Lures and traps for monitoring tomato fruitworm

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Although the commercial Scentry trap (lower photo) captured far more tomato fruitworm moths, a liquid trap (above) was considered effective for general use because of its small size and low cost.

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The tomato fruitworm is the primary lepidopterous pest of processing tomatoes in California's northern production areas, feeding on fruit and contaminating it with insect parts, excrement, and decay-causing organisms. A fruit damage sampling scheme (see *California Agriculture*, March-April 1983), used along with egg-sampling, currently provides pest managers with reliable monitoring tools and control decision guidelines. The use of pheromone traps, however, to monitor activity of adult male tomato fruitworm, *Heliothis zea,* and predict the timing and intensity of egg-laying would improve the management program for processing tomatoes.

For a pheromone trapping system to become useful in an integrated pest management (IPM) program, factors affecting trap catch must first be evaluated. We therefore tested, under field conditions, the relative attractiveness and length of effectiveness of commercially available tomato fruitworm pheromone lures and specially prepared lures. We also evaluated trap designs for effectiveness and operability.

Pheromone lure comparisons

Commercial tomato fruitworm pheromone lure formulations evaluated included: rubber septa formulations from Trece Inc. and Raylo Chemicals Ltd.; a slow-release membrane formulation from Consep Membranes Inc., sold under the name Biolure Inc. in 1984; and a hollow-fiber release system from Scentry, Inc. The remaining tomato fruitworm pheromone formulation was prepared at the U.S. Department of Agriculture Agricultural Research Service (USDA-ARS) laboratory in Yakima, Washington, and consisted of red rubber septa pre-extracted with dichloromethane, then treated with a 3.0:0.09 mg dichloromethane solution of Z11-16:Al and Z9-16:Al, hereafter referred to as the "septum" or "septa."

In the 1984 pheromone lure tests, we used the ARA trap developed by Dr. M. Bari of the Artichoke Research Association, Castroville, California. It consisted of two 1-quart translucent plastic containers, both attached to a 2-foot-tall wooden stake, one container inverted directly over the other with a 1-inch gap between. Three 1¾-inch-diameter holes equally spaced around the upper one-third of the top container allowed moths to enter. The bottom container was filled to just below the rim with a 50:50 mixture of water and ethylene glycol. Lures were suspended from the top inside center of the upper container.

The 1985 trap (Liquid-85) was an enlarged and modified version of a pink bollworm trap developed by Dr. R.T Huber and M.P. Hoffmann in Arizona. It consisted of a single 1-quart container with three holes equally spaced around the upper part of the trap. A lid, painted white to shade the pheromone lure, was placed on top of the container. Lures were hung from the inside center of the lid, and the container was filled with the ethylene glycol mixture to the base of entrance holes. Traps, attached to wooden stakes as in 1984, were installed at or just below the tomato plant canopy.

We used a liquid trapping medium, because sticky-based traps often lose their ability to retain moths after the capture surface becomes coated with insects, insect parts, dirt, and debris. Unless the bases are frequently replaced, the efficiency of sticky traps varies with the length of field exposure and previous number of moths captured. The efficiency of liquid traps is less likely to vary, because the liquid trapping surface changes little with time or previous captures. At each observation, we used a small household strainer to remove and count moths and then topped off the trap with additional liquid.

Unless stated otherwise, treatments (lures or traps) were arranged in a randomized complete block design with four to five replicates per treatment spaced 30 to 50 yards apart within rows of tomatoes. Trap rows were at least 15 yards apart and rotated or rerandomized at weekly or bi-weekly servicings. Statistical analysis of trap catch data was by analysis of variance. All tests took place in commercial processing tomato fields in Yolo County, northern California.

From August 19 to September 17, 1984, we compared tomato fruitworm and beet armyworm moth catches in traps baited with tomato fruitworm Biolure or specially made septum lures that were replaced weekly or left to age. We had noticed earlier that traps baited with fresh tomato fruitworm Biolure lures seemed to capture many beet armyworms. We quantified those observations in this test.

Formulations tested in 1985 were aged outdoors in empty traps for one, three, or five weeks until transferred to tomato fields for testing. To determine the effect of long-term cold storage on rubber septum lures, we stored them at −9°C for approximately 12 months and then compared them with fresh lures.

Results

In general, under the conditions of these tests, the rubber septa formulated at Yakima were more attractive to male tomato fruitworm moths than the commercial formulations were, and storage did not significantly reduce septum effec-

TABLE 1. Tomato fruitworm pheromone lure comparisons

	Mean catch/trap*			Longevity†	
	1984	1985			
Formulation	Aug. 16-Sep. 17	Aug. 27-Sep. 10	Sep. 11-24	1984	1985
				------ weeks ------	
Septa‡	98.0 a	—	22.0 a	4	4
Septa (stored)‡	—	25.6 a	15.5 ab	—	4
Trece	—	17.0 ab	11.5 bc	—	8
Biolure/Consep	39.8 b	10.0 b	5.8 c	5	2
Scentry	—	—	0.8 d	—	7
Raylo	—	1.5 §	—	—	5

* Means in columns followed by same letter(s) are not significantly different at 5 percent level, Duncan's Multiple Range Test (DMRT).
† Number of weeks before catches in traps containing aging lures were significantly lower than fresh (replaced weekly) lure.
‡ Formulated at USDA-ARS laboratory in Yakima.
§ During comparable time period (Aug. 27 to Sep. 3), Raylo lure caught significantly fewer moths than the septa and Trece but not the Consep lure.

tiveness (table 1). Among the commercial preparations, Trece-baited traps captured the most moths, followed by Consep. The Trece formulation also lasted the longest (up to two months), while the Biolure/Consep formulation was the shortest-lived, although results varied between years. Because the Scentry and Raylo lures caught so few moths, the longevity data presented here may not accurately reflect their effective life. It is possible, however, that placing any of these formulations in traps more compatible with their pheromone release characteristics or in more efficient trap designs could improve their effectiveness.

In the 1984 tests, trap catches were significantly higher ($P<0.05$) during the first few days following replacement of week-old septum lures with fresh septum lures. Observations were made twice a week for four weeks and catch per trap-day compared. We recorded an average of 3.49 male tomato fruitworms per trap-day at three to four days compared with 2.19 at six to seven days after new septa were placed in traps. Trap catches at the two observations with Biolure formulations were not significantly different.

This initial period of greater attractancy should be taken into consideration if the septa are used in monitoring programs where trap counts affect management decisions. Putting a fresh lure in a trap could result in artificially high catches for a few days, resulting in unwarranted control actions. This problem can be minimized by exposing the lures to the air a few days before placing them in a trap.

We also compared two different lots of lures from Trece after noticing substantial decreases in moth catch when we used lures from a new lot. The lots were compared (September 3-24, 1985) in a paired field test in which treatments were switched at each observation. Rubber septa in the two lots were distinctly different. One lot, with septa similar in appearance to those formulated at Yakima (septa obtained from West Company) captured 25.3 male moths per trap. The other lot, which had lighter colored, more flexible septa, captured 0.5 moth per trap. These septa resemble those from A.H. Thomas Company, which are known to contain chemicals that destroy certain pheromone chemical groups, including that of the tomato fruitworm. We suspect that the second lot performed poorly because the septa were not pre-extracted to remove pheromone-destroying components before being treated with pheromone.

Significantly more beet armyworms were captured in traps baited with fresh tomato fruitworm Biolure formulations than in traps baited with aged Biolure or with fresh or aged specially prepared septa (table 2). If the beet armyworm adults were male, then the tomato fruitworm Biolure formulation was probably contaminated with beet armyworm pheromone or some male attractant. It is unlikely that the beet armyworm pheromone contaminant was produced during the synthesis of the tomato fruitworm pheromone because of the dissimilarities in their chemical structure.

Trap comparisons

To determine the best trap design for general use, we compared the two liquid types with a commercial tomato fruitworm trap (Scentry Inc.). Traps baited with septa lures were spaced about 45 yards apart in a randomized complete block design and checked once a week. Traps were not rotated.

TABLE 2. Capture of beet armyworm moths in traps baited with tomato fruitworm pheromone lures, August 16 to September 17, 1984

Formulation*	Mean catch/trap†
Biolure (fresh)	55.6 a
Biolure (aging)	3.7 b
Septa (fresh)	2.0 b
Septa (aging)	1.8 b

* Fresh lures replaced weekly, aging lures 38 days old at end of test.
† DMRT at 5% level.

TABLE 3. Comparison of three trap designs for capture of male tomato fruitworm moths, August 30 to September 18, 1984

Trap design	Mean catch/trap*
Scentry Inc.	277.63 a
Liquid-85	6.19 b
ARA	4.06 b

* DMRT at 5% level.

The liquid traps captured male tomato fruitworm moths with similar efficiency but trapped far fewer than the Scentry trap did (table 3). A maximum of 812 male tomato fruitworm moths were captured in a single Scentry trap in a week compared with 16 in the Liquid-85 trap. The efficiency of the Scentry trap makes it a good research tool capable of detecting small to large fluctuations in population densities. This efficiency also makes it difficult for general use, because so many insects are captured when populations are high that trap servicing becomes time-consuming.

An advantage of the liquid design is its relatively small size; since most equipment can pass over the traps, they can be placed directly in the field. Another advantage is the low cost of assembly.

Conclusions

Of the commercially available lures tested, the Trece formulation performed best and, when placed in the Liquid-85 type of trap, should be effective for general use in monitoring tomato fruitworm in IPM programs for processing tomatoes. To be safe, we suggest replacement of these lures after four to six weeks of field exposure. These tests indicate that present commercial tomato fruitworm pheromone formulations vary a great deal. This variability may result from deficiencies in the quality control of pheromone purity, the pheromone formulation procedures, or the release rate for specific formulations.

We are also investigating other means of optimizing tomato fruitworm trap use, such as the best location in the field and the number needed per field. Our preliminary studies indicate that tomato fruitworm traps could be used to indicate the initiation of tomato fruitworm flights and concurrent periods of egg-laying. Further studies are in progress to improve the use of tomato fruitworm traps and incorporate them into the processing tomato pest management program. For such a program to be successful, commercial pheromone formulators must deliver a consistent and high-quality product.

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