Seasonal Trend in Population Density and Adult Body Size of the Diamondback Moth, *Plutella xylostella* (L.) (Lepidoptera: Yponomeutidae), in Central Thailand

Masahiko Kuwahara,¹ Piyarat Keinmeesuke² and Yoichi Shirai³

1 Japan International Research Center for Agricultural Sciences, Osawa 1–2, Tsukuba, Ibaraki 305, Japan
2 Department of Agriculture, Ministry of Agriculture and Cooperatives, Chatuchak, Bangkok 10900, Thailand
3 National Institute of Agro-Environmental Sciences, Kannondai 1–3, Tsukuba, Ibaraki 305, Japan

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Traps baited with a sex pheromone lure were placed in two fields located in Pathum Thani Province in central Thailand to estimate the seasonal trend in population density of the diamondback moth, *Plutella xylostella*, over a two year periods. Although a large number of moths were captured all year round regardless of different climatic conditions such as dry and rainy seasons, the population density was clearly different between the two fields, indicating that the number of emerging moths varied from place to place even in the same season. The population density declined sharply with the harvest of cruciferous vegetables, and recovered several weeks after the harvest. Forewing lengths of male moths captured in Thailand were constantly short through the year and about the same size as those of males found only in mid-summer in Japan.

**Key words**: *Plutella xylostella*, population density, seasonal trend, tropical insects

INTRODUCTION

Information on seasonal trend in the population dynamics of the diamondback moth (DBM), *Plutella xylostella*, is essential for determining the appropriate timing of insecticide application and for implementing the effective use of insecticides to reduce DBM population in the field. Often, damage of cruciferous vegetables by DBM is more serious in dry seasons (November to May) than in rainy seasons (June to October) in Thailand (Rushtapakornchaisri and Vattanatangum, 1986). This may mean that the insect occurs more abundantly in dry rather than rainy seasons. However, practical data on DBM population trends in the field are poorly documented, not only in Thailand but also in other tropical countries.

The body size of DBM in terms of forewing length is usually closely related to its seasonal trend in temperate regions; moths found in cool and cold seasons are much larger than those in warm and hot seasons (Yamada and Umeya, 1972). It was verified that larger moths with long forewings were more fecund (Yamada and Umeya, 1972), and could fly longer distances than smaller ones with short forewings (Shirai, 1991, 1993). However, in tropical regions, there is little information on the seasonal trend of body size and biological characteristics such as flight activity, longevity and fecundity related to body size. A study on these parameters is important for ecological comparison between the tropics and temperate zones. The present study was conducted as the first step to clarify the population

¹ Present address: National Institute of Agro-Environmental Sciences, Kannondai 3–1–1, Tsukuba, Ibaraki 305, Japan
dynamics of DBM in Thailand.

MATERIALS AND METHODS

To estimate the population trend of DBM in cruciferous fields, from July 1992 to June 1994, traps baited with sex pheromone (PX®, Takeda Pharmaceutical Co., Ltd.) were placed in two fields located in Bang Po and Bang Poon, Pathum Thani Province, suburbs of Bangkok city. In both fields, various kinds of vegetables have been cultivated with high-furrow irrigation in which each furrow (about 5 m in width) was separated by an irrigation canal that was about 1 to 2 m wide (Fig. 1). In each field, three traps were placed in adjacent furrows, separated by at least 30 m. In Bang Poon, the Chinese kale, *Brassica oleracea* var. *alboglabra*, has been cultivated successively all year round, while in Bang Po, the Chinese kale and the Chinese white cabbage, *B. pekinensis*, have been alternately cultivated. The period from sowing to harvest was about 45 to 50 d for the kale and about 50 to 55 d for the white cabbage. These vegetables were almost simultaneously harvested in fields where the pheromone traps were placed. Other crucifers and edible odorous plants (coriander, sweet basil and peppermint) have been grown all year round in close proximity to these fields.

The growers rely on insecticides to control insect pests, but there is a clear difference in insecticide treatment between the two fields; insecticides were sprayed every 3 to 7 d in the Bang Poon field and only when the infestation of vegetables by insects became severe in the Bang Po field. The number of DBM males captured was recorded weekly and the pheromone lure was exchanged once a month.

The body size in terms of forewing length of DBM males, which were captured in two fields from January to December in 1993, was measured using a stereoscopic microscope.
Fig. 2. Seasonal trend in population density of *Plutella xylostella* male moths captured by pheromone traps in two cruciferous fields located in Bang Po (---) and in Bang Poon (--.--), Pathum Thani Province, central Thailand. (A) July 1992 to June 1993, (B) July 1993 to June 1994. Dark bars indicate rainy season.

Fig. 3. Seasonal trend in population density of *P. xylostella* male moths captured by pheromone traps and cultivation periods of cruciferous vegetables in Bang Po. Dark bars indicate rainy season. : chinese kale; : white cabbage.

fitted with an eyepiece micrometer. As the body size was not significantly different between the two fields (*t*-test, *p* < 0.05), we refer only to the results from the Bang Po field in the present study.

RESULTS AND DISCUSSION

The population trend of DBM males captured by traps from July 1992 to June 1994 in two fields is shown in Fig. 2. Figure 3 redraws the population trend from July 1992 to June 1993 in Bang Po in relation to the cultivation terms of vegetables. There was a clear difference in the seasonal trend of male population density between the two fields (Fig. 2).
Table 1. Seasonal changes in relative wing length (R.W.L.) of *P. xylostella* male moths captured in Pathum Thani, Thailand

| Period          | n  | R.W.L. (average ± S.D.)
|-----------------|----|------------------------
| Mar. 11–25, 1993 | 30 | 5.86 ± 0.80
| Aug. 13–19, 1993 | 30 | 5.85 ± 0.70
| Dec. 17–23, 1993 | 30 | 6.04 ± 0.51

a R.W.L. = forewing length/thoracic length.

Fig. 4. Seasonal fluctuations in forewing length (mm) of *P. xylostella* male moths captured by pheromone traps in Bang Po. Figures are expressed as average ± S.D. (n = 30).

The total numbers of moths captured per trap were 14,928 (July 1992 to June 1993) and 12,826 (July 1993 to June 1994) in Bang Po, and 6,311 (July 1992 to June 1993) and 9,178 (July 1993 to June 1994) in Bang Poon; the number of moths captured in Bang Po was much higher than that in Bang Poon. This difference in population density appeared to be induced by the different frequency of insecticide application in each field, as mentioned above.

There was also a clear difference in recovery pattern of the number of captured moths after the harvest of vegetables between the dry and rainy seasons, especially in the Bang Po field (Fig. 3); the population density in the rainy seasons decreased sharply and remained at a very low level for several weeks, while that in the dry season decreased rather slowly. Because there were no host plants available in the furrows for several weeks after harvest and the active area of the sex pheromone is limited to less than several meters (ISHII et al., 1981), the moths captured in the periods after harvest were supposedly immigrants from nearby furrows and surrounding fields. The seasonal difference in the recovery pattern may imply that the DBM population density in the furrows, including the close proximity, is relatively higher in the dry season, or that moths immigrate more frequently from adjacent furrows in the dry season than in rainy season.

As mentioned above, in Thailand, the damage to crucifers by DBM often becomes more serious in dry seasons than in rainy seasons. However, the present study showed that DBM population density was high even in rainy seasons as long as the food resource was sufficient, suggesting that the relationship between population density and infection level may differ according to the seasons.

The forewing length and relative wing length of moths captured by pheromone trap are shown in Fig. 4 and Table 1, respectively. The forewing length and relative wing length were constant throughout the year. The average forewing length was 4.74 mm, which is relatively smaller than DBM in Japan and about the same size as DBMs found only in mid-summer in central Japan (SHIRAI, 1991). SHIRAI (1993) verified that the body size of DBM is
determined solely by rearing temperature during the larval stage irrespective of rearing density, photoperiod and genetic factors. The constancy of body size of DBM in Thailand reflects a temperature with little seasonal variation (mean annual temperature is 28.3°C, with a range from 26.0°C in December to 30.3°C in April).

Shirai (1991, 1993) also demonstrated that larger moths with long forewings have greater flight ability than smaller ones. Larger moths may benefit greatly from the ability to undertake long-distance flight, because DBM in temperate zones such as Japan are reported to undertake long-distance migration from southern areas to northern areas during spring and early summer seasons (Honda et al., 1992). Although there is little information available on long-distance migration in tropical regions, male moths with very short forewings in Thailand appear to have inferior flight ability to larger ones with long forewings in temperate zones, based on the relationship between body size and flight ability (Shirai, 1991, 1993).

The present study was conducted as a first trial for monitoring the DBM population dynamics in Thailand. In central Thailand, where the present study was conducted, construction of a water system and irrigation of fields made the cultivation of vegetables possible even during the dry seasons, while in other regions, where irrigation systems are not yet established, vegetables are cultivated only during the rainy seasons. In future studies, it is important to compare the seasonal trend of DBM population in these areas, because the phenology and population density of tropical insects may be changed by introduction of water systems or irrigation (Rivnay, 1964). In addition, the present study suggested that DBM population density differed between the fields even in the same season, probably due to different frequencies of insecticide application (Fig. 2). Therefore, the seasonal trend in DBM population should be studied with the aid of pheromone traps in various places of Thailand or in various vegetable fields with different cultivation conditions.

REFERENCES


