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# THE DEVELOPMENT OF A MONITORING SYSTEM FOR CORN BORER *OSTRINIA FURNACALIS* (GUENEE)

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## ABSTRACT

A monitoring study for corn borer, *Ostrinia furnacalis* (Guenee) was conducted at the Central Experiment Station, U.P. at Los Baños during 1985 wet season and 1986 dry season.

Kerosene light trap, crude pheromone extract and no bait were tested for 1985 wet season. Statistically, the light trap was significantly higher than the rest.

Virgin female, light trap, crude pheromone extract and no bait were studied for 1986 dry season. Statistically, the most efficient was the virgin female, followed by kerosene light trap and the crude pheromone extract. Except for the 50 female tips extracted from acetone, all the extracts were not significantly different from the control.

To relate the monitored data with practical insect pest management, a model that can predict a single field population of the corn borer by age class was utilized. Simulation were done on 7, 9, and 14 days catches by 25 female tips extracted from heptane and light trap during the wet season. Another run of the model using pest management sub-routine and the same immigration data were processed. The same immigration days were used for the virgin female data during dry season.

The observed adult peak timing was correctly predicted during wet season. The simulated peak egg deposition was nearly predicted in both season when compared to the observed peaks.

## Introduction

Except for cultural practices and varietal resistance which are still wanting when it comes to corn borer control, all the other methods share a common feature which is the presence of infestation prior to the initiation of control. It seems that monitoring system in the said methods is wanting. Also lacking are the most necessary environmental data that coincide with the coming of adults and the resulting development trend.

The use of pheromone to monitor population of lepidoptera is very attractive. The simplicity of construction and maintenance of the traps and their species-specificity give them many advantages over other methods (Campion and Nesbit 1983). Of the various monitoring methods for corn borer adults, the use of pheromone traps seems to be effective and inexpensive (Benigno, 1983). Sweeping is limited at a certain stage of the corn plants. It may also cause unnecessary damage to the plant. Suction devices are cumbersome to operate and laborious. Light traps are unreliable due to fluctuating luminiscene. In addition, fuel is costly and electricity is not always available. Passive traps are also non-workable (Jackman *et al.*, 1983).

The virgin female corn borer moth is known to produce a sex pheromone which Klun *et al.* (1980) identified and synthesized as (Z) and (E)-12-tetradecen-1-01 acetate in 1:1 geometric proportion. Thus, the pheromone component can be used for monitoring. The monitored data from corn borer bait can be utilized for population simulation.

Modelling of the corn borer mainly based on study by Camarao (1976, a & b) Jackman *et al.* (1984) with the incorporation of results of recent biological studies Saito and Oku (1976), Saito (1979), Saito (1980), Magalit (1983) and Lizarondo (1983), proved that more realistic modelling and simulation could be achieved. Lately, Lynch *et al.* (1984) found that heptane extract of ovipositors from lesser corn stalk females contain 10 compounds. Test with combination of these compounds showed that a mixture of these 10 compounds was as effective as virgin females in luring males into traps. This might also be true in corn borer.

This paper presents the comparative performance of three monitoring methods for corn borer. It also describes the utilization of trap catones data from the said methods for computer simulation of corn borer population.

## Materials and Methods

*Experimental area and experimental plots*

A 4500 square meters plot was utilized for the rainy season experiment, while a 3500 square meters area was utilized for dry season. IPB Var 1 was used in both trial. Planting, weeding, cultivation, fertilization and yield determination were based on the current recommended practices (UPLB-NFAC) Countryside Program. Control plots were also maintained.

*Insect traps*

Empty one gallon ice cream plastic cans were used throughout this study. A gallon is 20.3 cm in diameter and 12.7 cm deep. The gallon was placed in a 50 cm x 50 cm wood frame with an identical frame for cover and protection of bait supported on four corners by posts. The trap can be easily adjusted to the height of corn plants at a given stage by nails on the post. The posts used were ipil-ipil (*Leucaena leucocephala* Lam de Wit) and kakauate (*Gliricidia sepium* (Jack). The basins were filled with water at 3 cm and 1 teaspoon of commercial detergent was added.

*Baits*

Only crude pheromone extracts from male and female corn borers were used during the wet season. The females and males were reared individually in vials from larvae and pupae that were either mass-reared in the laboratory of field-collected.

Extracts were prepared by cutting at least 1-3 cm of the tip of abdomen of both the male and female corn borer with the use of ordinary nail cutter.

Extraction was done on rubber septa (Jackman *et al*, 1983, 1984) using three different solvents replicated three times per rate density of tip of abdomen. The solvents consisted of acetone, acetone after heptane and heptane alone. Extraction time was for 60 seconds instead of the 10 seconds method employed by Jackman *et al.* (1983, 1984).

The adult corn borers were 1-3 days old at the time of excision. The dry season experiment utilized three types of bait. These included virgin females, no bait and crude pheromone extracts. Virgin females were maintained individually in vials under ambient laboratory conditions. Healthy moths were selected as baits when deployed in the field. These were at least 1-2 days old. The moths were replaced when they perished.

The usual procedure for crude pheromone extraction was done. This time extraction was only on females at a rate of 25 and 50 tips of abdomen. The same solvent extraction time and storage were maintained. In both dry and wet season experiment, unbaited traps were deployed for the control. Likewise, a kerosene light trap was maintained for further comparison in the duration of the experiment.

*Trap location*

Traps were placed at the periphery or around the edges of corn fields from the date of emergence up to seven days before harvest. A total of 30 traps were deployed during the rainy season while 24 traps were used during the dry season. The traps were approximately 6 meters apart. Each rate or density of tip of abdomen and the virgin females were randomly deployed and replicated three times.

*Trap maintenance*

Pheromone crude extracts from both male were housed separately in a 3 cm by 10 cm wire screen cage suspended at 4-8 cm above the center of the water surface during the rainy season.

The virgin female was utilized in addition to the septum during the dry season. A 10% honey in water solution on a cotton swab served as food of the virgin female bait. The virgin females were changed whenever they were found dead. Water levels, bait and trap construction materials were maintained during the trapping duration.

*Insect data collection*

The collection of trapped corn borers was on a daily basis. Egg masses, larvae and pupae were counted 2-3 times a week.

*Data analysis*

The HP9845 B desktop computer statistical package was used for data analysis. The trap catches were transformed using the equation $\sqrt{x + 0.5}$ (Steel and Torrie, 1960). A one way ANOVA and two way ANOVA were employed for comparing overall trap performance.

A model that can predict a single field population of the corn borer *Ostrinia furnacalis* (Guenee) by age class through time was adopted from Jackman and Benigno (1983). The model can compute a time series of population density by age class form the input of temperature and immigration data.

*The corn borer model*

The model summarizes the ecological research on corn borers. The equations for development, oviposition and survival rates were derived from the studies of Camarao (1976a and b) and Saito and Nakayama (1981).

## Results and Discussion

*Wet season monitoring*

Table 1 describes the comparison of efficiency between the individual traps.

Table 1. Multiple comparison of different individual monitoring methods. Wet Season, CES (June 16 – August 19, 1985)

| *Trap Method* | *Mean** |
|---|---|
| 5A** | .0367 a |
| 5H | .0367 a |
| 5AA | .0733 a |
| 25A*** | 1.5144 a |
| 25H | 1.4078 a |
| 25AA | 1.2211 a |
| 25MA**** | .2567 a |
| 25MH | .0367 a |
| 25MAA | .0733 a |
| Kerosene light trap | 12.8889 b |
| Control | .1100 a |

*Means with the same letter are not significantly different at a = .05

**5 female tips extracted in A = acetone, H = heptane and AA = acetone after heptane

***25 female tips extracted in A = acetone, H = heptane and AA = acetone after heptane

****25 male tips extracted in A = acetone, H = heptane and AA = acetone after heptane

The tip rates of crude pheromone extracts are not significantly different from each other. On the other hand, the kerosene light trap is statistically significant with the rest of the traps. The kerosene light trap is the most efficient trap that monitored the adult corn borer.

Nevertheless, a closer look into the traps monitored data of the 25 female tips using the solvents, acetone, heptane and acetone after heptane showed that these have the highest catch among the extracts. These extracts likewise approximated the catch of the kerosene light trap in terms of consistency/nightly trapping including the quantity of catch. The extracts even attracted more male corn borer during the early entry/immigration of corn borers into the experimental corn field. The appearance of females particularly in the septa with male extracts suggests that there are also extractable compounds in the male tips that can readily attract females and this was confirmed by Atkinson (1981) in the case of the African sugarcane borer, *Eldana saccharia.* The presence of occasional catches in the control was due to simple blundering (Roeloffs and Carde, 1977).

*Dry season monitoring*

The relative efficiency of the individual traps is depicted in Table 2.

Table 2. Comparison of individual monitoring methods. Dry Season, CES (January 30 April 16, 1986)

| *Trap Method* | *Mean Catch** |
|---|---|
| 25A** | .0744 ab |
| 25H | .0522 ab |
| 25AA | .1044 ab |
| 50A*** | .3799 b |
| 50H | .0522 ab |
| 50AA | .1488 ab |
| Virgin Female | 4.6095 d |
| Kerosene Light Trap | 1.2947 c |
| Control | 0 a |

*Means with the same letter are not significantly different at a = .05

**25 female tips extracted in A = acetone, H = heptane and AA = acetone after heptane

***50 female tips extracted in A = acetone, H = heptane and AA = acetone after heptane.

All 25 female tips extracts are not significantly different with the 50 female tips extracts and the control. However, the 50 female tips extracted from acetone is statistically significant when compared with the control. The kerosene light trap is statistically different with all the extracts and the control while the virgin female is statistically significant with the rest.

It is interesting to note that in the absence of the virgin female baits, the extracts and light traps caught more in the wet season.

*Wet season simulation*

Table 3 shows the simulated and actual peak timing of egg and adult corn borer without pest management from the immigration data of a septum with 25 virgin female tips extracted in heptane.

The peak egg deposition for simulation using 7 days immigration input was 55 days after emergence. This true also for the 9 and 14 immigration days. The actual data for peak egg deposition was at 51 days. Thus, the predicted simulated value was 4 days late.

The simulated adult peak timing of emergence using 7 days immigragion input was at 51 days after emergence. Again the remaining two sets of immigration inputs showed the same peak. Nevertheless, the 14 days immigration entry yielded two adult peaks at 51 and 61 days after emergence. The observed peak adult emergence was 51 DAE. Hence the three runs duplicated the actual peak.

The simulated peak of egg deposition and adult appearance with pest management subroutine once more showed the usual peak egg deposition at 55 DAE and peak adult density at 51 DAE.

The only perceptible difference between the two runs of the model is that there was a reduction of egg density in the model with pest management subroutine. From an original 3111.94 egg density, this decreased to 2964.47. Other than this, the egg and adult simulated densities using 7, 9 and 14 days immigration inputs were the same. In short, the model can utilize either inputs and still generate the same peaks. However, a higher number of immigration input is better since it can simulate two or probably more adult peak instead of one as in 7 and 9 days immigration input. These peaks in 14 days immigration input can be used when compared with the observed peaks, that is there are more peaks that can be validated against the actual data.

Table 3 also shows the simulated peak timing of 14 days immigration input from kerosene light trap's male corn borer catches.

The run model with no pest management generated two simulated egg peaks at 52 and 54 DAE. These peaks are 1 day and 3 days late from the observed peak. It is clear that the kerosene light trap input provided the nearest predicted egg peak timing value as compared to the other runs from the 25 virgin female tips extracted from heptane. The run model with pest management predicted the adult peak emergence at 51 DAE like the other simulated run using 25 virgin female tips extracted from heptane. It was likewise noted that the observed peak of emergence from the 25 female tips and kerosene light trap coincide at 51 DAE with 17 and 5 male catches respectively for the said traps. Moreover, like the 14 days immigration input from the 25 female tips extracted from heptane, there was also corresponding increase of adult peaks in kerosene light trap.

The model shows that with increased immigration days input in both monitoring methods, there is a parallel increase in peak emergence of adult corn borers when compared with the actual data. In like manner, Nakasuji and Fijita (1980)

Table 3. Comparison of simulated and observed peak of corn borer population based from 25 female tips extracted in heptane and kerosene light trap catches. (Up to 65 days after emergence). Wet Season, CES (June 26 – August 19, 1985)*

| *Pest management practice* | *Peak stage* | *25 Heptane* | | | | | | | | | | | | *Kerosene Light Trap* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Simulated* | | | | | | | | | *Observed* | | | *Simulated* | | | *Observed* | | |
| | | *7 days immigration* | | | *9 days immigration* | | | *14 days immigration* | | | | | | *14 days immigration* | | | | | |
| | | *Date* | *DAE* | *Number* | *Date* | *DAE* | *Number* | *Date* | *DAE* | *Number* | *Date* | *DAE* | *Number* | *Date* | *DAE* | *Number* | *Date* | *DAE* | *Number* |
| None | Egg | Jul. 18 | (55) | 3111.94 | Jul.18 | (55) | 3162.98 | Jul.18 | (55) | 3162.98 | Jul 14 | (51) | 17 | Jul. 15 | (52) | 1681.05 | Jul. 14 | (51) | 17 |
| | | | | | | | | Jul. 14 | (51) | 19.94 | Jul. 14 | (51) | 17 | Jul. 17 | (54) | 1701.08 | Jul. 14 | (51) | 5 |
| | Adult | Jul. 14 | (51) | 19.94 | Jul.14 | (51) | 19.94 | Jul. 25 | (61) | 3.30 | Jul. 16 | (53) | 24 | | | | | | |
| Four Spray** + One Detasseling | Egg | Jul. 18 | (55) | 2964.47 | Jul 18 | (55) | 3162.98 | Jul. 18 | (55) | 3162.98 | Jul. 14 | (51) | 17 | Jul. 12 | (49) | 8.77 | Jul. 14 | (51) | 17 |
| | Adult | Jul. 14 | (51) | 19.94 | Jul 14 | (51) | 19.94 | Jul. 14 | (51) | 19.94 | Jul. 14 | (51) | 17 | Jul. 14 | (51) | 11.33 | Jul. 14 | (51) | 5 |
| | | | | | | | | Jul. 25 | (61) | 3.30 | Jul. 16 | (53) | 24 | Jul. 21 | (58) | 5.81 | | | |

*Observed egg density based from 200 random samples while observed adult density was based from the average of 3 crude pheromone extract bait and light trap.
**Sprays at 20, 39, 53 and 51 DAE, detasseling at 44 DAE.

Table 4. Comparison of simulated and observed peaks of corn borer population based from virgin female trap catches* (Up to 65 days after emergence) Dry Season, CES (January 30-April 16, 1986)

| *Pest management practice* | *Peak stage* | *Simulated* | | | | | | | | | *Observed* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *7 days immigration* | | | *9 days immigration* | | | *14 days immigration* | | | | | |
| | | *Date* | *DAE* | *Number* | *Date* | *DAE* | *Number* | *Date* | *DAE* | *Number* | *Date* | *DAE* | *Number* |
| None | Egg | Mar. 20 | (60) | 52790.65 | Mar. 23 | (63) | 89234.93 | Mar. 21 | (61) | 168832.02 | Mar. 12 | (53) | 15 |
| | Adult | Mar. 18 | (58) | 306.83 | Mar. 12 | (52) | 95.90 | Mar. 18 | (58) | 1067.43 | Mar. 5 | (45) | 25 |
| | | | | | Mar. 15 | (55) | 269.13 | Mar. 20 | (60) | 946.04 | Mar. 22 | (62) | 25 |
| | | | | | Mar. 21 | (61) | 520.81 | Mar. 24 | (64) | 689.08 | | | |
| One Spray at Whorl** | Egg | Mar. 20 | (60) | 50568.02 | Mar. 23 | (63) | 88294.76 | Mar. 21 | (61) | 161054.27 | Mar. 12 | (53) | 15 |
| | Adult | Mar. 19 | (59) | 285.48 | Mar. 12 | (52) | 24.03 | Mar. 18 | (58) | 1018.34 | Mar. 5 | (45) | 25 |
| | | | | | Mar. 15 | (55) | 224.99 | Mar. 20 | (60) | 910.57 | Mar. 22 | (62) | 25 |
| | | | | | Mar. 21 | (61) | 504.16 | Mar. 24 | (64) | 670.56 | | | |
| Detasseling*** | Egg | Mar. 20 | (60) | 50568.62 | Mar. 23 | (63) | 88294.76 | Mar. 21 | (61) | 161054.27 | Mar. 12 | (53) | 15 |
| | Adult | Mar. 19 | (59) | 285.48 | Mar. 12 | (52) | 24.03 | Mar. 18 | (58) | 1018.34 | Mar. 5 | (45) | 25 |
| | | | | | Mar. 15 | (55) | 224.99 | Mar. 20 | (60) | 910.57 | Mar. 22 | (62) | 25 |
| | | | | | Mar. 21 | (61) | 504.16 | Mar. 23 | (63) | 658.73 | | | |

*Observed egg density based from 200 random samples; adult based from average of 3 virgin female baits.

**Spray at 16 DAE against cutworm and 43'DAE for economic threshold against corn borer.

***Spray at 16 DAE; detasseling at 53 DAE.

found in their simulation test that the capturing rate of males or mating rates of females during a short period is not advisable to use as input.

*Dry season simulation*

Table 4 shows the simulated and actual observed peaks of eggs and adult with and without pest management practice.

The simulated peak egg deposition for 7, 9 and 14 days immigration input were 60, 63 and 61 days after emergence, respectively. The simulated adult peaks emergence are 58 days after emergence for 7 days immigration 52, 55, and 61 days after emergence for 9 days immigration and 58, 60 and 64 days after emergence for 14 days immigration input. In contrast, the actual egg peak deposition was 53 days after emergence while the adult peak emergence were at 45 and 62 days after emergence. The obvious disparity in peak egg deposition between the predicted and observed date can be attributed to the three day sampling interval of egg count. It was possible that the observed peak was missed in the process.

The actual peak egg deposition was very near the 7 days immigration input, while the adult peak density especially the second was approximated by the 9 and 14 days immigration input. Hence, as previously mentioned it is noteworthy to run the model based on several immigration days to find the most appropriate number of immigration. This is important when comparing the actual peak (observed) from the simulated peak.

This computer simulation model is essential in timing insect post management controls, assessment of control efficacy and a deeper analysis of the effects of natural enemies and physical factors such as temperature, wind velocity and others. These factors can be easily incorporated into the model and enhance the predictive value of the generated peak timing.

It is likewise noteworthy to explore the possibility of using virgin females as actual control measures for mass trapping due to their unusual ability to attract a large number of male corn borers. Moreover, it is important to test new synthetic extracts derived from corn borer with the use of different solvents in view of the findings of Jackman *et al.* (1984) where different response to different solvents was observed. Furthermore, it is essential to increase the number of tips to be extracted in crude pheromone extracts in order to see if increasing tip extraction will really increase catch. Finally, the newly explored topic of mating disruption as a promising control measure must also be given due attention.

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