinely by grower's pest control advisor. This is a report of the 1982 studies.

Comparisons

Aerial gossyplure applications began at first flowering. Six cotton fields, in each case, received NoMate PBW or Disrupt with (+) or without (−) permethrin (0.004 pound active ingredient per acre) added to the respective stickers, for a total of 24 fields of 24 to 66 acres each. The rate of gossyplure, as NoMate PBW or Disrupt, was 0.002 or 0.003 pound active ingredient per acre, which provided the recommended 0.03 or 0.13 pound product per acre, respectively. Six fields of 20 to 57 acres each were treated with insecticides only, as controls.

We compared effects of the treatments on male moth trap catches from the end of May through the first week in September. Baited delta traps (one per field quadrant at canopy height, 100 feet from field edges) were checked twice a week, and baits (Disrupt Lure-Tape) were changed monthly.

Pink bollworm-infested flowers and total white flowers were counted twice weekly along 100 feet of randomly selected rows, at least 100 feet from field edges in each quadrant. Counts were made from about 15 through 50 percent flowering.

Twenty-five susceptible bolls collected at random from each field quandrant were combined and stored outside in the shade in ventilated plastic boxes for 14 days, after which adult moths, pupae, and larvae in each box were counted. All bolls were then opened and examined for pupae and larvae. During the last week of August to mid-September, the numbers of bollworm-damaged open bolls, in 250 bolls examined, were determined for all quadrants of all 30 fields.

Sweep-net sampling indicated effects of the treatments on beneficial predators. Adults and immature forms of *Orius, Nabis, Geocoris, Chrysopa,* and Reduviidae, and adults of *Collops,* Coccinellidae, and spiders were counted in twice-weekly sampling of 100 sweeps in each field quadrant.

To determine how beneficial predators would be affected by including permethrin with pheromone stickers, we used data from each field taken during the period of the pheromone applications until 10 days after the last pheromone application. If any insecticide application was made before the last pheromone treatment, or, in control fields, if an insecticide other than trichlorfon was used, sweep sample data were not included beyond that point.

Planting and first irrigation in 27 of the fields were from March 13 to April 13. Three late-planted fields, treated with NoMate PBW(+), were planted and irrigated between April 29 and May 8.

Treatment schedules

During the approximately two-month NoMate PBW application period, trichlorfon was applied an average of 1.3 times to NoMate PBW(+) and 0.7 times to NoMate PBW(−) fields. The last applications of NoMate PBW(+) and (−) were followed by seasonal averages of 7.7 and 8.5 insecticide applications.

All fields receiving Disrupt (−) were treated once with trichlorfon and sulfur toward the end of the pheromone treatment period, and four of these six fields were treated with permethrin within a week before the last pheromone applications. Two of these fields treated with permethrin did not receive the fifth pheromone application scheduled for July 24 (see table 1). Pest control advisors or growers decided to interrupt pheromone treatments by an insecticide application or to terminate the pheromone program in individual fields when they found high numbers of larvae in bolls and male moths in traps. Because our information was delayed by the two-week incubation of green bolls, pest control advisors monitored in-boll larvae on the day they collected bolls. Their decisions were based on personal experience rather than on standard thresholds.

Results

Before initial treatments, gossyplure-baited traps caught significantly more male pink bollworm moths in fields scheduled for Disrupt applications than in fields scheduled for NoMate PBW or insecticide applications (fig. 1, table 2). An average of less than one male moth per trap per night was caught in fields treated with Disrupt and NoMate PBW during the periods pheromones were applied. Male moth trap catches after

pheromone treatments were significantly higher in fields previously treated with Disrupt than in those treated with NoMate PBW.

During the period of 15 to 50 percent flowering the percentage of infested flowers was significantly higher in fields treated with Disrupt(−) than in fields treated with Disrupt(+), NoMate PBW(+), NoMate PBW(−), or insecticides (table 2). There was no significant difference in numbers of infested flowers between early- and late-planted fields treated with NoMate PBW(+).

Fields treated with Disrupt(−) had a significantly higher percentage of damaged mature open bolls than did fields treated with Disrupt(+). Fields that received either Disrupt treatment had significantly higher percentages of damaged open bolls than did those treated with insecticides or NoMate PBW with or without permethrin (table 3). The seasonal average numbers of pink bollworms per 100 immature bolls showed similar results.

The late-planted fields treated with NoMate PBW(+) had lower infestations of immature bolls than did the earlier planted fields and the six fields treated with NoMate PBW(−) (fig. 2). Late-planted fields did not have susceptible bolls

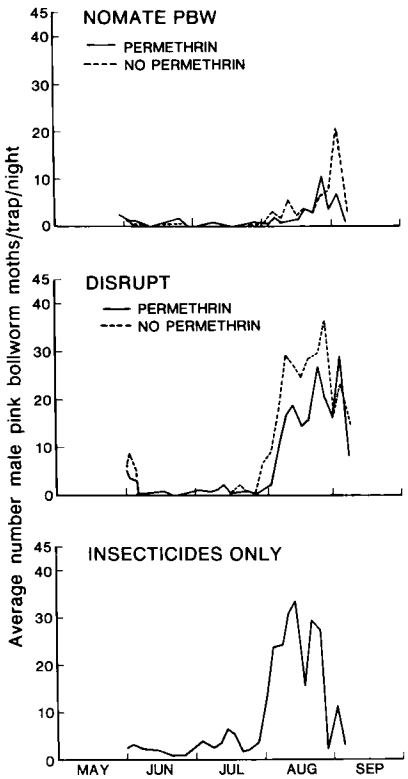

Fig. 1 Both pheromone formulations, with and without permethrin, reduced bollworm moths trapped during the June-July application period.

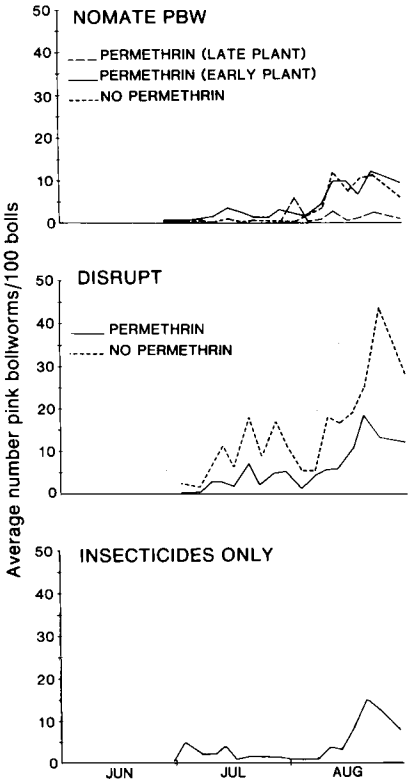

Fig. 2 Late-planted NoMate fields had lowest boll infestations. Disrupt fields had higher infestations; permethrin seemed to improve control.

Delta traps baited with gossyplure were checked twice a week to determine catches of male pink bollworm moths. (Garn Stanworth photo)

Table 1. Average number of treatments, gossyplure formulations plus (+) and minus (−) permethrin in the stickers, and insecticides in all pink bollworm suppression programs

Pink bollworm treatment*	Numbers of treatments†		
	Pheromone	Insecticide	Total
NoMate PBW(+)	3.5	9.0	12.5
NoMate PBW(−)	4.7	9.2	13.9
Disrupt(+)	5.0	6.7	11.7
Disrupt(−)	4.7	8.7	13.4
Insecticides Only	—	12.8	12.8

†Averages of six cotton fields per treatment.
*NoMate PBW(+) applied June 6 — August 5; NoMate PBW(−) applied June 6 — July 30. Disrupt(+) and (−) applied June 4 — July 24. Insecticide treatments considered as interruptions in a pheromone program, and trichlorfon treatments applied to the control (insecticide-only) fields during the period of pheromone applications to other fields, are described in the text. After pheromone programs were terminated, all fields received treatments of, primarily, pyrethroids or parathion.

Table 2. Pink bollworm-infested flowers and moth trap catches in treated cotton fields*

Pink bollworm treatment	Percent infested flowers†	Male moths/trap/night in relation to pheromone applications‡		
		Before	During	After
Nomate PBW(+)	0.1 b	1.7 c	0.4 b	3.4 c
Nomate PBW(−)	0.1 b	1.4 c	0.3 b	5.8 c
Disrupt(+)	0.3 b	3.8 b	0.6 b	18.0 b
Disrupt(−)	0.6 a	6.8 a	0.7 b	25.1 a
Insecticides	0.1 b	2.6 bc	2.7 a	20.0 b

*Averages of six replications. Averages in the same column not followed by the same letter are significantly different according to Duncan's multiple range test, P = 0.05.
†Twice weekly from about 15 to 50 percent bloom (June 10 to July 22, 1982).
‡Before = three sampling dates, May 28 to June 4; during = various sampling dates within the time pheromone-only applications were utilized, or during the time when only trichlofon treatments were utilized for insecticide-only fields; after = nine sampling dates, August 10 to September 8.

Table 3. Infested immature bolls and damaged open bolls in treated cotton fields

Pink bollworms treatment	Immature bolls		Percent mature open bolls damaged‡
	Percent infested*	Number pink bollworms/ 100 bolls†	
Nomate PBW(+)	2.5 c	2.3 b	1.0 c
Nomate PBW(−)	3.0 c	3.3 b	1.2 c
Disrupt(+)	5.6 b	6.1 b	4.5 b
Disrupt(−)	10.8 a	14.6 a	10.5 a
Insecticides	3.8 bc	4.0 b	1.8 c

*Seasonal averages of six replications, twice weekly samples of 100 bolls per field from June 28 to September 1. Averages in the same column not followed by the same letter are significantly different, according to Duncan's multiple range test, P = 0.05.
†Average seasonal number of the sum of adults, larvae, and pupae per 100 bolls.
‡Average of six replications, 1,000 bolls per replication. Sampled between August 24 and September 16.

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Pink bollworm control (cont'd)

until after mid-July.

Seasonal averages of beneficial predators sampled (excluding spiders and Reduviidae) showed significantly more predators in Disrupt(−) fields than in other treatments. The lowest numbers of predators were found in fields treated with the two gossyplure products with permethrin added. Including permethrin with either Disrupt or NoMate PBW did not adversely affect spiders and Reduviidae, nor did permethrin with NoMate PBW affected *Geocoris*.

Discussion

Both NoMate PBW and Disrupt were highly effective in reducing male moth catches in baited traps within treated fields. Numbers caught averaged less than one per trap per night and may have been too low to show differences between pheromone products or between use and non-use of permethrin with the pheromone sticker.

The addition of permethrin appeared to improve the effectiveness of the Disrupt-sticker combination in pink bollworm control, as measured by male moth catches after the pheromone application period, and by crop damage; however, it is possible that higher trap catches and greater crop damage recorded in Disrupt(−) fields resulted from greater initial pink bollworm populations in those fields. The addition of permethrin to the NoMate-sticker combination did not significantly improve the effectiveness of control for that product.

Infestations in Disrupt-treated fields increased to economically damaging levels in July. An average of one trichlorfon application per Disrupt(−) field and subsequent commercial insecticide applications on all Disrupt-treated fields failed to reduce larval populations in bolls or prevent them from increasing; this result indicates that populations were very high in those fields when the season began. Unfortunately, no untreated control fields were available for comparison.

NoMate PBW with or without permethrin in the sticker, applied to fields with lower pink bollworm population densities, gave control in early to mid-season which was equal to that obtained in fields treated with insecticides only. However, an average of one trichlorfon application per field was also made on all NoMate PBW fields during the same period.

Our results, although variable on a daily basis, indicate that the addition of permethrin to NoMate PBW and Disrupt reduced seasonal average numbers of six of eight beneficial predators sampled (*Orius*, *Geocoris*, *Nabis*, *Chrysopa*, *Collops*, and Coccinellidae). We suspect that the greater reduction in beneficial predators observed in the Disrupt-sticker-pyrethroid combination, as compared with the NoMate PBW combination, may be due to the greater number of point sources in the former.

The effects of these predator reductions on other pest populations in the insect complex is unknown; other investigations have reported significant increases in the density of *Heliothis* spp. associated with 63 to 73 percent reductions in the same beneficial insect predator complex caused by increased insecticide use in cotton fields.

The benefits of adding permethrin to either NoMate PBW or Disrupt for pink bollworm control need to be weighed against possible adverse effects on beneficial predators. However, the reductions in predator populations in our tests were considerably less than reductions that have been reported as a result of scheduled applications of many recommended insecticides.

Timing of the initial application of gossyplure, frequency of subsequent applications, rate of application, and performance at low and high pink bollworm population densities are additional areas that need to be studied.

C. A. Beasley is Area Integrated Pest Management Specialist, Cooperative Extension, University of California, Imperial County, and T. J. Henneberry is Laboratory Director and Research Entomologist, USDA-ARS, Western Cotton Research Laboratory, Phoenix, Arizona. *The authors thank the following for their assistance: Jerry Guilin, Chris Guilin, Michael Naranjo, Bhavani Ganeshalingam, Carol Adams, Lori Yates, Ann Strawn, and George Butler. This research was supported in part by California Cotton Pest Control Board.*