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FIELD TESTS OF (Z) AND (E)–12–TETRADECEN–1–01 ACETATE AS A SEX ATTRACTANT FOR ASIAN CORN BORER, *OSTRINIA FURNACALIS* (GUENEE)

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The sex pheromone for Asian corn borer was evaluated as a bait in traps for monitoring populations. Virgin females, extracts of females and synthetic pheromone were all tested as baits. Two types of water pan traps and two sticky traps were included in the study. Number of moths per trap of corn borer and a microlepidoptera are reported from extensive field tests in various combinations.

INTRODUCTION

Sex pheromones are now described for many species of Lepidoptera (Mayer and McLaughlin 1975; Inscoe 1982) and are rapidly becoming important tools in pest monitoring programs (Klassen et al. 1982; Hartstack et al. 1976). Since a sex pheromone was described (Klun et al. 1980, Zhiging et al. 1980) for the Asian corn borer, *Ostrinia furnacalis* (Guenee) we attempted to evaluate it for use in monitoring this major corn pest in the Philippines. This paper reports the findings of a variety of field tests designed primarily to compare the pheromone against virgin females as a bait in traps for population monitoring and to a lesser extent to evaluate trap design. We also expect to use population monitoring data as input to a simulation model for Asian corn borer which is currently under development (Jackman and Benigno). The simulation model will be used in pest management programs similar to one on *Heliothis* (Hartstack et al. 1976).

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METHODS

Insect traps

Four types of traps were used: metal basin traps, plastic basin traps, Pherocon(R) 1C sticky traps and Biotrap(R) sticky traps. Metal basin traps consisted of a circular metal pan 60 cm in diameter and 7.5 cm deep placed on a metal frame at 1.2 meter high and covered with a 1 cm thick plywood cover 8 cm above the pan top.

Plastic basin traps were designed similar to metal basin traps. Plastic basin traps consisted of a circular plastic pan 30 cm in diameter and 9 cm deep, placed in a wood frame at 1.2 meters high and cover with a 1 cm thick wooden cover 8 cm above the pan top.

Pherocon 1C sticky traps were supplied commercially from Zoecon Corporation while Biotrap(R) sticky traps were supplied from Hoescht. These sticky traps were placed in the field at a height of 0.5 cm and 1 cm respectively.

Traps Baits

Three types of baits were used: virgin female corn borers, rubber septa treated with a synthetic pheromone and rubber septa treated with extracts of virgin females.

Virgin females were reared individually in vials from pupae that were field collected at Los Banos, Laguna or less often near Sto. Tomas and Lipa City, Batangas. Upon hatching, females were maintained individually under ambient laboratory conditions or sometimes under refrigeration at about 10°C. Females selected as bait were as healthy and as recently emerged as possible usually emerging the previous night before baiting and seldom were more than 2 days old. Once females were placed in the field, they were not replaced until they were dead.

Standard rubber septa with synthetic pheromone were prepared by dispensing into the interior bottom of the large end of each septum 10 ul of a heptane solution containing 5.1 mg/ml of Z-tetradecen-1-01 acetate and 5.35 mg/ml of E-tetradecen-1-01 acetate and allowing the solvent to evaporate. To add doses, the septa were treated with 0.1, 25 and 100 ul of the same heptane solution. Synthetic pheromone solution and standard septa were prepared (Klun) in the United States (US) and mailed to Los Banos. Septa treated in the US were tested in Los Banos using a gas chromatograph evaluation of a hexane extract from a septum and found to contain compounds in appropriate locations to indicate the presence of the above two acetate compounds. Additional standard septa and varying dose rate septa were prepared in Los Banos using solutions supplied in a glass ampuole from the same US laboratory.

Extracts from virgin females were prepared by rinsing an excised abdomen tip in 0.3 ml of heptane for 10 seconds in a 6 dram vial. The heptane solution was decanted into the large end of a rubber septum and allowed to evaporate. Females used to prepare extracts were handled as detailed above for virgin females. Extract of one virgin female was dispensed per septum.

Trap Location

Traps were placed along edges of corn fields between 30 days after planting and post harvest stages. Traps were placed at least 30 m apart to assure no interference between traps. Fields were located at the Central Experiment Station, University of the Philippines at Los Banos (UPLB), Laguna.

Trap maintenance and Data Recording

Females were housed in a 3 by 10 cm wire screen cage and suspended 2 to 8 cm above the center of the water or sticky trap surface. Females were supplied with a 10 percent honey in water solution on a cotton swab as food. Females were changed whenever they were found dead and more positive trap catches were recorded, since we then assumed that the female died after attracting males the previous night but before traps were checked. Thus, known dead females were considered as no bait.

Septa baits were similarly dispensed or suspended directly on a wire placed through the small end of the septum.

The number of moths per trap were recorded each day with a few exception when traps were checked after 2 to 3 days. Data recorded was assumed to be evenly distributed over the trapping period and numerically distributed across multiple nights of trapping.

Water levels, baits and trap construction materials were all maintained when traps were checked. Only data from sound, properly maintained traps was recorded. Septa baits were replaced with fresh septa each week or biweekly in only three cases.

Trap data was recorded from May 26, 1982 through Jan. 31, 1983. Data consist of over 100 nights of trapping giving about 550 total observations in 12 test configurations. Counts of a microlepidoptera captured in traps were also recorded from Jan. 25 to 31, 1983 after they were found in corn borer traps.

Field observations of corn borer behavior

Six caged virgin female moths were placed around the edges and along alleyways in a corn field on Dec. 2, 1982, between 1 to 2 meters in height at 1900 H. Observations were started about 2000H and each caged female was observed for several minutes at a time at least once each half hour until 0200H, Dec. 3. Behavior and density observations of male corn borers were recorded generally during this observation period.

RESULTS

Trap Studies

Table 1 shows that the number of corn borers captured per trap per night is generally low for all traps tested. Moreover, the results from the four traps tested do not show noticeable differences between traps. It is significant that sticky traps were shown to have positive captures of corn borer moths. Only about 25 percent of the nightly recording were positive for corn borers and under 13 percent of the recordings had over one adult borer per trap per night. Trap catch numbers are low compared with studies at other locations e.g. China (Klun et al, 1980. The Whole China Corn Borer Research Group et al. 1982).

Table 1. Frequency of number of Asian corn borers captured per trap per night at Los Banos, 1982-1983, summarized by trap type.

NUMBER/TRAP/NIGHT	TRAP TYPE			
	Metal basin	Plastic basin	Pherocon(R) 1C	Biotrap(R)
0	271	·53	82	7
1	56	6	7	1
2	11	0	3	0
3	10	0	1	0
4	10	2	1	0
5	8	2	2	0
6	6	0	0	0
7	4	0	0	0
8	2	0	0	0
9	1	0	0	0
10	2	0	0	0
11	2	0	0	0
12	1	0	0	0
13	0	0	0	0
14	0	0	0	0
15	2	0	0	0

Table 2 shows the frequency of the number of corn borers captured per trap per night summarized by bait. The mean number captured per trap by bait type indicates that virgin females (1.14/trap/night) rank slightly better than the control (1.11/trap/night) but rank above heptane extracts (.41/trap/night) and synthetic pheromone (.24/trap/night). The number of cases when more than three moths were trapped per trap per night was over 13 percent for virgin females under one percent for synthetic pheromone and about eight percent for the control.

Table 2. Frequency of number of Asian corn borers captured per trap per night at Los Banos, 1982-1983, summarized by bait.

	BAIT TYPE			
NUMBER/TRAP/NIGHT	*Virgin female*	Synthethic *Pheromone* (10 ul/septum)	Heptane *Extract*	Control
0	110	213	39	21
1	30	26	3	3
2	6	4	0	0
3	8	1	2	1
4	4	3	1	2
5	8	0	0	3
6	2	1	1	0
7	2	0	0	0
8	1	1	0	0
9	1	0	0	0
10	1	0	0	0
11	2	0	0	0
12	1	0	0	0
13	0	0	0	0
14	0	0	0	0
15	2	0	0	0

Table 3 shows the mean and range of the number of moths captured per trap per night using various concentration of synthetic pheromone. The two tests are reported separately since the corn borer density declined during the test weeks. The low sample size of this test (7 for Nov. 13-19 and 18 for Nov. 23-Dec. 1) and lack of replication leave the results in question. However, the lack of strong differences between pheromone density and the general inverse trend between amount of pheromone per septum and number caught per trap per night should be noted.

Table 3. Mean number and range of Asian corn borers capture per trap per night at Los Banos, 1982, with selected pheromone concentrations as bait in metal basin traps.

DATES	CONTROL	ul of pheromone solution per septum				
		.1	1	10	25	100
Nov. 13-19	3.3 (1-5)	5.6 (1-10)	2.3 (0-5)	3.8 (0-8)	–	–
Nov. 23 Dec. 1	–	–	–	.8 (0-6)	.3 (0-2)	.2 (0-1)

On Jan. 25 a microlepidoptera was observed in the plastic basin traps (Table 4). These were collected in high numbers (79 to 100/trap/night) using synthetic pheromone. At the same time two female corn borer baited traps captured only one microlepidoptera in seven nights. Moreover, a trap baited with a heptane extract of a female corn borer captured only one corn borer and 67 microlepidoptera. Confirming results were obtained since one Biotrap(R) baited with synthetic pheromone captured one corn borer and 56 microlepidoptera while an unbaited control captured zero of each from January 28 to 31, 1983.

Table 4. Number of Asian corn borer and microlepidoptera captured per trap at Los Baños, 1983 (number of Asian corn borer/number of microlepidoptera).

DATE	BAIT				
	Female	Pheromone	Female	Extract	No Bait
Jan. 25	5/0	0/ 100	3/0	0/8	0/0
26-27	9/0	0/180	1/0*	1/25	0/0
28	1/1	1/79	3/0	0/13	0/0
29-31	1/0*	0/220	0/0	0/21	0/0

*Female dead – rebaited.

Table 5 shows the paired comparison between baits summarized by the number of cases of nights of trapping. Comparing baits in this manner eliminates the problems of population levels, differences between fields and trap location. Virgin females were found to be much better than synthetic pheromone ($P > .001$), heptane extracts of single females ($P > .001$) and the control ($P > .001$). However, pheromone was not significantly better than the unbaited control traps indicating that the pheromone tested is not an effective bait.

We desired to determined if using baited traps would be an indicator of population level to satisfy our main objective of monitoring Asian corn borer populations. Figure 1 indicates mean number of corn borers captured per trap per night using water basin traps, both metal and plastic, with the currently best bait i.e. virgin female moths. The large changes in number of moths captured is consistent with fluctuations in population data. We assume from this indirect evidence that the number of moths captured per trap per night will be an indicator of adult moth density.

Field Observations

Direct field observations were able to clarify many points although the information is qualitative in nature. Male moths were first observed about 1245H although they could have been overlooked during observer orienta-

Table 5. **Paired comparison of bait using moths/trap/night on a case by case basis.**

Bait 1	NUMBER OF CASES Bait 1 Exceeding	Both Baits Even	Bait 2 Exceeding	Bait 2
Female	50	112	8	Pheromone
Female	16	6	1	Extract
Female	25	19	0	Control
Pheromone	3	11	3	Control

tion. At that time several specimens were captured and identified as corn borer moths. After that time, moths with appropriate size and flight activity were considered to be corn borers.

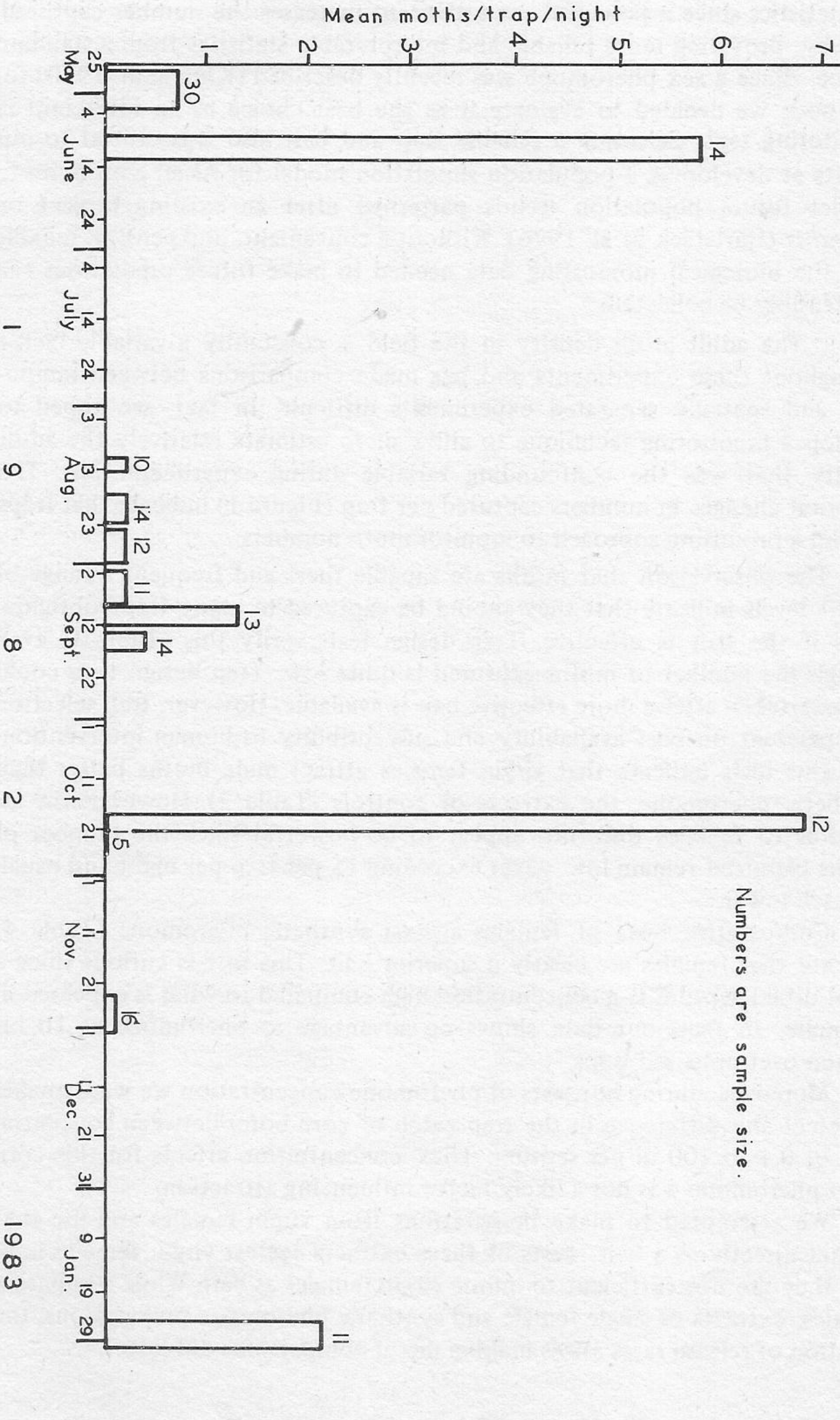
The presence of corn borer moths was quickly established by this observation method. Also crude estimates of populations were made since six moths per 30 meters of row were seen while walking slowly in the field. In some sites, moths were observed as dense as five per square meter indicating reasonable population levels.

Although moths were seen commonly throughout the night, little evidence of attraction to caged females was observed. One male was seen flying near a female about 2100H but it was quickly distracted and approached a flashlight that was used intermittently for observations. Also about 0130H, four moths flew to within 0.3 to 0.5 m. of a caged female but quickly flew away for no apparent reason.

Another important observation is that most moths were seen near the top of grasses and weeds in the corn field. Some were seen to fly up as high as the corn canopy and occasional moths flew nearly straight up and out of sight. In any case moths are very capable fliers and able to negotiate flight through a maze of grass stems.

DISCUSSION

The use of pheromone traps to monitor populations of lepidoptera is very attractive because of the advantages over passive traps, light traps or female baited traps. Pheromone traps generally are easier to maintain, less laborious in sorting desired pests, independent of electrical or fuel sources and less expensive. Pheromone traps also generally provide more meaning-


Mean moths/trap/night
1 2 3 4 5 6 7
May June July Aug. Sept. Oct Nov. Dec. Jan.
1982
1983
30 14 10 14 12 11 13 14 12 15 16 11
Numbers are sample size.

ful statistics since a powerful sex attractant increases the number captured, thereby, providing more reliable and interpretable statistics from a standard source. Since a sex pheromone was recently described (Klun et al. 1980) for this pest, we decided to evaluate it as the best choice as an attractant in monitoring taps. Selecting a reliable trap and bait also was crucial to our efforts at developing a population simulation model for Asian corn borer to predict future population trends patterned after an existing project on *Heliothis* (Hartstack et al. 1976). Without a convenient, inexpensive, reliable trap the biological monitoring data needed to make future predictions can not feasibly be collected.

The adult moth density in the field is constantly a variable factor throughout these experiments and has made comparisons between temporally and spatially separated experiments difficult. In fact, we hoped to develop a monitoring technique to allow us to estimate relatively the adult density that was the confounding variable during experimentation. The temporal changes in numbers captured per trap (Figure 1) indicate that traps are still a promising approach to monitor moth numbers.

The observation that moths are capable fliers and frequent a range of height levels indicate that they should be captured in many trap configurations if the bait is effective. Trap design tests verify this (Table 1) even though the number of moths captured is quite low. Trap design tests could be undertaken after a more effective bait is available. However, trap selection is dependent on cost availability and susceptibility to human intervention.

Our tests indicate that virgin females attract male moths better than synthetic pheromone, the extracts or controls (Table 2). However, the attraction to females does not appear to be powerful since the number of moths caputred remain low, never exceeding 15 per trap per night and usually much lower.

Comparative tests of females against synthetic pheromone (Table 4) indicate that females are clearly a superior bait. This fact is curious since a 10 ul dosed septum is a concentration high compared to what is expected in a female. In fact, our data shows no advantage to pheromone at 10 ul/ septum over unbaited traps.

Moreover, during our tests of pheromone concentration we were unable to detect any difference in the trap catch of corn borer between concentration of 0.1 to 100 ul per septum. Thus, concentration effects for this corn borer pheromone was not a likely factor influencing attraction.

We attempted to make preparations from virgin females and use that extract directly as a bait. Tests of these extracts against virgin females indicate they are not sufficient to mimic virgin females as bait. While comparing females, extracts of single female and synthetic pheromone preparations, the question of release rates arises making direct comparisons dubious.

The general low number of moths captured and high frequency of zero captures remains an enigma. While part of the explanation may be attributed to population density, there are alternate explanations which are meritorious. Based on our direct observations of females, we believe that females call mates only intermittently. This phenomenon is reported in other lepidoptera (Bjostadt et al. 1980) and is a sufficient explanation to agree with our data. Alternate explanations, such as low trap efficiency or the pheromone acting only for a short distance remain viable.

The synthetic pheromone, however, does act as a sexual attractant for a species of microlepidoptera in a convincing fashion. Thus, a pheromone described from extracts of the Asian corn borer does not work properly for that species but serendipitiously was found to attract an unrelated moth.

The fact that synthetic pheromone and heptane extracts of virgin females attract microlepidoptera while virgin female corn borers do not attract make a convincing case for the notion that there is more to the corn borer attractant than just the release of the compounds in the synthetic preparation. The fact that virgin female corn borers do not attract microlepidoptera while an extract from them will, makes the biology and chemistry of these insects enchanting.

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