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Disruption Effect of the Synthetic Sex Pheromone and its Analogues on Diamondback Moth

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Abstract

Five mg and 50 mg of sex pheromone (Z-11-16:Ald, Z-11-16:Ac and Z-11-16:OH), 5 mg and 10 mg of Z-9-14:Ac and 1 mg and 10 mg of Z-11-16:OH were tested to show the disruption effect on diamondback moth, *Plutella xylostella* (L.), in a field. When the distance between the sticky trap and tested chemical was zero or 2.8 m, the chemicals did not show the disruption effect. However, when the distance increased to 6.3 or 8.4 m, all tested chemicals,except 1 mg of Z-11-16:OH, showed the disruption effect. In control traps more males were attracted to the long distance (6.3 and 8.4 m) than to the short one (0 and 2.8 m). The data obtained from this observation suggest that the active space of DBM in the field is possibly between 0 and 6.3 m.

Introduction

Diamondback moth (DBM), *Plutella xylostella* (L.) (Lepidoptera:Yponomeutidae), is one of the serious pests of cruciferous vegetables in Taiwan. Its sex pheromone has been identified as a mixture of (Z)-11-hexadecenal (Z-11-16:Ald) and (Z)-11 hexadecenyl acetate (Z-11-16:Ac) (Tamaki et al. 1977). (Z)-11-hexadecen-1-ol (Z-11-16:OH) and (Z)-9-tetradecenyl acetate (Z-9-14:Ac) were thought to be parts of the DBM's pheromone system (Ando et al. 1979; Koshihara and Yamada 1981; Chisholm et al. 1983). The ratio and dosages of the components of DBM pheromone were important factors that affect the pheromone activity (Chow et al. 1977; Koshihara et al. 1978; Koshihara and Yamada 1980; Chisholm et al. 1979; Lin et al. 1982). The optimal dosage of the sex pheromone of DBM in the field was 50-100 μg of the mixture Z-11-16:Ald, Z-11-16:Ac and Z-11-16:OH in the ratio of 5:5:0.1 in rubber septa (Koshihara and Yamada 1980); in Canada the optimal dosage was Z-11-16:Ald (70 μg), Z-11-16:Ac (30 μg), Z-11-16:OH (1 μg) and Z-9-14:Ac (0.01 μg) (Chisholm et al. 1983).

The use of high dosages of synthetic compounds similar or related to the true sex pheromone to confuse the communication between insects to prevent mating is called the disruption method (Hirano 1979; Nakasuji 1979). This control method has been successfully conducted on gypsy moth (*Lymantria dispar*), and *Spodoptera litura* in the field (Cameron et al. 1975; Shorey et al. 1974; Nakasuji 1979; Hirano 1979). However, in DBM, only mating inhibition has been demonstrated in the laboratory by its main components or minor Z-11-16:OH (Fujiyoshi et al. 1979; Lin and Chow 1982). In the present study, the disruption effects of synthetic sex pheromone on DBM were evaluated in the field in Hsin Chu County in Taiwan.

Materials and Methods

Two separate experiments were carried out in a cabbage field. Five mg and 50 mg of sex pheromone (Z-11-16:Ald, Z-11-16:Ac and Z-11-16:OH in the ratio of 5:5:0.1), 5 mg and 10 mg of Z-9-14:Ac, and 1 mg and 10 mg of Z-11-16:OH were tested as disruption chemicals.

The sticky traps baited with 50 μg of the sex pheromone in the ratio 5:5:0.1 in polyethylene microtubes were used as a monitoring trap (Lin et al. 1982). The height of the trap was set the same height as the cabbages. Field design for location and distance of sticky trap and tested chemicals is shown in Fig. 1.

The number of male moths attracted was recorded every 3 or 4 days. The data obtained were analyzed with analysis of variance and Duncan's multiple range test to show the disruption effect of the tested chemicals on DBM.

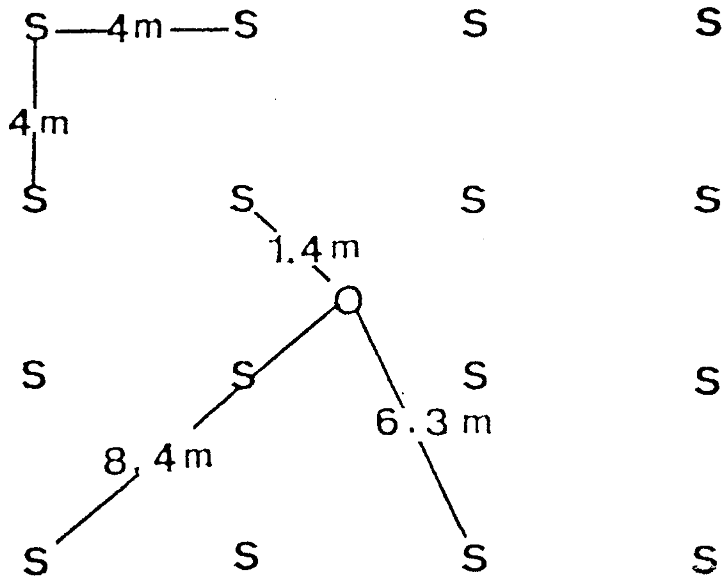

Fig. 1. Field design for location and distance of sticky trap and tested chemicals (S: sticky trap with 50 μg of sex pheromone, O: original disruption point with 50 mg of sex pheromone, and other tested chemicals or no chemicals.

Results

The results are presented in Table 1. The average number of attracted males per trap in the control traps was not significantly different from that in other treatments when the distance between sticky trap and tested chemical was zero or 2.8 m. When the distance between sticky trap and chemical increased to 6.3 m or 8.4 m, the results of the control and Z-11-16:OH (1 mg) traps were significantly different from those of the others. Therefore, 5 and 50 mg of sex pheromones, 5 and 10 mg of Z-9-14:Ac and 10 mg of Z-11-16:OH showed disruption effects, i.e. DBM males could not locate the female partners effectively. One mg of Z-11-16:OH did not show the disruption effect. On the other hand, except for 1 mg of Z-11-16:OH, the mean catch of control (10.8 males) was higher than other treatments (5.6-7.8 males). So a disruption effect did exist in these observations.

Discussion

Koshihara and Yamada (1980) used 0.01, 0.1, 1 and 10 mg of Z-11-16:Ald, Z-11-16:Ac and Z-11-16:OH (5:5:0.1) to test the attraction of DBM and found that 0.01-1 mg were optimal dosages and few if any males were attracted by the 10 mg dosage. Our results confirmed these data that higher dosages (5-10 mg) of sex pheromone could show the disruption effect. Koshihara and Yamada (1980) also used the mixtures of Z-11-16:Ald and Z-11-16:OH in the ratio of 5:5 at the 0.01 mg level, to which Z-11-16:OH was added in different ratios (0, 0.01, 0.1, 1 and 10 μg), and found that 10 μg of Z-11-16:OH had the least effect in attracting the male moths. Our results indirectly support their data that the higher dosage (10 mg) of Z-11-16:OH has the best disruption effect (last column in Table 1). Chisholm et al. (1983) evaluated the attractiveness of Z-11-16:Ald (70 μg), Z-11-16:Ac (30 μg), Z-11-16:OH (1 μg) and Z-9-14:Ac (0.01 to 10 μg) and found that when higher dosage of Z-9-14:Ac was used, a lower number of male moths were attracted. Our findings also support these results.

The average number of males per trap in the control was not significantly different from other experimental treatments in the shorter distance (0 m). However, in longer ones (6.3 and 8.4 m), the control and 1 mg of Z-11-16:OH were significantly different. In the control, more males were attracted in the long distance (6.3 and 8.4 m) than in the short one (0 and 2.8 m). Therefore, it seemed that there was a disruption effect among monitoring traps in the short distance but little or no effect in the long one. In the middle range (2.8 m), the different effects of Z-9-14:AC and Z-11-16:OH were obtained in the experimental treatment but not in the control. The reason for this may be the different thresholds of the male for the female sex pheromone. Under the influence of disruptive chemicals, the males respond with a higher threshold. Therefore, the hypothesis that the active space of sex pheromone of DBM is 4-5 m as proposed by Ohbayashi et al. (1989) is reasonably true. The factors affecting the pheromone activity such as wind speed, temperature, population density, etc., varied widely under field conditions. The data obtained in this study suggest that the active space of sex pheromone of DBM in the field is greater than 1 m, possibly up to 6.3 m.

Table 1. Trapping of DBM males 3 or 4 days for different tested chemicals and different distances.

Treatment		No. males trapped per plot set at distance between tested chemicals and sticky trap of				
		0 m	2.8 m	6.3 m	8.4 m	mean
Sex Pheromone	5 mg	5.0 a	6.1 bc	8.2 b	8.4 b	6.9
Sex Pheromone	50 mg	3.3 a	5.9 bc	9.5 b	12.5 b	7.8
Z-9-14:Ac	5 mg	3.4 a	8.6 a	9.0 b	9.8 b	7.7
Z-9-14:Ac	10 mg	2.8 a	8.2 a	9.1 b	9.3 b	7.3
Z-11-16:OH	1 mg	4.9 a	7.4 ab	12.8 a	18.6 a	10.9
Z-11-16:OH	10 mg	3.0 a	4.9 c	7.3 b	7.3 b	5.6
Control		5.5 a	6.8 abc	12.5 a	18.7 a	10.8

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