Recapture of Sugarcane Borer (*Diatraea saccharalis* (F)) Males Released at Different Distances from Pheromone-Baited Traps[1, 2]

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INTRODUCTION

A method commonly used in entomology to determine the effectiveness of light and/or pheromone traps in a given area is to evaluate trap catches of marked and released insects. Johnson (6) points out some of the disadvantages of mark-release-recapture methods for studying insect dispersal and states that usually but a small percent of the released population is recaptured.

Henneberry et. al. (4) reported recapture of *Trichoplusia ni* (Hubner) males averaged 17 percent when 22 blacklight traps baited with virgin females were spaced equidistant, one from another, in a 680-acre field. Kishaba et. al. (8) released males of *T. ni* at 350 feet, 500 feet and 1,000 feet downwind from a pheromone source and recaptured 30, 19 and 6 percent, respectively. When four traps were placed in a line 650 feet apart, percent recapture of males released at 160 feet, 650 feet, 1,325 feet and 2,020 feet downwind, was 35, 15, 5, and 2 percent, respectively.

Wong et. al. (14) released males of the red-banded leaf roller, *Argyrotaenia velutinana* (Walker), in a 4-acre apple orchard and recovered 37 percent of 4,600 released when 10 traps, each containing 10–20 virgin females, were spaced 50 m. apart within the orchard.

Hammond (3) reported recapture of only 3.89 percent, when males of the sugarcane borer, *Diatraea saccharalis* (F.), were released 25 feet to 50 feet from two traps, each baited with two virgin females. Patrick and Hensley (9) recaptured 4.44 percent of 1,936 *D. saccharalis* males released downwind at distances ranging from 40 feet to 320 feet from a trap baited with 10 virgin females. Dispersal away from release points before males be-

[1] Manuscript submitted to Editorial Board March 26, 1973.

[2] This work is adapted from a dissertation submitted by the senior author to the Faculty of the Graduate School at Louisiana State University and Agricultural and Mechanical College, Baton Rouge in partial fulfillment of the requirements for the degree of Doctor in Philosophy (1971).

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came responsive to the pheromone was ascribed as most responsible for this low percent recapture.

The pheromone of *D. saccharalis* was discovered by Pérez and Long (10). Techniques and dye compounds for marking Lepidoptera for release in the field have been published by Vail et. al. (12), Graham and Mangum (2) and Wong and Cleveland (13).

The study reported herein was undertaken to: (a) determine the percent recapture of *D. saccharalis* males released at different distances from traps baited with virgin females, (b) evaluate the influence of wind direction on male recapture, and (c) compare different trap designs.

MATERIALS AND METHODS

FIELD TRAPPING AREA

Tests to determine the percent recapture of marked males released at different distances and directions from traps baited with virgin female sugarcane borers were conducted during 1970 and 1971 at the Louisiana State Experiment Station farm near St. Gabriel, Louisiana. This site was selected because it afforded less interference from natural infestations of the sugarcane borer than many other local areas in sugar production. Sugarcane was not planted there until 1969; thus, little if any natural infestation was present. Uninfested seed cane was planted in 1969, and insecticides were applied on rigorously fixed application schedules to minimize development of infestation. Furthermore, no other sugarcane is grown within a 5-mile radius of this farm, thus reducing chance of moth migration from other sugarcane farms.

The recapture experiments were conducted within a 20-acre planting of single seedling entries in a varietal selection trial. As these seedlings were randomly distributed in the test, there was potentially little if any varietal effect on the moth recapture experiments. The seedlings were planted 36 feet apart, and each produced from three to 30 mature stalks when harvested. No other cane was grown on this farm in 1970, although a similarly sized planting was grown in 1971 approximately half a mile from the experimental area.

The sugarcane borer moths were obtained by rearing larvae on a Pinto bean diet developed by Burton (1) and according to procedures described by Hensley and Hammond (4). Male moths to be released were marked in the laboratory with Black Ray[R] [4] fluorescent dyes (Ultraviolet Products

[4] Trade names are used in this paper solely for the purpose of providing information. Mention of a trade name does not constitute a guarantee or warranty of the equipment by the Agricultural Experiment Station of the University of Puerto Rico or an endorsement over other equipment or materials not mentioned.

Company, Inc., St. Gabriel, California). Different colored dyes were employed to identify males released at different times or at different distances from traps. Immediately before carrying males to the field for release, ¼ teaspoon of powdered dye was placed in a holding cage containing the males. The cage top was then covered with a paper towel and air puffed inside with a bulb-type pump to aid in coating the moths with dye. The dye adhered to the integument and was especially noticeable on wings and antennae. After recapture, the marked moths were differentiated from

FIG. 1.—Wire trap used in recapture of male sugarcane borer moths.

those trapped from natural populations by detecting the presence of dye on the integument with the aid of a binocular microscope and a fluorescent lamp. The dye was easily detected on recaptured males for a period of 3 days after release.

Cages of males marked in this manner were transported to the field in 25-lb.-capacity paper bags, where they were released by opening the cages and shaking them gently over sugarcane plants. All releases were made between the hours of 5:00 p.m. and 7:00 p.m. Cages of females used as bait moths were transported to the field in paper bags similar to those used for transporting males.

PHEROMONE TRAPS

The traps initially employed were similar to those used by Patrick and Hensley (9). Each trap (fig. 1) consisted of a cylinder of ¼-inch mesh hardware wire screen 18 inches long and 12 inches in diameter. The exterior surface of the trap was coated with Stikem[R] (Michael Pelton Company, Oakland, California), an adhesive substance which served to entrap lured males. This cylindrical trap was suspended in a vertical posi-

FIG. 2.—Plastic cylinder trap used in recapture of male sugarcane borer moths.

tion in the field by attaching it to a 2-inch X 2-inch X 6-foot redwood stake which was driven into the soil. A 2-inch X 2-inch X 12-inch strip of wood nailed across the top was used to attach the traps to the stakes.

The hardware wire screen traps were replaced with those made from plastic cans after comparison of the two indicated that more males were recaptured by the plastic can traps. These traps were constructed from 5-gallon white plastic cans from which the tops and bottoms had been removed. Two types were used during the remainder of the recapture studies. One (fig. 2) was composed of the entire cylindrical surface area of the can and the other (fig. 3) of half of the cylindrical area. Both types were suspended in a horizontal position in the field by attaching them to stakes

similar to those used to support the hardware screen traps. The inner surface of each trap was coated with Stikem and recoated at 3-day intervals during each test.

Five virgin female sugarcane borers were used in each trap as bait regardless of trap design. They were confined in a cylindrical ½-pint-capacity ice cream carton from which the top and bottom had been removed and replaced with 12-mesh copper wire screen. The moth cage was

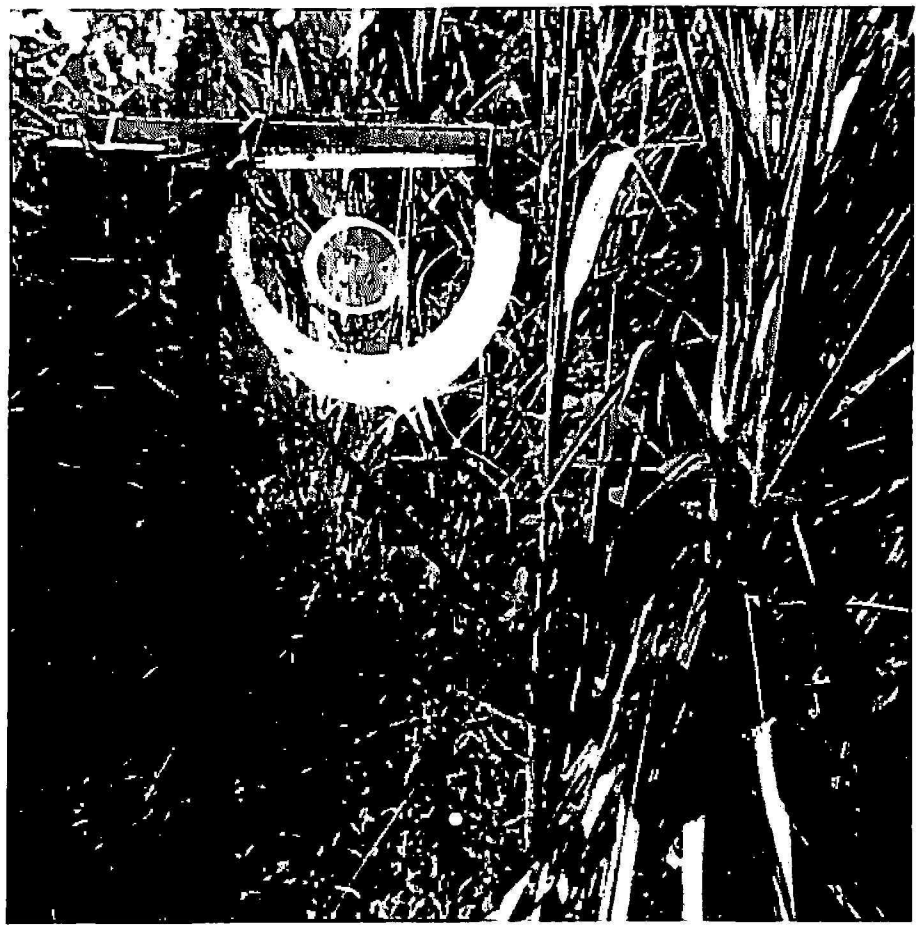

FIG. 3.—Half-cylinder plastic trap used in recapture of male sugarcane borer moths. (The blacklight lamp attached to the trap was not used in this study.)

suspended within the trap by a wire fastened to the top of the trap. All traps were suspended approximately 2½ feet above ground level regardless of the height of the sugarcane crop. Trap stakes were coated with a 2-inch band of Stikem to prevent ants from destroying the bait moths caged within the traps.

MALE RECAPTURE EXPERIMENTS

Experiment 1 was conducted during the last week in June 1970, when the sugarcane crop averaged approximately 18 inches in height. Twelve

baited hardware screen traps were arranged 18 feet apart in a circle with a radius of 120 feet. Marked males were released daily for 4 days from a central point in the circle. The number of marked males recaptured and the number of wild males trapped from the natural population were recorded daily for individual traps after males were first released.

Experiment 2 was conducted from July 7 to July 16. Two sets of 6 hardware wire traps were located 120 feet apart in the field. Individual traps in each set were spaced 18 feet apart and arranged in a line extending from northwest to southeast. Males were released on five dates from July 7 to July 16 at a central point between the two lines of traps. The number of males recaptured and those trapped from the natural population were recorded for each trap the morning after each release.

Experiment 3 was conducted from July 21 to August 4. It was designed to compare the efficiency of the hardware wire trap with that of traps constructed from plastic cans. Three wire traps and three can traps were spaced 18 feet apart and arranged in a paired block design in a line extending from northwest to southeast. Marked males were released in a northeastern direction at a point located 60 feet from the center of the line of traps. Males were released on five dates and records were kept of the number recaptured in each trap.

Experiment 4 was conducted to obtain information on the percent recapture of males released simultaneously at two different distances northeast of a line of traps. Six can traps were arranged 18 feet apart in a line extending from northwest to southeast. All males available on each release date were separated into two groups, and each group was coated with a different color dye. The two groups of moths were released at 120 feet and 180 feet, respectively, from the line of traps on each release date. Five releases were made from August 6 to August 16, and the number of males recaptured was recorded the morning after each release. During the time releases were made, the sugarcane crop averaged about 5 feet in height.

Experiment 5 was conducted to determine the percent recapture when marked males were released 220 feet northeast of a line of six traps baited with virgin females. This test was conducted during June 1971 at the St. Gabriel farm. The study area was over the first year stubble crop of the 20-acre varietal planting previously described. The height of the sugarcane in this planting during June averaged about 24 inches. The pheromone trap employed was similar in all respects to the plastic can trap used in previous tests except that only half of a 5-gallon can was used as a trapping surface to entrap moths (fig. 3). Six of these traps were positioned in the field 24 feet apart and aligned from northwest to southeast. From June 1 to June 30, nine releases of marked males were made at a point located

220 feet northeast of the traps. Records were kept of the number of males recaptured and those trapped from the natural population.

RESULTS

EXPERIMENT 1

The number of male sugarcane borers recaptured when males were released from a central point within a 120-foot diameter circle of traps baited with virgin females is shown in table 1. The number recaptured was extremely low regardless of direction of individual traps from the release point. Only 5.3 percent of 297 males released on four dates were recaptured. Percentages recaptured on different dates of release ranged from 7.8 percent on July 26 to 0 percent on July 27. Recapture of marked males was

TABLE 1.—*Number, percent, and direction from release site of recaptured male sugarcane borers released from a central point within a 120-foot diameter circle composed of 12 sticky traps, each baited with five virgin females, St. Gabriel, Louisiana*

Date of release	Released	Recaptured				Total	Recaptured	Trapped from natural population
		Direction of traps from release point—						
	Number	*North*	*South*	*East*	*West*	*Number*	*Percent*	*Number*
June 26	133	1	4	2	5	12	7.8	2
27	33	0	0	0	0	0	0	0
28	67	1	0	1	1	3	4.4	0
29	64	0	1	0	0	1	1.5	3
Total	297	2	5	3	6	16	5.3	5

too low in this experiment to provide meaningful information on any possible effect of wind direction on trap catch. Only five wild males were trapped from the natural population.

EXPERIMENT 2

Table 2 shows the number and direction of recapture when males were released between two lines of traps baited with virgin females and positioned crosswise (northwest to southeast) to the direction of the prevailing winds (southwest to northeast) at the time of release. Upwind traps, those positioned southwest of the release point, captured more males than downwind traps (those positioned northeast of the release point). However, differences in numbers recaptured were not statistically significant between upwind and downwind traps. Of 1,015 marked males released on five different dates, 113 (11.7%) were recaptured by upwind traps, and 30 (2.9%) were recaptured by downwind traps. Only six wild

TABLE 2.—*Effect of prevailing wind direction on recapture of male sugarcane borer moths released at a centrally located point between two lines of baited pheromone traps extending from northwest to southeast, St. Gabriel, Louisiana*

Date of release	Released	Recaptured				Trapped from natural population
		Upwind		Downwind		
	Number	*Number*	*Percent*	*Number*	*Percent*	*Number*
July 7	345	62	18.0	12	3.5	0
9	120	19	15.8	4	3.3	2
10	180	6	3.3	2	1.1	0
14	140	2	1.4	6	4.4	0
16	230	24	10.4	6	2.2	4
Total or percent	1015	113	11.7	30	2.9	6

TABLE 3.—*Comparison of the number of male sugarcane borers recaptured by three wire traps and three can traps, St. Gabriel, Louisiana*

Date of release	Released	Wire traps			Can traps		
		Recaptured		Trapped from natural population	Recaptured		Trapped from natural population
	Number	*Number*	*Percent*	*Number*	*Number*	*Percent*	*Number*
July 27	110	0	0.0	0	9	8.2	3
29	79	2	2.5	0	4	5.1	0
August 2	170	12	7.1	2	23	13.6	3
3	92	0	.0	0	7	7.6	3
4	136	0	.0	0	11	8.1	6
Total or percent	587	14	2.4	2	54	9.4	15

males were trapped from the natural population during the period of male release (July 7–16).

EXPERIMENT 3

A comparison of the number of males recaptured by three hardware wire traps with those recaptured by three plastic can traps is shown in table 3. Greater numbers of males were recaptured by the can traps than by the wire traps. From a total of 587 males released on five dates, 14 (2.4%) were recaptured by wire traps compared to 54 (9.6%) by can traps. Differences in trap catches between wire and can traps were statistically significant ($p = 0.01$). Fifteen wild males from the natural population were recaptured by can traps compared to two by wire traps.

EXPERIMENT 4

The number of males recaptured when releases were made 120 feet or 180 feet downwind from a line of can traps is shown in table 4. Sixty-five of 343 (18.6 %) and 67 of 291 (23.0 %) were recaptured when releases were made at 120 feet and 180 feet, respectively. These differences were not statistically significant ($p = 0.05$). Percentages of recapture on individual release dates, which ranged from 8.3 to 45.0 percent for males released at 120 feet and 11.4 to 31.1 percent for those released at 180 feet, were higher than obtained in previous experiments. A total of 40 wild males were trapped from the natural population.

TABLE 4.—*Number of male sugarcane borers recaptured when releases were made 120 feet or 180 feet downwind from a line of six traps, each baited with five virgin females, St. Gabriel, Louisiana*

Date of release	Distance from release point						Trapped from natural population
	120 feet			180 feet			
	Released	Recaptured		Released	Recaptured		
	Number	*Number*	*Percent*	*Number*	*Number*	*Percent*	*Number*
August 6	120	10	8.3	90	17	18.8	5
8	60	9	15.0	35	4	11.4	8
9	40	18	45.0	43	8	18 6	4
10	33	12	36.6	33	10	30.3	12
16	90	16	17.7	90	28	31.1	11
Total or percent	343	65	18.6	291	67	23.0	40

EXPERIMENT 5

Table 5 shows the number of males recaptured when releases were made 220 feet downwind from a line of six half-can traps. Of 683 males released during the period June 1 to June 30, 1971, 166 (24.3 %) were recaptured. Percent recapture on individual dates of release were comparable to those obtained in Experiment 4, and ranged from 11.4 to 31.4 percent. A total of 144 wild males were trapped from the natural population.

DISCUSSION

The percent recapture of males in Experiment 1 (table 1) was very low, and no useful information was obtained concerning the influence of prevailing winds on the attraction of males to virgin females. The low number of males recovered in this test was due most likely to: a, arthropod predation, b, inefficient capture in the wire traps employed and c, cool temperature. This experiment was conducted in June when night temperatures

were often below 15° C. The males were released in large groups on plants near ground and they were sluggish and not prone to fly. Ants, spiders, and carabids were observed preying on released males and numerous dyed remnants of wings were found the day after releases were made. Inefficient capture by the wire traps may have been a factor, especially as percent recapture was much higher in can traps used in subsequent experiments. To minimize arthropod predation, males always were released in lower numbers per plant and at sites higher on plants in later experiments.

Differences between the number of males recaptured by upwind and downwind traps (table 2) were not significant ($p = 0.05$), although upwind traps captured 79 percent or almost four times more males than

TABLE 5.—*Number of male sugarcane borers recaptured when releases were made 220 feet downwind from a line of six half-can traps, each baited with five virgin females, St. Gabriel, Louisiana*

Date of release	Released	Recaptured		Trapped from natural population
	Number	*Number*	*Percent*	*Number*
June 1	70	8	11.4	7
2	51	16	31.4	2
4	31	5	16.1	4
6	141	44	31.2	10
7	106	31	29.3	30
9	70	16	22.9	34
21	115	24	20.9	20
24	49	9	18.8	24
30	50	13	26.0	4
Total or percent	683	166	24.3	144

downwind traps. Furthermore, male recapture by upwind traps was higher on four of the five occasions when releases were made. As wind direction was recorded only at the time when males were released, it could have changed on the one occasion (July 14) when more males were recaptured by downwind traps. The high percent recapture of moths released upwind from traps also lends credence to the theory that pheromone attraction is associated with wind direction.

Five-gallon can traps were found to be more efficient in recapture of released males than wire traps of about the same dimensions (table 3). Rapid drip-off of the Stikem from trap surfaces apparently greatly affected the ability of the wire trap to contain moths alighting on traps. Films of moisture, which lowered the adhesive capacity of the Stikem coating, were also found more frequently on wire traps than on can traps.

Although Stikem on the inner surfaces of the can traps also tended to drip from the lateral walls, it accumulated in the bottoms of traps and little drip-off was observed. The concentration of Stikem on the lower surfaces of traps probably accounts for the majority of moths being trapped there. Although the entire surface of can traps was recoated at 3- to 4-day intervals, few moths were caught on the upper surfaces at any time. Sharma et al. (10) used cylindrical solid surface traps in release studies with *T. ni* and reported that 91 percent of the moths recaptured were caught on the lower surfaces of traps. Nevertheless, it is possible that the pheromone substance in vapor form is heavier than air and thus responsible for most males being caught on lower trap surfaces. Killinen and Ost (6) observed that males of *T. ni* approached on a low flight trajectory on still nights and gradually rose to a pheromone source.

The 9.4-percent recapture of *D. saccharalis* males by can traps (table 3) was much higher than the 3.98 percent obtained by Hammond (3) in smaller can traps and the 4.44 percent reported by Patrick and Hensley (9) from wire traps. Hammond released males from 6:00 a.m. to 11:00 a.m. and releases were made from 3:00 p.m. to 4:00 p.m. by Patrick and Hensley. All releases in the study reported herein were made from 5:00 p.m. to 7:00 p.m. Although improvement was made in percent recapture, it might be further enhanced by releasing males from midnight to dawn, especially as Patrick and Hensley (9) reported that dispersal from release points prior to male response to the pheromone may have been partially responsible for the low number recaptured. Pérez and Long (10) in Louisiana reported that *D. saccharalis* females were most attractive to males during the hours of 1:00 a.m. to 4:00 a.m.

Differences in percent recapture when males were released at different distances from pheromone traps (table 4) were not significant ($p = 0.05$). Mixing of males from different release points before they became responsive to the pheromone may have been responsible for lack of significance in these data.

During 1970, only 68 wild males from natural *D. saccharalis* populations were trapped in the four experiments conducted, thus providing evidence that natural populations were too low to interfere appreciably with recapture of the marked males released. Further indications of low infestations at St. Gabriel farm were provided by weekly field surveys. Larval infestations did not attain levels of 5 percent and insecticide applications were not required to prevent economic crop damage.

SUMMARY

Stikem-coated traps constructed from 5-gallon plastic cans and baited with virgin females of *Diatraea saccharalis* (F.) were more effective in

recapture of males than comparable wire traps. Percent recapture for males released at 120 feet, 180 feet, and 220 feet from traps baited with virgin females were 18.6, 23.0 and 24.3 percent, respectively. Higher numbers were recaptured when males were released upwind from pheromone traps than when releases were made downwind, thus indicating that the male response to the pheromone may be through chemical olfactory receptors. Cool temperatures, arthropod predation and poor trap design can be responsible factors for inefficient recapture of released males.

RESUMEN

Las trampas construidas de envases plásticos con una capacidad de 5 galones y revestidas en su interior con Stikem(R), en las que se colocaron como señuelo hembras vírgenes del adulto del barrenador de la caña, *Diatraea saccharalis* (F.), fueron más eficientes en recapturar machos liberados del adulto de la misma especie que trampas similares hechas de alambre de tela metálica. El porcentaje de machos recuperados después de ser liberados a 120 pies, 180 pies y 220 pies de distancia de las trampas cebadas con hembras vírgenes fue de 18.6, 23.0 y 24.3 por ciento, respectivamente. Se recuperó un mayor número de machos adultos cuando éstos fueron liberados en dirección contraria a la del viento con referencia a la fuente de atracción (feromona) que cuando lo fueron en dirección favorable en relación a la fuente de atracción, indicando así que el estímulo del macho a orientarse hacia la fuente de atracción (feromona) puede deberse a factores olfativos de naturaleza química en su sistema. El bajo porcentaje de machos recuperados pudo haber sido causado por las bajas temperaturas que se registraron durante las pruebas, por ser éstos presa de los artrópodos y por un diseño inadecuado de las trampas que se usaron.

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