Factors Improving Field Trapping of Male Rice Stem Borer Moth, *Chilo suppressalis* WALKER (Lepidoptera: Pyralidae), by Using Synthetic Sex Attractant

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Factors improving the attractiveness of traps baited with the synthetic sex attractant of *Chilo suppressalis*, i.e., appropriate mixtures of Z-11-hexadecenal (HDAL) and Z-13-octadecenal (ODAL), were examined in the field. Both rubber septa and polyethylene capsules were good dispensers for loading of the chemicals because they retained attractiveness for a long period. The amount of the attractant loaded on rubber dispensers was shown to be a critical factor. Attraction was shown by the dispensers loaded with 0.1–10 mg of the attractant. Two mg was the best dispenser, having caught about 64% of the catch of virgin female traps. The ratio of the two pheromonal components was not so critical for attraction. Attractiveness was revealed by the mixtures ranging in ratios from 20 : 1 to 1 : 1 (HDAL : ODAL). Among these, 3 : 1, 5 : 1 and 7 : 1 were more attractive than other mixtures.

INTRODUCTION

We have previously reported that field attractiveness of the synthetic sex pheromone of *Chilo suppressalis* was revealed when the two pheromonal components, Z-11-hexadecenal (HDAL) and Z-13-octadecenal (ODAL), were appropriately combined (TATSUKI et al., 1977). However, the attractiveness of the chemicals treated on a filterpaper tip was consistently less than that of live virgin females and was retained for only a few hours from the beginning of each test. This level of activity and longevity of the attractivity were attributed in part to the method of dispensing, i.e., type

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of dispensers, amount of chemicals treated and so on.

In this paper, we report on the relationships between trapping efficiency and some of the factors mentioned above from the results of further field experiments.

Recently, BEEVOR et al. (1977) also reported on the attraction tests of this species using synthetic pheromones in the Philippines, Iran and Korea.

MATERIALS AND METHODS

Chemicals. HDAL and ODAL were synthesized at the I.P.C.R. (KANNO et al., 1978). The purities of the synthesized products used in 1977 were presumed to be greater than 95% from the spectral data on their infrared, mass and nuclear magnetic resonance spectra. But, for a 1978 test, they were purified with argentation thin-layer chromatography (AgNO_3 -TLC).

Insects. Virgin female moths used for the control traps were from the stock culture maintained at the I.P.C.R. for several years using rice seedlings as the larval diet. The detailed rearing method has previously been described (UCHIUMI, 1974). For the field tests, both female pupae and the emergents were kept in a wire-screen cage at room temperature under a natural light condition until use.

Field trapping. Field tests were conducted in a paddy field of the Tohoku National Agricultural Experiment Station, Omagari, Akita, in June, 1977 and 1978. This period coincided with the first flight of *Chilo suppressalis*.

1977 test : Tub-type traps and Takeda pheromone traps¹ (sticky type) were used in this study. The former, which basically consisted of a plastic water tub ($35 \times 28 \times 12$ cm) with a wooden roof (Fig. 1), was used only for a comparison of various dispensers. In this test, a 5 : 1 mixture of HDAL and ODAL (total 1 mg) dissolved in 0.1 ml of hexane was treated on a rubber septum¹, a polyethylene capsule¹ and a tobacco filter¹, respectively. Each dispenser treated was hung in the middle of a tub trap with a wire. These traps were placed on a levee at ground level more than 15 m apart.

The other tests were carried out simultaneously using the sticky traps. A rubber septum treated with a 0.1 ml hexane solution of the chemicals or a plastic vial with wire-screen ends (6×3 cm) including two virgin females and a small moist cotton

Fig. 1. Tub-type trap. WT: water tub, R: roof, A: attractant.

¹ Supplied by the following corporations: Takeda Chemical Industries, Ltd. for the pheromone traps, Zoecon Co., U.S.A., for the rubber and the polyethylene dispensers, and Japan Monopoly Co., for the tobacco filters.

was placed in the center of each sticky floor. The traps were hung on the roadside at a height of about 0.4 m. Trap intervals were the same as described above. Trap positions were rotated every day. The dispensers were used without renewal during the experiments. The number of male moths caught in the traps was counted every morning.

1978 test : A method similar to that of the 1977 test was used. Modifications were as follows; a rubber septum treated with the chemicals was placed in the attractant chamber beneath the ceiling of a Takeda sticky trap. Traps were not rotated during the experiment.

RESULTS

Comparison of 3 kinds of dispensers on trap catch (1977)

To prolong the activity of the chemicals in the field traps, the different types of dispensers described above were compared. Cumulative trap catches obtained by the three types of dispensers are shown in Fig. 2. Of these, the tobacco filter was inadequate when used with the present method. The other two dispensers, the rubber septum and the polyethylene capsule, were attractive to male moths for a much longer period than the filterpaper used in the previous work (TATSUKI et al., 1977). The polyethylene dispenser caught more moths in total than that of rubber. However, this was due mainly to the presence of the inactive phase in the latter for the first 6 days (Fig. 2). On the other hand, the polyethylene was no longer attractive after 2 weeks, while the rubber retained activity for more than 20 days. Since wild moth flight decreased rapidly in the last ten days of June, during which period the difference in the male catch between the two dispensers was unclear. Comparing the data obtained during June 11 to 20, the rubber dispenser was somewhat more attractive

Fig. 2. Comparison of trap catches of male *Chilo suppressalis* by three kinds of dispensers each of which was loaded with 1 mg of 5:1 mixture of HDAL and ODAL. The chemicals were treated on June 5, 1977.

Table 1. EFFECT OF AMOUNT OF SYNTHETIC SEX ATTRACTANT ON TRAP CATCH OF MALE *Chilo suppressalis*

Test period	Bait	Mean No. males caught/trap/night ^a	Relative trap catch (% of virgin female/trap)
June 4-10, 1977	attractant (mg) ^b		
	0.1	0.0	1
	1	1.5	38
	10	0.2	4
	virgin female	4.0	100
June 2-23, 1978	blank	0.0	0
	attractant (mg) ^b		
	0.2	1.1	17
	0.5	2.0	29
	1	1.8	27
	2	4.3	64
	5	1.6	25
	virgin female	6.7	100
	blank	0.0	0

^a Data obtained from 2 traps in each treatment in the 1977 test, from 1 trap in the 1978 test.

^b Ratio of HDAL and ODAL was 5 : 1. Chemicals were loaded on rubber septa.

than that of polyethylene.

Effect of amount of attractant on trap catch (1977, 1978)

The effect of the amount of attractant was evaluated using rubber septa loaded with various doses of the 5 : 1 (HDAL : ODAL) mixtures. In 1977, as shown in Table 1, of the three doses treated, only the median dose of 1 mg mixture was attractive. On the other hand, the 0.1-mg and the 10-mg traps caught only a few moths throughout the test period.

Furthermore, the 1-mg trap caught about 40% of the number of the moths caught by the virgin female traps.

The second test was carried out in 1978 by using the AgNO₃-TLC purified materials. The results obtained are shown in Table 1. Attractiveness was shown

Table 2. EFFECT OF MIXING RATIO OF TWO PHEROMONAL COMPONENTS (HDAL AND ODAL) ON TRAP CATCH OF MALE *Chilo suppressalis*

Mixing ratio ^a (HDAL : ODAL)	Mean No. males caught/trap/night ^b
20 : 1	0.8
7 : 1	1.4
5 : 1	1.5
3 : 1	1.5
1 : 1	0.7
1 : 3	0.1

^a Total 1mg on a rubber septum.

^b Data obtained from 2 traps in each treatment during June 4-16, 1977.

in all the dispensers loaded with the 5 : 1 mixture at doses ranging from 0.2 mg to 5 mg. The best male catch was obtained by the 2-mg dispenser, which caught more than twice as much moths as any other dosage. However, even with the optimum dosage, the mean number of males caught was about 65% of that of the virgin females.

Effect of mixing ratio of HDAL and ODAL (1977)

We have reported on the suitable mixing ratio of the two components when treated on filterpaper (TATSUKI et al., 1977). Since somewhat different results might be obtained by using rubber dispensers, mixtures of the two components of the various ratios used in the previous study were tested again. The result obtained (Table 2), however, were quite similar to those described previously, i.e., attractiveness was shown in the traps containing from 1 : 1 to 20 : 1 (HDAL : ODAL) mixtures, the best ratios being 3 : 1, 5 : 1 and 7 : 1. The 1 : 3 mixtures showed little activity.

DISCUSSION

Comparison of dispensers

Rubber and polyethylene dispensers were shown to be useful for field trapping with the synthetic attractant of this insect. The former was better than the latter, considering the durability of attractiveness. The rubber septum loaded with a sufficient amount of the attractant is probably capable of use throughout a flight period.

The reason why the rubber was almost inactive for several days after treatment with the chemicals in 1977 is unknown. One possible reason is the impurity of the chemicals, since dispensers in the 1978 test were already attractive on the second night of the treatment with the AgNO₃-TLC purified materials.

Effect of amount of attractant on trap catches

It was expected that the amount of the chemicals loaded on the rubber septum was a critical factor, on the basis of the results of an attraction test in the laboratory (KURIHARA et al., 1978). In the present work, similar results were obtained in the field. In the 1977 test, only the 1-mg dispenser was clearly attractive. These data suggested the presence of an optimum amount around 1 mg. The results of the second test in 1978 showed the 2 mg was far better than the 1 or 5 mg.

The above results clearly show that the evaporation rate of the pheromonal compounds within the optimum range, which is rather narrow, is necessary for male attraction. Furthermore, this fact, as BEEVOR et al., (1977) also pointed out, suggests that the disruption method may be useful for direct control of *Chilo suppressalis* using the pheromonal components or related chemicals. This possibility was indicated in our preliminary experiments (KANNO et al., 1978).

The chemicals used in the 1977 test contained a small proportion of E-isomers, in consideration of the synthetic method. This might also be one of factors that lowered male catches relative to that of virgin females. Consequently, the chemicals tested in 1978 were further purified by AgNO₃-TLC to remove the geometrical isomers. However, the effect of the purification could not be adequately evaluated from the data obtained. Another test should be made on the effect of addition of E-isomers to the attractant.

Effect of mixing ratio of HDAL and ODAL

Although the two pheromonal components, HDAL and ODAL, were inactive when they were separately applied to males, they showed activity when mixed together over a wide range in the mixing ratio (OHTA et al., 1976; TATSUKI et al., 1977). In the use of rubber dispenser, the present data showed that the effective and optimum ranges for attraction were similar to those of filterpaper.

BEEVOR et al. (1977) reported that, in the Philippines, *Chilo suppressalis* male attraction was obtained not only by the pheromone mixtures, but also by each component alone. This fact is inconsistent with our previous results. It may be due to differences in environmental factors, such as population density or temperature, or in ecological races within this species.

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