

**Monitoring Field Populations with Pheromone Trap
and Seasonal Trend of Adult Body Size of the Diamondback Moth,
Plutella xylostella (L.) (Lepidoptera:Yponomeutidae),
in Central Thailand**

Masahiko KUWAHARA^{a)}, Piyaratt KEINMEESUKE^{b)} and Yoichi SHIRAI^{c)}

^{a)} *Crop Production and Postharvest Technology Division, Japan International
Research Center for Agricultural Sciences (JIRCAS)
(Tsukuba, Ibaraki, 305 Japan)*

^{b)} *Division of Entomology and Zoology, Department of Agriculture, Ministry
of Agriculture and Cooperatives
(Chatuchak, Bangkok 10900, Thailand)*

^{c)} *Division of Entomology, National Institute of Agro-Environmental Sciences
(NIAES)
(Tsukuba, Ibaraki, 305 Japan)*

Received January 9, 1996

Abstract

Three traps baited with a sex pheromone lure were placed in a field with cruciferous vegetables located in Pathum Thani, in the suburbs of Bangkok City in Central Thailand, to estimate the seasonal trend in population density of the diamondback moth, *Plutella xylostella*. A large number of moths was captured all the year round regardless of the distinctive differences in climatic conditions. Sharp decline in population coincided with harvest of the vegetables in the furrows and lag to recover the population density was detected for several weeks after harvest, indicating a low flight activity of the moths in the near proximity and/or narrow range of action of the pheromone lure. The insects maintained a high population level all the year round, and there were no clear differences in the number of the moths captured by traps between seasons. The body size of the male moths found in Thailand was small and constant throughout the year, as the temperature is always hot with negligible seasonal changes. The size coincided with that of the moths found only in mid-summer in Japan.

Additional key words : population fluctuation, immigration, forewing length, tropics ,
biological characteristics

^{a)} Present address: National Institute of Agro-Environmental Sciences (Tsukuba, Ibaraki, 305 Japan)

Introduction

Information on seasonal trend in population dynamics of the diamondback moth (DBM), *Plutella xylostella*, is essential for determining the appropriate time of insecticide application and the correct use of insecticides to reduce DBM populations in the field. It has often been observed that damage of crucifers caused by DBM was more serious in the dry season (November to May) than in the rainy season (June to October) in Central Thailand⁷⁾. These facts suggest that the insects occur in abundance in the dry season but in relatively small numbers in the rainy season. However, there is little information on population trend of the insects in the fields not only in Thailand but also in other tropical countries.

Considering the high bio-activity and species-specificity of sex pheromones, attempts to apply them not only for monitoring the population trend but also for pest control have been made in some countries. Traps baited with a sex pheromone lure can be used to monitor the population trend and to assist in the decision on the need and/or time of insecticide application.

The seasonal difference in the body size of the moths in terms of forewing length is one of the peculiar biological characteristics of DBM in the temperate zone; moths found in cool and cold seasons are larger than those in warm and hot seasons.¹⁰⁾ Furthermore, it was already reported that larger moths with a long forewing display a higher fecundity and a superior ability to fly over longer distances comparing with the smaller ones with a short forewing.^{8,9)} Hence, the characteristics of the moths found in the temperate zone are highly correlated with the fecundity and flight ability.

On the other hand, there has been little information on the seasonal trend in these biological characteristics in the tropics in relation to flight movement and fecundity. The present study was carried out to analyse the biological characteristics of DBM in Thailand.

Materials and Methods

To estimate the population trend of DBM in fields with cruciferous vegetables, traps baited with a sex pheromone lure (PX®; Takeda Pharmaceutical Co., Ltd.) were placed in fields located in Bang Po, Pathum Thani Province, in the suburbs of Bangkok City, where various kinds of vegetables have been grown based in high-furrow (Chinese) farming system (Plate 1). Three traps were placed in three furrows adjacent to each other, and they were separated by a distance at least 30m. Chinese kale, *Brassica oleracea* var *alboglabra*, and Chinese white cabbage, *B. pekinensis*, were grown alternately in the field. Crucifers and edible odorous plants such as coriander, sweet basil and peppermint were grown all the year round in close proximity. The growers relied on insecticides for the control of insect pests and sprayed them only when infestation of vegetables with insects became severe. The number of DBM captured was recorded weekly and the pheromone lure was changed once a month.

In specimens of male DBM captured by traps, the body size in terms of forewing length was observed during a period of one year. Forewing length was measured using a stereoscopic microscope with a micrometer in the eye piece, and 30 specimens were checked in each observation.



Plate 1. High-furrow (Chinese) farming system adopted by farmers in Pathum Thani area where various kind of vegetables are grown all year round.

Results and Discussion

The population trend of male DBM captured by traps in relation to the period of cultivation of vegetables from July 1992 to June 1993 is shown in Fig. 1. There was a clear difference in the recovery pattern of the number of captured moths after harvest of the vegetables between the dry and rainy seasons; the population density in the rainy season decreased sharply and remaining at a very low level for several weeks, while that in the dry season decreased slowly. These differences seemed to reflect the fact that the DBM population density in the furrow, including the close proximity, was relatively high in the dry season, and that the immigration of moths from the adjacent furrows was more frequent in the dry season than in the rainy season. Hence, the population density in the dry season might have been maintained at a relatively high level even after harvest of the vegetables.

It is obvious that the sharp decline in the number of captured moths coincided with the harvest of the vegetables, and a time lag in the recovery of the population density was also detected for several weeks after harvest of the vegetables, especially in the rainy season (Fig.1). Since host plants were not available in the furrows for several weeks after harvest, the moths captured

during the period just after harvest were presumably immigrants from furrows in close proximity. Furthermore, the range of action of the pheromone lure was assumed to be narrow as already demonstrated elsewhere^{4,5)}.

As mentioned above, it has often been observed that the damage of crucifers caused by the infestation with DBM was more serious in the dry season than in the rainy season. Hence, it was assumed that the insects occurred in abundance in the dry season. But as shown in Fig. 1, the present study indicated that the moths were able to maintain a high population level even in the rainy season provided a sufficient amount of food was available.

Forewing length of the male moths captured by traps is shown in Fig. 2. Forewing length was constant throughout a year without seasonal changes. The average forewing length was 4.74mm, and in the DBM found in Thailand the size was as small as that of the DBM found only in mid-summer in Central Japan⁸⁾.

The body size of the DBM in Thailand was small and remained constant all the year round, because the temperature was always high with negligible seasonal changes (mean annual temperature was 28.3°C, with a range from 26.0°C in December to 30.3°C in April). It was confirmed that the body size of the DBM is determined solely

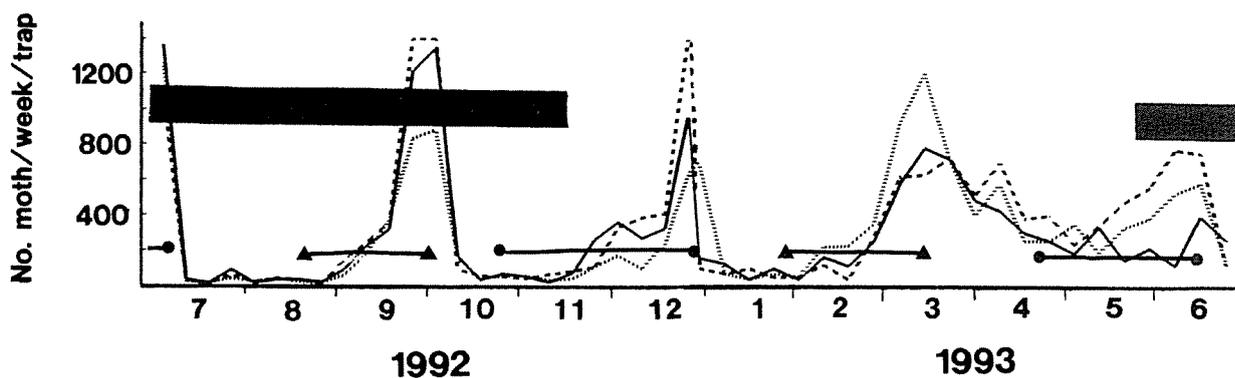


Fig. 1. Seasonal trend in population density of *P.xylostella* male moths captured by pheromone traps and the cultivation terms of cruciferous vegetables in Pathum Thani. The dark bar indicates rainy seasons in Central Thailand.

●—●: chinese kale, ▲—▲: white cabbage

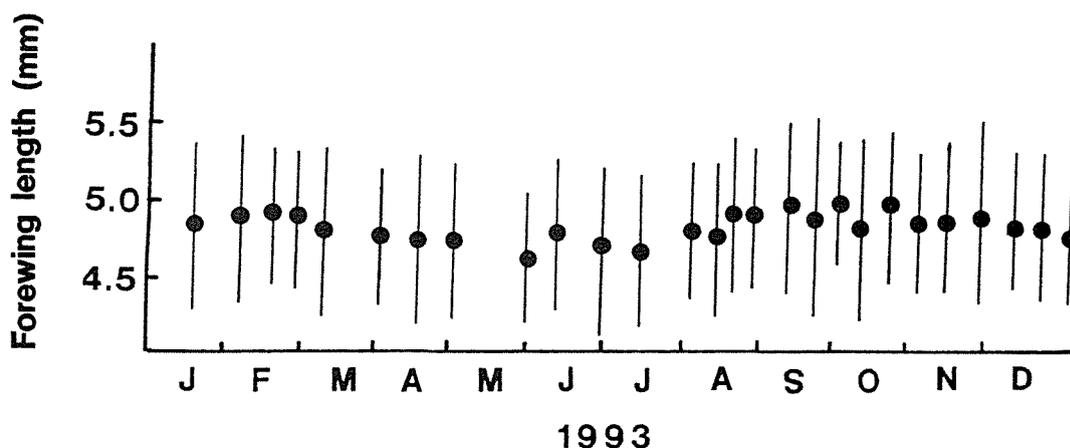


Fig. 2. Seasonal fluctuation of forewing length of *P.xylostella* male moths captured by pheromone traps in Pathum Thani. Figures are expressed as mean \pm S.D. (n=30).

by the rearing temperature at the larval stage irrespective of rearing density, photoperiod and genetical factors. The larger moths with a longer forewing display a higher flight ability than those with a smaller one^{8,9}. The DBM in the temperate zone such as Japan undertake long distance migrations from southern to northern areas in spring and early summer seasons³. Therefore, a large size may be advantageous for long-distance flight.

The present study was conducted as a first step for monitoring the population dynamics of DBM in Thailand. In future, it will be necessary to analyse the relationship between the number of moths captured by traps and actual population density in the field. It has been shown that the major drawback of pheromone-monitoring traps is the difficulty in relating trap-catch to pest insect density or damage level¹. In addition, the efficacy of a pheromone trap is modified by various factors such as the population density of wild females, flight ability of the target insects, temperature and wind velocity^{2,6}. In Thailand, farming systems (e.g. high-furrow system or not) and frequency of sprinkling may be also important factors. Thus, quantitative monitoring by using pheromone traps over a long period of time should be carried out to analyse the insect population density and the damage level of vegetables in a large number of

vegetable fields under various cultivation conditions.

Acknowledgements

The authors thank Mr. Montri Rumakon, Director General, Department of Agriculture (DOA), Thailand, for his administrative support and encouragement. The authors are greatly indebted to Dr. Aphirat Arunin, Secretary General, and Mrs. Tuenchai Niyamangkoon, Chief of Foreign Research Section, National Research Council of Thailand, for their friendly advice and coordination. The authors are also indebted to Mr. Ocha Prachubmoh, Director of Entomology and Zoology Division, DOA, and staffs of Vegetable and Ornamental Plant Entomology Research Group of the Division for their assistance in the research activities. They also acknowledge the cooperation of the members of the joint research project between Thailand and Japan "Insect Toxicological Studies on Resistance to Insecticides and Integrated Control of the Diamondback Moth" for their advice and encouragement.

References

- 1) Allen, D.C. *et al.* (1986). Monitoring spruce budworm (Lepidoptera:Tortricidae) population

- with pheromone-baited traps. *J.Econ.Entomol.* **79**:152~165.
- 2) Hartstack, A.W. and Witz, J.A. (1981). Estimating field populations of tobacco budworm moths from pheromone trap catches. *Environ. Entomol.* **10**:908~914.
 - 3) Honda, K. et al. (1992). Seasonal abundance and the possibility of spring immigration of the diamondback moth, *Plutella xylostella* (Lepidoptera: Yponomeutidae), in Morioka city, northern Japan. *Appl. Entomol. Zool.* **27**:517~525.
 - 4) Ishii, T. et al. (1981). Active space of sex pheromone of the diamondback moth, *Plutella xylostella* (L.) (Lepidoptera: Yponomeutidae). *Jpn. J. Appl. Entomol. Zool.* **25**:71~76.
 - 5) Obayashi, N. (1980) The attractive area of a synthetic sex pheromone PX (f-01) for trapping diamondback moth. *Proc.Kanto-Tosan Pl. Prot.Soc.* **27**:140~141.
 - 6) Riedl, M. and Croft, B.A. (1974). A study of pheromone trap catches in relation to codling moth (Lepidoptera: Olethreutidae) damage. *Can.Entomol.* **106**:525~537.
 - 7) Rushtapakornchai, W. and Vattanatangum, A. (1986). Present status of insecticide control of diamondback moth in Thailand. pp.307-312. *In: Diamondback Moth Management* (ed. by Talekar and T.D.Griggs), AVRDC, Taiwan.
 - 8) Shirai, Y. (1991). Seasonal changes and effects of temperature on flight ability of the diamondback moth, *Plutella xylostella* (L.). *Appl. Entomol. Zool.* **26**:107~115.
 - 9) Shirai, Y. (1993). Factors influencing flight ability of male adults of the diamondback moth, *Plutella xylostella* (L.), with special reference to temperature conditions during the larval stage. *Appl.Entomol.Zool.* **28**: 291~301.
 - 10) Yamada, H. and Umeya, K. (1972). Seasonal changes in wing length and fecundity of the diamondback moth, *Plutella xylostella* (L.). *Jpn.J.Appl.Entomol.Zool.* **16**:180~186.

タイ中部におけるコナガの発生密度と雄成虫の体長の季節変異

桑原雅彦^{a)}、ピヤラット カインミースク^{b)}、白井洋一^{c)}^{a)} 国際農林水産業研究センター (〒305 茨城県つくば市大わし1-2)^{b)} タイ農業協同組合省農業局昆虫・動物部 (バンコク市チャトチャ区10900)^{c)} 農業環境技術研究所 (〒305 茨城県つくば市観音台3-1-1)

摘 要

タイ中部平原に位置するバンコク市近郊パトンタニ県の灌漑地帯にあるアブラナ科野菜ほ場にフェロモントラップを設置し、毎週誘殺虫数を調査した。また、定期的にトラップに誘殺された雄成虫の体長を測定し、その季節変異を検討した。タイでは以前からコナガは乾季に多発し、雨季には発生が少ないとされていた。しかし、トラップへの誘殺数から判断して、コナガは雨季、乾季ともに一年中高密度で発生していることを確認した。作物の収穫後には誘殺虫数が急激に減少し、暫く回復が認められなかった。これは雄成虫の飛翔範囲が狭いのか、ま

たはフェロモンの有効範囲が狭いことが関係していると思われた。雄成虫の体型は小型で、日本では夏期の一時期にのみ認められるそれに相当しており、この形質は一年中安定していることを明らかにした。成虫の体長は幼虫期の温度条件によって決定され、高温条件では低温条件に比較して体型が小型になることが確認されている。したがって、タイのコナガの体型が小型で一年中安定しているのは、気温が一年中高く、年較差が小さい温度条件を反映したものと思われた。

キーワード：コナガ、タイ、密度変化、体長、生物学的特性

^{a)} 現在：農業環境技術研究所 (〒305 茨城県つくば市観音台3-1-1)