Pheromone Trap Catches of the Rice Stem Borer Moth, *Chilo suppressalis* (WALKER) (Lepidoptera: Pyralidae) and Related Trap Variables in the Field¹

Akira KONDO and Fukusaburo TANAKA

*Okayama Prefectural Agricultural Experiment Station,
Sanyo-cho, Okayama 709-08, Japan*

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Three factors affecting the trap catch of the rice stem borer, *Chilo suppressalis* (WALKER) were examined. Synthetic sex pheromone which consists of (Z)-11-hexadecenal, (Z)-13-octadecenal and (Z)-9-hexadecenal (48: 6: 5; total 0.6 mg per rubber septum) was used as lure. Trap types (water-trap and sticky-trap), trap heights (0.5 m and 1 m above the ground) and trap locations (inside and at the boundary of paddy fields) were analysed and trap catches of males were counted over two flight seasons for two years in the southern part of Okayama Prefecture, western Honshû, Japan. In the first flight season, the trap catches were significantly greater at trap heights of 0.5 m than at 1.0 m, at field boundaries than in field centers and in water-traps than in sticky-traps, respectively. In contrast, the second flight season's trap catches were not significantly different between trap heights, locations and types. Peak times of trap catch in each season were not affected by these trapping variables. Seasonal patterns in trap catches inside paddy fields and at field boundaries were remarkably different. In the latter, numbers of males trapped in the first flight season were much greater than those in the former. Sticky traps set at 0.5 m above the ground of the boundary are adequate for population monitoring throughout the flight seasons.

Key words: pheromone trap, *Chilo suppressalis*, paddy field

INTRODUCTION

TATSUKI et al. (1983) identified a third component, (Z)-9-hexadecenal of the female sex pheromone of *Chilo suppressalis*, after the identification of two other pheromone components, (Z)-11-hexadecenal and (Z)-13-octadecenal (NESBITT et al., 1975; OHTA et al., 1976). Since then, several trials for the development of a monitoring system of this species by using the synthetic ternary blend have been made (KANNO et al., 1984 a, b; MOCHIDA et al., 1984; KANNO et al., 1985; NAKANO et al., 1986). However, there are no reports on the effect of trap type and trap placement on trap catches of *C. suppressalis* except TANAKA (1989). Studies of these factors may also be necessary for utilizing sex pheromone of this species as a monitoring tool of many other lepidopteran insects (e.g., SAARIO et al., 1970; BEROZA et al., 1973; HIRANO, 1976; RIEDL et al., 1979; KAWASAKI and TAMAKI, 1980; KOSHIHARA, 1984; DIX and DOOLITTLE, 1985; VINCENT and SIMARD, 1986; SATO et al., 1987).

¹ The major part of this work was presented at the 32nd Annual Meeting of the Japanese Society of Applied Entomology and Zoology (Kochi, April, 1988).

The purpose of this study is to analyse the effect of factors such as trap type, height and location on trap catches in the field.

MATERIALS AND METHODS

Experiments were carried out in 1987 and 1988 in three adjacent commercial paddy fields in Hata, Soja City. The size of the study area was 70 a. Large quantities of rice plant stems are kept in grapevine vinylhouses in nearby paddy fields, and serve as hibernating sites for *C. suppressalis* larvae in this district. Rice crops are therefore seriously damaged by *C. suppressalis* almost every year. Rice plants (variety: Akebono) were transplanted on 13–15 June in both years of the study. The synthetic sex pheromone used in this study was a mixture of (Z)-11-hexadecenal, (Z)-13-octadecenal and (Z)-9-hexadecenal (48: 6: 5). About 0.6 mg of the mixture and 0.06 mg of butylated hydroxytoluen (BHT), an antioxidant, were soaked into a rubber septum. The rubber septa were provided by Shin-Etsu Chemical Co. Ltd., Japan. Water-traps (trapping area: 24 × 29 cm) and sticky-traps (24 × 25 cm), both of which were products of Takeda Chemical Industries Co. Ltd., Japan, baited with the rubber septa were used. These traps were placed inside paddy fields and at field boundaries at 0.5 m and 1.0 m above the ground. Trapping parameters were combined as follows: ① water-trap–paddy field–0.5 m, ② water-trap–paddy field–1.0 m, ③ water-trap–boundary–0.5 m, ④ sticky-trap–paddy field–0.5 m. Numbers of males captured were compared between trap heights (①–②), trap locations (①–③) and trap types (①–④). Trap intervals were greater than 15 m. Three traps were used for each combination. The traps were placed on 16 June and removed on 16 September in both years to cover the majority of the two flight seasons. Trap catches were counted every five days in 1987 and every seven days in 1988, respectively, unless otherwise stated. Water with detergent in the water-traps and sticky boards in the sticky-traps were renewed on every census and every 30 days, respectively. Pheromone dispensers were exchanged on the 45th day after the trap placement. For measurement of rice plant height, 10 rice plant hills were randomly selected in the center field of the three paddy fields.

RESULTS AND DISCUSSION

Trap height

Table 1 shows the number of males captured in water-traps at different heights

Table 1. Comparisons of pheromone trap catches of *C. suppressalis*: trap heights

	1987			1988		
	1st ^a	2nd ^b	Total	1st ^c	2nd ^d	Total
0.5 m	83.0 ± 3.0 ^e **	32.3 ± 13.0 ns	115.3 ± 15.0 ns	81.7 ± 16.4 ns	20.3 ± 2.7 ns	102.0 ± 13.9 ns
1.0 m	27.3 ± 7.6	22.3 ± 7.3	49.7 ± 14.8	30.7 ± 0.3	25.3 ± 4.2	56.0 ± 4.1

Water-traps were placed inside paddy fields (3 replications for each year). ^a: 16 June–31 July, ^b: 1 August–16 September, ^c: 16 June–1 August, ^d: 2 August–16 September, ^e: means ± S.E. Significant levels (*F*-test); ns: not significant, * *p* < 0.05, ** *p* < 0.01.

which were placed inside of the paddy fields. In the first season, numbers of trapped males were significantly greater at 0.5 m than at 1.0 m in 1987, although significant difference was not found in 1988. In the second flight season, the trap catches were not significantly different between the trap heights.

In the first flight season (the abundant trapping period), rice plant heights were 15–50 cm (Fig. 1). In the second they were 80–120 cm. Thus, in the second flight season, the traps at 0.5 m were within rice growth. However, the trap catches at 0.5 m were equivalent to those occurring at 1.0 m. In the first flight season, TATSUKI and FUKAMI (1972) observed that *C. suppressalis* male moths flew within 30 cm above the ground for mating. In the second flight season, TANAKA (1989) compared the pheromone trap catches of *C. suppressalis* among four trap heights—0.5 m, 1.5 m, 2.5 m and 3.5 m—in a paddy field, and reported that the most effective height was 0.5 m. The results of this study suggest that male moths searching for females mainly fly relatively close to the ground: nearly at 0.5 m in the first flight season and 0.5–1.0 m in the second.

Trap location

In the first flight season, the trap catches were significantly greater at field boundaries than inside the fields (Table 2). In the second flight season, however, the trap catches were not significantly different between the trap locations. This may be caused by the fact that first-season moths emerge from piles of rice plant stems which are near the boundaries, whereas in second-season moths emerge from rice growing in the paddy fields. Moth densities are lower in the plants.

Fig. 1. Growth of rice plants in the paddy field. —: 1987; ...: 1988. Arrows on the left and right indicate periods of abundant trap catches of *C. suppressalis* in the first and second flight seasons, respectively.

Table 2. Comparisons of pheromone trap catches of *C. suppressalis*: trap locations

	1987			1988		
	1st ^a	2nd ^b	Total	1st ^c	2nd ^d	Total
P	83.0±3.0 ^e **	32.3±13.0 ns	115.3±15.0 **	81.7±16.4 *	20.3±2.7 ns	102.0±13.9 *
B	201.7±3.0	28.0± 6.6	229.7± 7.9	151.7± 9.0	16.0±4.9	167.7±11.0

Water-traps were placed 0.5 m above the ground (3 replications for each year). P: paddy field, B: boundary. For other symbols, see Table 1.

Trap type

In the first flight season, the trap catches were significantly greater in water-traps than in sticky-traps in 1987, although significant difference was not found in 1988 (Table 3). In the second flight season, sticky-traps caught more male moths than the water-traps, although with no significant differences.

Table 3. Comparisons of pheromone trap catches of *C. suppressalis*: trap types

	1987			1988		
	1st ^a	2nd ^b	Total	1st ^c	2nd ^d	Total
W	83.0±3.0 ^e **	32.3±13.0 ns	115.3±15.0 ns	81.7±16.4 ns	20.3±2.7 ns	102.0±13.9 ns
S	42.0±3.4	35.0±7.1	77.0±3.8	42.7±5.1	70.3±21.3	113.0±26.1

Traps were placed inside paddy fields, 0.5 m above the ground (3 replications for each year). W: water-trap, S: sticky-trap. For other symbols, see Table 1.

Fig. 2. Seasonal changes in pheromone trap catches of *C. suppressalis* and combinations of trap type, location and height. W: water-trap, S: sticky-trap, P: paddy field, B: boundary, 0.5 and 1.0: trap height (m).

TANAKA (1989) reported that the trap catches of *C. suppressalis* were greater in water-traps than in sticky-traps in the first flight season, inconsistent with the second flight season. These results are consistent with those of our experiment; trap catches were greater in water-traps than in sticky-traps in the first flight season but did not differ in the second.

Seasonal changes in trap catches and practical use

Two peaks of trap catches were detected. Peak times were roughly coincident among different combinations of trap types, trap locations and trap heights (Fig. 2). The seasonal pattern of trap catches located inside paddy fields (W·P·0.5) and that at the boundaries (W·B·0.5) were remarkably different, despite the fact that the two sites were not so far from each other (15–54 m). The first flight season, trap catches in the latter were much greater than those in the former.

Based on the total number of the trap catches in both flight seasons, the optimum trapping system for population monitoring should use water-traps placed at 0.5 m at field boundaries throughout both seasons. However, one of the merits of sex pheromone traps is the simplicity of handling (SATO et al., 1987). In this context, sticky-traps may be better than water-traps in most cases. Although the trap catches in sticky-traps were smaller than those from water-traps in the first flight season, total numbers of trap catches were not significantly different (Table 3). Sticky-traps set at 0.5 m above the ground at the boundary would therefore also be adequate for population monitoring throughout the flight seasons.

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