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Development and Implementation of the Yellow Sticky Trap for Diamondback Moth Control in Thailand

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Abstract

Yellow, sticky, cylindrical-shaped traps painted with 5% polybutane were highly effective in catching diamondback moth, *Plutella xylostella* (L.), adults in cruciferous crops in 1988-89. The mass trapping of DBM adults by the yellow sticky trap coupled with use of action threshold and *Bacillus thuringiensis* Berliner sprays were studied in cabbage fields at Kanchanaburi Province in Thailand from December 1989 to February 1990. Traps were set up and the number of diamondback moth adults sticking to the traps were recorded daily. The diamondback moth larvae were counted and *B. thuringiensis* at the rate 2.0 kg/ha was sprayed every 3 days if the larvae reached the action threshold level. Three applications were made for the mass trapping field, whereas the conventional control field required five applicatons of *B. thuringiensis* mixed with mevinphos at a rate 0.48 kg ai/ha at weekly intervals. An average 12.97 moths/trap/day were caught. The catch consisted of 55.9% males and 44.1% females. Marketable yield obtained was 24 t/ha and 12.8 t/ha from mass trapping field, and conventional controlled field respectively. These results indicated that the yellow sticky trap could be used partially to control the diamondback moth in cruciferous fields, and could play a prominent role in integrated pest control of the diamondback moth.

Introduction

Since 1972, diamondback moth (DBM), *Plutella xylostella* L. (Lepidoptera:Yponomeutidae), in Thailand has developed resistance to several insecticides. Recently, DBM has shown moderate resistance to even *Bacillus thuringiensis* Berliner. The high resistance was shown to the organophosphorus group: phenthoate, prothiophos, pyraclofos and mevinphos; synthetic pyrethroids group: fenvalerate, cypermethrin, permethrin, cycloprothrin, ethofenprop, and cyhalothrin L; and insect growth regulators group: chlorfluazuron, teflubenzuron, methoprene, and NK-081 (Vattanatangum 1988; Miyata et al. 1988; Rushtapakornchai et al. 1988, 1990). To date there are very few new insecticides, such as abamectin, diafenthiuron and S-71639, that seem to give satisfactory control of DBM (Rushtapakornchai et al. 1990; Katanyukul et al. 1989).

The farmers still believe in pesticide application on a calendar basis, without due regard to pest population and environmental damage. The Thailand Department of Agriculture policy emphasizes the use of integrated pest control. Therefore, an Integrated Pest Control for Secondary Crops in Thailand Project was established in 1984-89. The integrated pest control technology for vegetable crops, especially crucifiers and onion, has been developed and transferred to extension officers and farmers. The development of integrated pest control of DBM involved:

action thresholds, efficient sampling methods which would reduce the use of either chemicals or labor for scouting, physical control including light trap, screen net house, and biological control which included use of *B. thuringiensis* and release of parasitoids.

A yellow sticky vinyl chloride plate trap was reported to catch greater numbers of adult DBM than others such as a light trap and a pheromone trap. The trap could be used for forecasting adult population density in the field (Sivapragasam and Saito 1986; and Saito et al. 1988). The comparison of various trap materials, trap shape and trap height over the plant showed that the most effective trap was cylindrical painted with 5% polybutane in hexane, and the bottom edge of the trap either 10 or 30 cm over the plant. A yellow plastic container or bucket trap was more effective than the yellow plastic trap. Three cylindrical yellow plastic traps/48 m^2 caught the highest (average 106.5) number of adults per trap. The sex ratio of insects caught was 1:0.47, male to female (Saito et al. 1989; Rushtapakornchai et al. 1989). We present here the results of our mass trapping by yellow plastic bucket trap painted with 5% polybutane in hexane in catcHing DBM adults in cabbage fields, and integration of action threshold and *B. thuringiensis* at Kanchanaburi Province, Thailand.

Materials and Methods

Experimental field

The experiment was carried out in a cabbage field which consisted of mass trapping field, (20 × 40 m), and conventional control field (20 × 20 m) at Thamuang district, Kanchanaburi Province from November 1989 to February 1990.

Trap

The yellow plastic bucket (25 cm diameter, 25 cm high) was used as a trap. Forty traps were placed in the cabbage field and the distance between traps was 4 × 4 m as shown in Fig. 1.

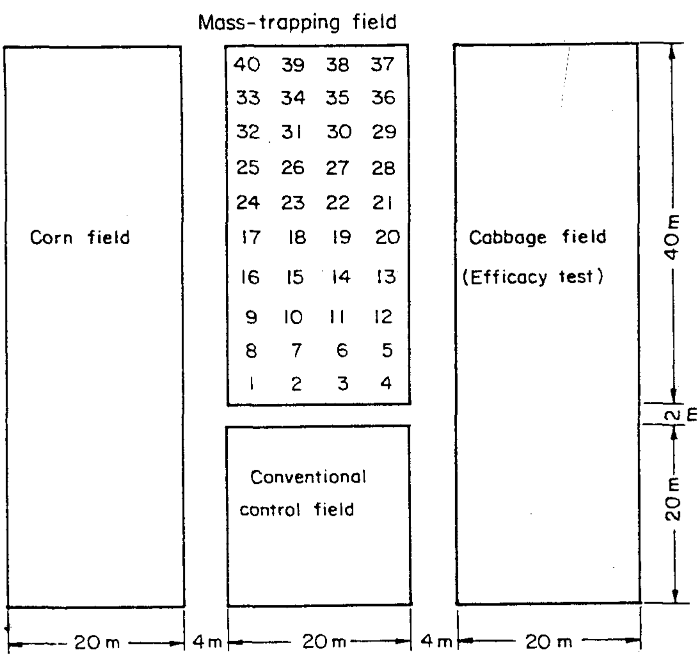

Fig. 1.
Plan of the experimental field; the numbers show the position of traps.

Each trap was nailed to a wooden stake and was placed upright and upside down with the bottom edge of bucket 10 cm above the cabbage plant.

Sticky material

The sticky material was polybutane HT-A (Indemitsu Petrochemical Co., Tokyo) diluted to concentration of 5% in hexane.

Forty traps were placed in the field from 20 December 1989 to 23 January 1990. The traps were painted on the outerside with sticky material once a week. The number of DBM adults caught per trap per day was recorded and the insects removed daily. The number of DBM larvae and the other insect larvae was recorded on cabbage by using a sequential sampling technique for action threshold (Table 1) every 3 days.

Table 1. The action threshold of DBM in a cabbage field.

Sample	Threshold level[a]		Sample	Threshold level[b]	
plan	Low	High	plans	Low	High
1-10	10	27	1-5	2	25
1-15	20	41	1-10	20	53
1-20	31	55	1-15	42	82
1-25	42	70	1-20	64	111
1-30	54	84	–	–	–

[a]For 1-35 days after transplanting (before heading period). [b]For over 35 days after transplanting (heading period).
Note: 1 cabbage looper = 20 DBM larvae.

Insecticide application

Mass trapping field was sprayed immediately with *B. thuringiensis* (Delfin WG, Sandoz Co., Ltd.) at a rate of 2.0 kg product per hectare when the number of DBM larvae reached the action threshold. The conventional control field was sprayed with a tank mix of Delfin WG at a rate of 2.0 kg product and mevinphos 24 EC at a rate of 0.48 kg AI/ha at weekly intervals.

Results

Population of DBM adults in yellow traps

A total of 22,829 DBM adults were caught in the 40 traps in mass trapping field (Table 2). There were 12,773 males and 10,056 females, and the average sex ratio was 1:0.79, male to female. The number of males and females trapped and sex ratio were almost the same as those found by Sivapragasam and Saito (1986). Koshihara (1986) and Bhalla and Dubey (1986) reported that the number of males was greater than females caught in all traps and the sex ratio was 1:0.79, 1:0.62 and 1:0.84, males to females. This phenomenon suggested that either the males were more active in searching to mate or they were more responsive to yellow color than females. This might be the effect of the diameter of each facet of eyes in male being larger and the number of facets of male being greater than the female (Wang 1982).

Effect of mass trapping and action threshold

When the mass trapping field was incorporated with action threshold of DBM, the initial threshold was 10-27 larvae per 10 plants. In late growth stage the threshold was 20-53 larvae per 10 plants. The mass trapping field required three applications of *B. thuringiensis* whereas the conventional controlled field required five applications of mixtures of *B. thuringiensis* and mevinphos (Table 3). The mass trapping field showed that it not only reduced the number of insecticide applications but it also provided a higher yield and less infestation when compared to conventional control field. The number of DBM adults caught in all traps was high, therefore the number of larvae in the field might be high, because a female can lay on average of 80.8 eggs/day (Bhalla and Dubey 1986). The results indicated that the yellow trap can catch DBM adults before oviposition. Generally, the moths are active before dusk and oviposition begins shortly after dusk. The period from pupa emergence to the first peak of oviposition is 32-40 hours, and mating occurred on the day of emergence (Sakanoshita and Yanagita 1972). The egg mortality is 1.8-17.9%, and large numbers of eggs laid are nonfertile if the male to female ratio is 1 (Sivapragasam et al. 1988; Yamada 1979).

Table 2. Number of DBM adults caught by yellow plastic bucket sticky traps in cabbage field.

Days after transplanting	No. adults caught/40 traps: male	No. adults caught/40 traps: female	Sex ratio, male to female
24-30	2172	1584	0.72
31-37	939	1113	1.18
38-44	4987	3805	0.76
45-51	2282	1117	0.48
52-58	2413	2437	1.01

Table 3. Sequential sampling of DBM larvae on cabbage in mass-trapping field.

Observation date	No. of DBM larvae/10 plants: Mass trapping field	No. of DBM larvae/10 plants: Conventional controlled field
23 Dec. 1989	18 (622)	–
26 Dec. 1989	24 (318)	–
29 Dec. 1989	28[a] (822)[a]	–
1 Jan. 1990	17 (296)	–
4 Jan. 1990	30[a] (790)	–
7 Jan. 1990	8 (2402)	–
10 Jan. 1990	6 (846)	–
13 Jan. 1990	6 (803)	–
16 Jan. 1990	88[a] (379)	184
19 Jan. 1990	32 (195)	156
22 Jan. 1990	31 (615)	159
No. of infested leaves removed/plant	14.2	15.9
Head weight, kg/head	0.60	0.02
Marketable yield, t/ha[b]	24.0 a	12.8 b

[a]Sprayed Delfin WG at 2.0 kg/ha ( ) = number of DBM adults caught on a day before larvae count. [b]LSD at 5% = 9.2; 1% = 13.2.

Discussion

In this study, the adult DBM mass trapping, incorporated with the use of action threshold for control of DBM in cabbage fields, has given promising results. The decline in insecticidal inputs of more than 50% and increase of marketable yield by nearly 100% are sufficient to favor the use of yellow sticky traps over the existing chemical approach practiced by farmers. The greater number of DBM adults trapped per day indicated that yellow sticky traps could be a satisfactory tool for suppression of DBM populations in integrated pest management programs. Research efforts will continue to determine the use of other simplified traps and sticky materials and finding the optimal number of traps to be used per unit area to refine the integration of these components. In future studies, natural enemies such as egg parasite *Trichogrammatoidea bactrae* Nagaraja, a key parasitoid of DBM in Thailand (Keinmeesuke et al. 1989) will be incorporated as one component in integrated pest management programs in cruciferous crops.

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References

Bhalla, O.P., and Dubey, J.K., 1986. Bionomics of diamondback moth in northwestern Himalaya. *In* Talekar, N. S., and Griggs, T. D. (ed.) Proceedings of the First International workshop on Diamondback Moth Management: Asian Vegetable Research and Development Center, Shanhua, Taiwan, 55-61.

Katanyukul, W., Pongprasert, W., and Vititanyanon, P. 1989. Field evaluation of abamectin for the control of diamondback moth, *Plutella xylostella*. *In* The First Asian-Pacific conference of entomology, Chiang Mai, Thailand, Abstract Volume, p. 242.

Keinmeesuke, P., Sarnthoy, O., Miyata, T., and Vattanatangum, A. 1989. Egg parasite of diamondback moth, *Trichogrammatoidea bactrae* Nagaraja in Thailand. In The Asian-Pacific Conference of Entomology, Chiang Mai, Thailand, Abstract Volume, p. 240.

Koshihara, T. 1986. Diamondback moth and its control in Japan. *In* Talekar, N. S., and Griggs, T. D. (ed.) Proceedings of the First International workshop on Diamondback Moth Management: Asian Vegetable Research and Development Center, Shanhua, Taiwan, 43-53.

Miyata, T., Sinchaisri, N., Sayampol, B., Rushtapakornchai, W., and Vattanatangum, A. 1988. Insecticide resistance patterns. *In* Report on insect toxicological studies on resistance to insecticides and integrated control of the diamondback moth, Department of Agriculture, Bangkok, Thailand, 8-13.

Rushtapakornchai, W., Miyata, T., Vattanatangum, A., Sinchaisri, N., and Sayampol, B. 1988. Field experiment. *In* Insect toxicological studies on resistance to insecticides and integrated control of diamondback moth, Department of Agriculture, Bangkok, Thailand, 24-28.

Rushtapakornchai, W., Saito, T., and Vattanatangum, A. 1989. Yellow sticky traps for diamondback moth. *In* Asian-Pacific Conference of Entomology, Chiang Mai, Thailand, Abstract Volume, p. 247.

Rushtapakornchai, W., Vattanatangum, A., Saito, T., Miyata, T., and Sinchaisri, N. 1990. Field experiment candidate insecticides. *In* Report on insect toxicological studies on resistance to insecticides and integrated control of diamondback moth. Department of Agriculture, Bangkok, Thailand, 84-88.

Sakanoshita, A., and Yanagita, Y. 1972. Fundamental studies on the reproduction of diamondback moth, *Plutella maculipennis* Curtis. (I) Effects of environmental factors on emergence, copulation and oviposition. *In* Annotated Bibliography of Diamondback Moth, Asian Vegetable Research and Development Center, Shanhua, Taiwan, p. 78.

Saito, T., Rushtapakornchai, W., Vattanatangum, A., and Sinchaisri, N. 1988. Yellow trap experiments. *In* Report on insect toxicological studies on resistance to insecticides and integrated control of diamondback moth. Department of Agriculture, Bangkok, Thailand, 76-81.

— 1989. Yellow trap experiments. *In* Report on insect toxicological studies on resistance to insecticides and integrated control of diamondback moth. Department of Agriculture, Bangkok, Thailand, 16-25.

Sivapragasam,A., and Saito,T. 1986. A yellow sticky trap for the diamondback moth *Plutella xylostella* (L.) (Lepidoptera: Yponomeutidae). Appl. Entomol. Zool., 21, 328-333.

Sivapragasam,A., Ito,Y., and Saito,T. 1988. Population fluctuations of the diamondback moth, *Plutella xylostella* (L.) on cabbage in *Bacillus thuringiensis* sprayed and non sprayed plots and factors affecting within-generation survival of immatures. Res. Popul. Ecol., 30, 329-342.

Vattanatangum, A. 1988. Recent problems on chemical control of Thailand agricultural insect pests in relation to insecticide resistance of diamondback moth and other major species. *In* Report on insect toxicological studies on resistance to insecticides and integrated control of diamondback moth. Department of Agriculture, Bangkok, Thailand, 8-13.

Wang, C. H. 1982. The compound eye of diamondback moth, *Plutella xylostella* (L.) and its pigment migration. Bull. Inst. Zool. Acad. Sin., 21, 75-92.

Yamada, M. 1979. Mating habits of the diamondback moth, *Plutella xylostella* (L.). *In* Annotated Bibliography of Diamondback Moth, Asian Vegetable Research and Development Center, Shanhua, Taiwan. p 104.