한국식물보호학회지 제20권 제1호
Korean J. pl. prot. 20(1) : 25~30(1981)

Field Study on Mating Confusion of Synthetic Sex Pheromone in the Striped Rice Borer, *Chilo suppressalis* (Lepidoptera: Pyralidae)

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性 pheromone에 依한 이화명나방의 交尾攪亂에 關한 研究

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ABSTRACT

Mating confusion of the Striped Rice Borer with its synthetic sex pheromone, a mixture of (Z)-11-hexadecenal and (Z)-13-octadecenal in a ratio of 4.5 : 1, was estimated during the first and second generation in rice field near Suweon.

The mixture was highly disruptive to pheromonal communication between males and females. The orientation behavior of male moths toward the females was confused at a dosage of 29.3g per 30a during the first generation and even at 33mg per 20m² during the second generation.

INTRODUCTION

Compounds that confuse the attraction of insects to the sex pheromone of the species are of interest because of the possibility that they may be useful for insect control, judging fron an ecological standpoint to preserve effective natural enemies.

The pheromones, which are chemicals, either odor or taste substances, are being utilized in several ways for pest control:

1. Detection and surveilance of insects species,
2. Mass trapping of male moths,
3. Communication disruption between sexes during mating.

Army moth, *Spodoptera litura*, is hardly attracted by light trap, but the moth was attracted by rubber cap permeated with 1mg of its sex pheromone(Yushima, 1974).

Forbush(1876) found that male Gypsy moth fly considerable distances when a trap contains the virgin females.

Collins(1932) demonstrated that male Gypsy moth was attracted by scent from trap baited with a benzene extract prepared from abdominal tips clipped from virgin female moths.

Particulary, Boutenandt(1959) identified chemical structure of the active substance as 'Bombikol' using abdominal tips of 5,000,000 silkworm virgin female moths.

Schneider(1962) reported that electrophysiological recordings from the antennae of male *Bombyx mori* have not revealed a sensitivity to any compound other than the natural and synthetic

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sex attractant of the insects and the natural attractant of closely related species.

From an economic control standpoint, Fujiyoshi (1979) reported that mating of Diamond Back moth between the sexes was completely inhibited at a dosage of 100μg per flask.

Hathaway(1974) showed that in field test, 0.05 mg of 8,10-Da inhibited 95~100% of the attraction of male Codling Moths.

Studies on communication disruption were well reported by many researchers (Tamaki, 1975; Wakamura, 1975; Everett, 1975; George, 1975).

The presence of a sex pheromone of female *Chilo suppressalis* was first reported by Kaburaki(1937).

In IRRI(1966) it has been reported that females made male moths excited and attract them into trap in the field.

Also, the pheromones of female *Chilo suppressalis* were isolated, indentified and synthesized at the Topical Products Institute(TPI) in London.

The pheromones are two oleflnic aldehydes, (Z)-11-hexadecenal(Ⅰ) and (Z)-13-octadecenal(Ⅱ), in a ratio of approximately 4.5 : 1(Nesbitt, 1975).

The trials reported in this paper were conducted to find a direct and effective control method by a confusion technique of *Chilo suppressalis* sex pheromone during the first and second generation in 1980, in collaboration with the Korea Institute of Science and Technology(KIST).

MATERIALS AND METHODS

1) First generation

A mixture of (Z)-11-hexadecenal(Ⅰ) and (Z)-13-octadecenal(Ⅱ) in a ratio of 4.5 : 1 was mixed with 25g BHT(2, 6-di-terf-butyl-p-cresol) as antioxidant, and microencapsulated 2 times as a means of a slow release system.

24g of Ⅰ+5.3g of Ⅱ of the pheromone diluted with 100L water, was broadcasted with a sprayer on a whole area of 30a rice field on June 9, ten day after transplanting. The disruptive effect of the candidate compounds was assessed by determining whether males could locate pheromone-releasing females placed at the center of treated plot when the males were simultaneously exposed to an atmosphere permeated with compounds sprayed. Thus, we install a water trap containing two to three 1-to 2-day-old virgin females, which were held at ca. 100cm above the soil surface in the center of treated plot, while another water trap of untreated plot was placed at a dis tance of 2 kilometer from the treated plot.

The females used as bait were obtained in the laboratory from overwintered larvae.

Females used as a bait were replaced every 2 days. Captured insects were collected and counted every other days throughout a 16-day period. Also, males caught every day were counted in light trap and water trap, both of which were installed in the untreated plot, to investigate continued effect of mating disruption by comparing the number of males caught in pheromone-released plot with that in pheromone-untreated plot.

Finally, we investigated percentage of damaged stems so that we might indirectly presume existance of copulation between males and females in each plot.

2) Scond generation

The sex pheromone used during the 2nd generation is the same as that of the 1st generation, but the microencapsulation was done once and twice. The amount of pheromone was subdivided into 3 levels such as 33, 66, and 200mg per 20m².

Pheromone diluted with 3L water was mixed with 1.5m*l* triton, spreader, to well adhere on rice leaves, and broadcasted with a sprayer on August 1. All treatments including control I and blank trap were arranged at an interval of 20m.

Control Ⅱ was installed at a distance of 300m from control Ⅰ, which is expected to get out of the sex pheromone-effective sphere.

As attractant sources of each trap, one replication was used for a water trap containing two to three virgin females, which were reared in the laboratory. And the other was used for a water trap containing polyethylene vials covered with hat to shade sunlight. Also, the male moths caught by light trap were separated from female moths in order to investigate the sex ratio of emerged adults during the 2nd generation.

Percentage confusion was defined as:

$$\% \text{ confusion} = \frac{\text{No. caught in control} - \text{No. caught in test}}{\text{No. caught in control}} \times 100$$

RESULTS AND DISCUSSION

1) First generation

Experiments were carried out to determine the effect of mating confusion by the pheromone by means of male moth catches in trap baited with two to three 2-day-old virgin females.

In this confusion trial during the 1st generation, the pheromone I and II mixed in the natural ratio markedly reduced the number of male moth catches in a water trap when the pheromones were released from the rice leave stained with the materials.

The rate of communication disruption between sexes of striped rice borers was about 90%, as compared with the number of male catches in a water trap of the untreated plot(Table 1).

Table 1. Expected communication disruption between sexes of *C. suppressalis* by means of confusion using aldehyde I+II[a] sprayed in a rice field during the first generation.

Treatment	16 nights	
	Catch of male moths(No.)	Expected disruption(%)
Virgin females in trap (VF)+ pheromone spray	6	90.4
VF alone(far from treated plot)	62	—

[a](Z)-11-hexadecenal (24g)+(Z)-13-octadecenal (5.3g)/30a

It has been reported that mating between male and female of the insect was confused by their synthetic sex pheromone(Arida, 1978; IRRI, 1976, 1978).

We can find that the confusion, a kind of mating disruption, resulted from a competition between the pheromone released from synthetic sources and the identical pheromone normally released from the female insects, when the synthetic sex pheromone of target species permeated into air during mating.

We can utilize the sex pheromone for insect control through disrupting the pheromone-guidance system of insects.

The number of male moths caught in a water trap of pheromone-treated plot, in a light trap and water trap of pheromone-untreated plot was observed every other day to measure the continuous period of mating disuption in rice field sprayed with microencapsulated materials.

When the number of male moths caught in a water trap of pheromone-treated plot was excessively lower throughout a 16-day period, as compared with that of untreated plot, we can presume that the possible period of mating disruption was about 9 days, considering the last day of moth peak(Table 2).

Table 2. Continued effect of mating disruption by means of aldehyde I+II microencapsulated two times as a slow release system during the first generation.

Date	Catch of male moths(No.)		
	Treated plot	Untreated plot	
	VF trap	VF trap	Light trap
June 10	0	0	13
12	0	1	16
14	1	23	11
16	0	1	5
18	2	32	11
20	1	1	0
21	1	4	1
23	0	0	0
25	1	0	1

Aldehyde I+II was sprayed on June 9.

Also, we examined percentage of damaged stems per 250 hills in three different plots including the pheromone-treated plot in order to estimate the existance of mating-action between sexes of the insects.

The percentage of damaged stems in pheromone-treated plot was slightly lower than that in untre-

Table 3. Expected communication disruption between sexes of *C. suppressalis* by means of confusion using aldehyde Ⅰ+Ⅱ sprayed in a rice field during the first generation.

Treatment	% of damaged stems (per 240 hills)
Treated plot	12.7
Control(near treated plot)	16.5
Control(far from treated plot)	21.8

ated plot, but the percentage even in the pheromone-treated plot is in excess of an economic threshold level, showing 3~9% infested stems in the first generation(Table 3).

An experiment in field gave no good result because of the immigration of the mated females. Therefore it is necessary that the synthetic sex pheromone for control of insect pest must besprayed in larger areas. Also, we can indirectly recognize the effect of mating disuption, considesing that the number of male moths caught throughtout a 16-day period even in the rice field having higher infestation. was remarkably as low as 6 moths.

Special attention must be paid to a timely application for the most effective control in both generations.

2) Second generation

Based on experimental results obtained during the 1st generation. confusion tests were conducted to determine a reasonable amount of the pheromone for mating disruption.

In case we utilize a water trap baited with virgin females as attractant sources of male moths, it seemed that the number of male moths caught was not significantly different among treatment and mating disruption was recognized even at a dose of 33mg per $20m^2$.

However, there was a significant difference between all the treatments and control Ⅱ set at a distance of 300m from pheromone-treated plot

The rate of communication disruption was about 92~100% as compared with control Ⅱ (Table 4).

On the other hand, we also used a water trap

Table 4. Expected communication disruption between sexes of *C. suppressalis* by means of confusion using aldehyde Ⅰ+Ⅱ sprayed in a rice field during the second generation.

$mg/20m^2$	Encapsulation (No.)	18nights	
		Catch of male moths (No.)	Expected disruption (%)
Virgin female	Ⅰ	0	100
in trap (VF)+33mg	Ⅱ	1	92
VF+66mg	Ⅰ	0	100
	Ⅱ	0	100
VF+200mg	Ⅰ	0	100
	Ⅱ	0	100
VF alone(near treated plot)	—	4	—
VF alone(far from treated plot)	—	13	—
Blank	—	1	—

Table 5. Expected communication disruption between sexes of *C. suppressalis* by means of confusion using aldehyde Ⅰ+Ⅱ sprayed in a rice field during the second generation·

$mg/20m^2$	Encapsulation (No.)	18nights	
		Catch of male moths (No.)	Expected disruption (%)
Attractant source[a]	Ⅰ	2	84.6
in trap (AS)+33mg	Ⅱ	1	92.3
AS+66mg	Ⅰ	1	92.3
	Ⅱ	3	76.9
AS+200mg	Ⅰ	2	84.6
	Ⅱ	0	100
AS alone(near treated plot)	—	1	—
AS alone(far from treated plot)	—	13	—
Blank	—	1	—

a Trap baited with 100μg of pheromones.

with polyethylene vials containing 100μg of pheromone as another attractant sources of male moths.

There was a slight difference among treated plots with respect to the number of attracted male moths. The rate of communication disruption appeared to be 78 to 100%(Table 5).

Especially, considering that male moths were attracted even in blank trap, which was not baited with any attractant sources of male moths, one to there male moths were caught by accident in the process of copulation.

When the number of male moths caught in a water trap of control Ⅰ, which is located in the neighboring area of pheromone-treated plot, is considerably lower, as compared with that of control Ⅱ. further studies to determine an effective distance for mating confusion of synthetic pheromone are required.

We can readily study the sex ratio of emerged abult moths during the 2nd generation, depending on the number of striped rice borer moths collected by light trap in the field. From the sexual separation of the moths attracted, we found that 2nd generation had more female moths than male moths(Table 6).

Table 6. Number of *C. suppressalis* collected by light trap in a untreated field during the second generation.

Date	Catch of male moths(No.)	Catch of female moths(No.)
Aug. 3	0	1
5	0	1
7	0	2
9	0	4
11	1	12
13	1	19
15	1	17
17	1	12
18	2	10
Total	6	78

Accordingly, in case of a field monitroing of the insects using synthetic pheromone or virgin females, it is difficult for us to monitor male moth density of the 2nd generation because of a lower population of male moths, as compared with those of female moths.

摘　要

性 pheromone을 利用한 이화명나방의 交尾攪亂效果를 究明하고저 合成 性 pheromone, (Z)-11-hexadecenal과 (Z)-13-octadecenal을 4.5 : 1로 供試하여 本試驗을 野外에서 遂行한 結果 1化期에는 30a當 合成性 pheromone 29.3g 處理한區에서 90.4%의 交尾攪亂效果가 認定되었고 2化期에는 20m²當 合成 性 pheromone 33mg 處理까지도 攪亂效果가 있었다.

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