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Field Monitoring of Cruciferous Insect Pest Populations by Synthetic Sex Pheromone Traps in Chiang Mai Cauliflower Production Areas

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Abstract: Field monitoring of the diamondback moth (DBM*), Plutella xylostella* (Linnaeus) and the common cutworm (CW), *Spodoptera litula* (Fabricius) adult insect populations by the synthetic sex pheromone traps were conducted during 1995-1997 cauliflower growing seasons at Sarapee, Chiang Mai, to determine the densities and population dynamics of the insect pests in correspondence with the meteorological data. The total area of study was 800 m^2 (0.8 ha) and was divided into thirty plots of 5 m long and 2 m wide, the crop spacing was 30x30 cm, and there was a total of 75 cauliflower plants on each plot. The DMB population attained its first peak of 819 insects on January 2, 1966, during the harvest time of the third cropping of the 1995 growing season, then remained low through the first cropping of the 1996 growing season. The population then reestablished and reached the second peak of 859 insects on March 5, 1966, and continued diminished through the second crop plantation with a small peak of 279 insects during the mid harvest time. The adult insects of less than 100 insects per sampling date were detected through the third crop plantation, then sharply increased and attained a triple peak of more than 500 insects, during the first crop plantation of the 1997 growing season. The DBM population had never exceeded 330 insects through the rest of the field trial. The CW population continued increased during the first six sampling dates then attained the maximum peak of 1,465 insects on December 12, 1995. The adult population reached a triple peak of more than 600 insects per sampling date during the second crop plantation, then remained low through the rest of the study, never exceeded 370 insects per sampling date.

Although the meteorological factors including the temperature, relative humidity, and the rain precipitation displayed inconsistently correlated with both the DBM and the CW populations, the rainfall seemed to exert the negative correspondence with the DBM adult population. This insect population exhibited persistently declined through the rainy seasons of both the 1996 and 1997 growing seasons.

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Index words : sex pheromone trap, monitoring, the diamondback moth: *Plutella xylostella* (L.), the common cutworm: *Spodoptera litura* (F.), the cauliflower: *Brassica oleracea* var. *botrytis* L.

Introduction

Northern Thailand is one of the major cash-crop cultivated area producing the high quantity and quality cruciferous vegetables including cabbage, Chinese cabbage, Chinese kale, cauliflower, and others, accommodating the nation needs. One of the chief limiting factors for the crop production is the insect pest and disease problems. Billions of bahts have been spent annually on crop production and protection aspects nationwide.

Wongsiri (1991) reported the totals of eighteen species are the major insect pests of cruciferous vegetables in Thailand (Table 1). However, the green peach aphid: *Myzus persicae* (Sulzer); the striped flea beetle: *Phyllotreta sinuata* Stephens; the beet armyworm: *Spodoptera exigua* (Hübner); the common cutworm: *Spodoptera litula* (Fabricius); the cabbage looper: *Trichoplusia ni* (Hübner); and the diamondback moth: *Plutella xylostella* (Linnaeus); are more predominant and the most injurious insect pests of the vegetables in Chiang Mai cultivated areas. Rushtapakornchai (1992) provided the detail information on biology, ecology, natural enemies, and control strategies for each of cruciferous insect pest in Thailand. He had also summarized and recommended the combined management program for those insect pests.

Monitoring a population of insects is a prerequisite for making a management decision; it also serves as the fundamental tool for insect pest management. The purposes for this monitoring are diverse, from detecting the spread of an insect into a restricted area to estimating the numbers of insect per plant and relating this to an economic threshold. To cope with this diversity, application of appropriate monitoring technique for the specific purpose is required. The complexity of insect behavior often allows entomologists the opportunity to apply a diverse set of monitoring tactics including the use of kairomones, pheromones, or visual traps. Traps designed to attract insects with a light source or pheromones are better detection tools although they give biased counts of insect density per unit area (Shelton and Trumble, 1991). Rushtapakornchai *et al*. (1992) reported the development and implementation of the yellow sticky trap for the diamondback moth (DBM) control in Thailand; they also concluded that this trap could be partially used to control the DBM in cruciferous fields and could be an important tool in integrated management program of the DBM. Synthetic sex pheromones have been utilized for insect pest population suppression either by disruption of communication between both sexes or by mass trapping of adult males (Nemoto *et al*., 1992). The DBM sex pheromone has been identified as a mixture of (Z)-11-hexa-decenal and (Z)-11-hexadecenyl acetate (Tamaki *et al*., 1977), Kitamura and Kobayashi (1985) described the common cutworm (CW) sex pheromone as a mixture of (Z, E)-9-11-tetradecadienyl acetate and (Z, E)-9-12-tetradecadienyl acetate.

The primary objective of this trial is to monitor and estimate the DMB and the CM adult populations by synthetic sex pheromone traps under field condition and relate the obtained data to the meteorological data existing within the field ecosystem for determining the status of the insect population whether an economic threshold has been exceeded, and also estimating insect population density, dispersion, and dynamics, to help prevent insect pests from becoming established. The acquired data should provide necessary precaution information for better pest management and control decision.

Table 1 **Lists of insect pests of cruciferous crops in Thailand (Wongsiri, 1991).**

Species	Classification	Common name
***Agrotis ipsilon* (Hufnagel)**	**Lepidoptera: Noctuidae**	**Black cutworm**
***Aphis gossypii* Glover**	**Homoptera: Aphididae**	**Cotton aphid**
***Bemisia tabaci* (Gennadius)**	**Homoptera: Aleyrodidae**	**Tobacco whitefly**
***Crocidolomia binotalis* Zeller**	**Lepidoptera: Pyralidae**	**Cabbage moth**
***Eurydema pulcha* Westwood**	**Hemiptera: Pentatomidae**	**Cabbage bug**
***Hellula undalis* (Fabricius)**	**Lepidoptera: Pyralidae**	**Cabbage webworm**
***Lipaphis erysimi* (Kaltenbach)**	**Homoptera: Aphididae**	**Cabbage aphid**
***Liriomysa brassicae* (Riley)**	**Diptera: Agromyzidae**	**Cabbage leafminer**
***Myzus persicae* (Sulzer)**	**Homoptera: Aphididae**	**Green peach aphid**
***Phyllotreta chontalica* Duvivier**	**Coleoptera: Chrysomelidae**	**Blue flea beetle**
***Phylloterta sinuata* Stephens**	**Coleoptera: Chrysomelidae**	**Striped flea beetle**
***Pieris brassicae* Doubleday**	**Lepidoptera: Pieridae**	**Cabbage white butterfly**
***Pieris canidia* Sparrman**	**Lepidoptera: Pieridae**	**Cabbage white butterfly**
***Plutella xylostella* (Linnaeus)**	**Lepidoptera: Yponomeutidae**	**Diamondback moth**
***Rhopalosiphum maidis* (Fitch)**	**Homoptera: Aphididae**	**Corn leaf aphid**
***Spodoptera exigua* (Hübner)**	**Lepidoptera: Noctuidae**	**Beet armyworm**
***Spodoptera litura* (Fabricius)**	**Lepidoptera: Noctuidae**	**Common cutworm**
***Trichoplusia ni* (Hübner)**	**Lepidoptera: Noctuidae**	**Cabbage looper**

Materials and Methods

Two year-round monitoring of the DBM and the CW adult populations with synthetic sex pheromones were conducted at crucifer cultivated area at Sarapee, Chiang Mai, during November 1995 – November 1997. This is one of the most intensive cauliflower production areas of Chiang Mai. The cauliflower: *Brassica oleracea* var. *botrytis* L. is triple cultivated annually in this area. The first cropping season is begun by sowing the cauliflower seeds in early January, transplanted in early February, and harvested in late March, likewise, the second cropping season is started in April, transplanted in May, and harvested in July. The production land will be left idled during August each year due to the annual heavy rainfall, and then the third cropping season is begun in September, transplanted in October, and harvested during November till December. Different varieties of planting seeds with varying maturity duration have been practiced in accordance with the successive field ecosystem. Besides, the farmers usually apply either organophosphate, synthetic pyrethroid insecticides or bioinsecticides for a total of 7-8 times during each cropping season for their crop protection. The total area of study was 800 m^2 (0.8 ha) and was divided into thirty plots of 5 m long and 2 m wide, the crop spacing was 30x30 cm, and there was a total of 75 cauliflower plants on each plot. A DBM monitoring trap composed of a rectangular sticky board (27x30 cm) baited with a mixture of DBM synthetic sex pheromones, (Z)-11-hexadecenal (Z-11-16: Ald), and (Z)-11-hexadecenyl acetate (Z-11-16: Ac), containing in a rubber septum positioned in the middle of the sticky board was set in 400 m^2 (0.4 ha) on the first halve of the open study field. The sticky board was then placed inside a roof-like corrugated polyethylene cover board, its base were settled and secured with two 2-cm double clips on a rectangular plywood board attached to a wooden stake, was set at 50 cm above the ground level at center of the treated field (Figure 1).

A CW monitoring trap composed of a cylindrical polyethylene bucket-like body of 22 cm high with a flatted round lid of 16 cm in diameter supported by four plastic rods of 4.0 cm long stood at the top round edge of the trap body with a long cotton string at top of the lid. The lid was embedded at the middle with the CW pheromones, (Z, E)-9-11-tetradecadienyl acetate (Z9E11-14: Ac), and (Z, E)-9-12-tetradecadienyl acetate (Z9E12-14: Ac), containing in a rubber septum. The trap was then suspended at the apex of a bamboo pole tripod at 1.0 m above the ground level and was set at center of 400 m^2 (0.4 ha) on the second halve of the open study field (Figure 2).

Figure 1 The diamondback moth (DBM) synthetic sex pheromone trap.

Figure 2 The common cutworm (CW) synthetic sex pheromone trap.

The DBM and CW adult insect data was collected 105 times during the studies. Sampling was begun on November 25, 1997. The sticky board of the DBM monitoring trap was replaced every week while the pheromones of both DBM and CW monitoring traps were restored every four weeks. In addition, the meteorological data including the temperature, the relative humidity, and the amount of rainfall were also collected at weekly intervals from the nearby meteorological station in accordance with the sampling dates.

Results and Discussion

The numbers of DBM and CW adult populations collected at weekly intervals from the pheromone traps at Sarapee, Chiang Mai, during 1995-1997 cauliflower growing reasons, and the data on the average temperature (^{O}C), relative humidity (%), and rainfall (mm) corresponded with the sampling date is given in Table 2. The DBM population started to build up sharply on the first 5 sampling dates and reached its first peak of 819 insects on 2 January 1996 agreed with the harvest time of the third cropping of 1995 cauliflower growing season, then steadily declined during the sowing time of the first cropping of 1996 growing season. After this first crop had been transplanted the DBM population reestablished and attained the second peak of 859 insects on 5 March 1996 concurred with the early harvest time, then continually diminished through the second crop plantation with a small peak of 279 insects during the mid harvest time. The adult population remained low with less than 100 insects per sampling date through the crop plantation in late December 1996, then sharply increased and reached a triple peak of more than 500 insects during the first crop plantation of 1997 growing season. After attained a small peak of 330 insects during the sowing time of the second cropping, the DBM adult population had never exceeded 300 insects during the latter part of 1997 growing season till the study terminated. The CW adult population remained high on the first 6 sampling dates through the harvest time of the third cropping of the 1995 growing season with the maximum peak of 1,465 insects occurred on 12 December 1995, then had never reached 600 insects per sampling date during the first crop plantation of 1996 growing season. However, the adult population attained a triple peak of more than 600 insects during the second crop plantation, then remained low throughout the third crop plantation and continued through the entire 1997 growing season, the population had never exceeded 370 insects per sampling date.

Table 2 Numbers of *Plutella xylostella* and *Spodoptera litura* adult populations collected from the pheromone traps in accordance with the average temperature (°C), relative humidity (%), and rainfall (mm) collected at weekly intervals, during 1995 – 1997cauliflower growing seasons, Sarapee, Chiang Mai.

Week	Collected date	*P. xylostella*	*S. litura*	Temp.	% RH	Rainfall
1.	28/11/95	111	1,236	23.21	75.71	0
2.	5/12/95	202	728	23.86	72.86	0
3.	12/12/95	451	1,465	20.63	68.71	0
4.	19/12/95	287	1,008	21.34	68.57	0
5.	26/12/95	416	1,208	22.54	0.14	0
6.	2/1/96	819	1,207	18.69	64.86	0
7.	9/1/96	610	722	19.57	63.71	0
8.	16/1/96	208	592	21.34	4.14	0
9.	23/1/96	196	491	21.50	9.71	0
10.	30/1/96	152	523	21.81	6.43	0
11.	6/2/96	421	527	22.34	2.00	0
12.	13/2/96	698	598	21.90	1.43	0
13.	20/2/96	580	498	24.09	3.51	0
14.	27/2/96	515	369	22.81	6.57	5.80
15.	5/3/96	859	282	25.80	6.71	1.13
16.	12/3/96	312	270	26.09	1.43	0
17.	19/3/96	236	363	27.21	9.86	0
18.	26/3/96	263	575	28.91	5.57	0
19.	2/4/96	218	343	28.83	2.00	0.19
20.	9/4/96	367	314	29.73	7.14	0
21.	16/4/96	145	321	30.27	1.29	0
22.	23/4/96	191	390	28.99	4.43	27.01
23.	30/4/96	114	653	27.37	6.86	3.49
24.	7/5/96	105	472	28.47	74.00	3.56
25.	14/5/96	48	382	28.69	70.71	0.34
26.	21/5/96	13	249	29.43	69.14	2.09
27.	28/5/96	75	649	28.43	6.71	2.79
28.	4/6/96	69	290	28.44	75.14	4.97
29.	11/6/96	38	285	28.26	7.29	1.96
30.	18/6/96	50	38	27.20	9.57	7.96
31.	25/6/96	95	238	27.57	6.86	2.53
32.	2/7/96	74	355	27.67	5.86	1.13

Table 2 (continued).

Week	Collected date	*P. xylostella*	*S. litura*	Temp.	% RH	Rainfall
33.	9/7/96	88	613	28.07	2.14	3.51
34.	16/7/96	208	415	28.41	5.71	5.14
35.	23/7/96	279	178	27.81	77.43	2.57
36.	30/7/96	54	320	26.00	83.71	5.21
37.	6/8/96	82	348	26.74	81.57	7.06
38.	13/8/96	6	275	27.43	77.86	0.63
39.	20/8/96	40	346	26.19	85.14	4.29
40.	27/8/96	52	182	25.70	84.43	15.56
41.	3/9/96	48	103	26.76	81.29	10.50
42.	10/9/96	7	207	26.96	77.71	8.47
43.	17/9/96	9	135	27.11	83.14	7.94
44.	24/9/96	9	221	27.13	83.86	1.49
45.	1/10/96	1	226	26.76	81.86	8.10
46.	8/10/96	8	80	26.80	81.00	14.41
47.	15/10/96	10	34	26.56	80.14	12.71
48.	22/10/96	26	109	26.69	77.14	4.69
49.	29/10/96	54	97	26.29	75.57	0
50.	5/11/96	13	235	26.01	80.71	0
51.	12/11/96	29	154	26.09	79.00	4.07
52.	19/11/96	72	118	24.79	76.29	0.06
53.	26/11/96	40	98	24.01	76.14	0
54.	3/12/96	32	40	24.36	75.00	0
55.	10/12/96	40	211	24.41	78.43	0
56.	17/12/96	51	260	23.03	74.00	0
57.	24/12/96	87	356	21.40	70.29	0
58.	31/12/96	201	269	20.24	66.43	0
59.	7/1/97	385	335	20.00	67.29	0
60.	14/1/97	526	260	20.41	67.43	0
61.	21/1/97	323	275	21.07	64.57	0
62.	28/1/97	368	93	21.10	61.14	0
63.	4/2/97	521	143	22.03	60.14	0
64.	11/2/97	390	184	21.16	52.71	0
65.	18/2/97	319	144	22.54	51.43	0
66.	25/2/97	314	91	23.39	52.00	0
67.	4/3/97	471	169	24.43	51.86	0
68.	11/3/97	388	150	26.17	52.57	0

Table 2 (continued).

Week	Collected date	*P. xylostella*	*S. litura*	Temp.	% RH	Rainfall
69.	18/3/97	542	135	26.87	48.57	0
70.	25/3/97	549	63	28.37	52.57	0
71.	1/4/97	160	41	27.26	60.71	0.96
72.	8/4/97	136	117	27.61	53.86	0.50
73.	15/4/97	131	114	27.06	56.00	0.44
74.	22/4/97	278	139	28.40	61.86	4.26
75.	29/4/97	330	365	25.69	70.86	6.76
76.	6/5/97	143	79	29.06	60.29	0.06
77.	13/5/97	163	45	31.06	59.80	0
78.	20/5/97	287	179	30.59	60.29	1.19
79.	27/5/97	44	98	28.37	72.00	6.74
80.	3/6/97	76	73	28.90	70.43	1.23
81.	10/6/97	73	30	29.33	66.29	0.53
82.	17/6/97	59	103	29.49	66.29	0.07
83.	24/6/97	77	80	28.73	70.43	3.30
84.	1/7/97	136	106	29.16	69.86	0.07
85.	8/7/97	125	38	28.53	69.71	0.11
86.	15/7/97	112	129	28.96	72.71	0.81
87.	22/7/97	80	123	28.36	75.86	6.24
88.	29/7/97	132	49	27.31	85.00	20.31
89.	5/8/97	146	74	27.39	83.86	7.00
90.	12/8/97	108	71	28.04	79.71	3.67
91.	19/8/97	9	215	27.41	81.43	2.56
92.	26/8/97	83	117	28.04	77.57	10.50
93.	2/9/97	41	121	26.77	86.00	9.33
94.	9/9/97	15	115	26.24	84.43	1.91
95.	15/9/97	22	126	27.74	74.86	0.16
96.	23/9/97	68	7	27.79	77.86	2.63
97.	30/9/97	26	56	26.09	84.14	14.27
98.	7/10/97	98	99	26.81	83.43	12.91
99.	14/10/97	45	61	26.66	80.57	3.53
100.	21/10/97	81	44	27.14	77.29	0
101.	28/10/97	58	34	27.76	74.00	4.99
102.	4/11/97	39	33	25.14	73.57	0.01
103.	11/11/97	25	193	22.87	80.00	0.13
104.	18/11/97	120	76	25.83	74.00	0.19
105.	25/11/97	153	115	26.26	76.00	1.66

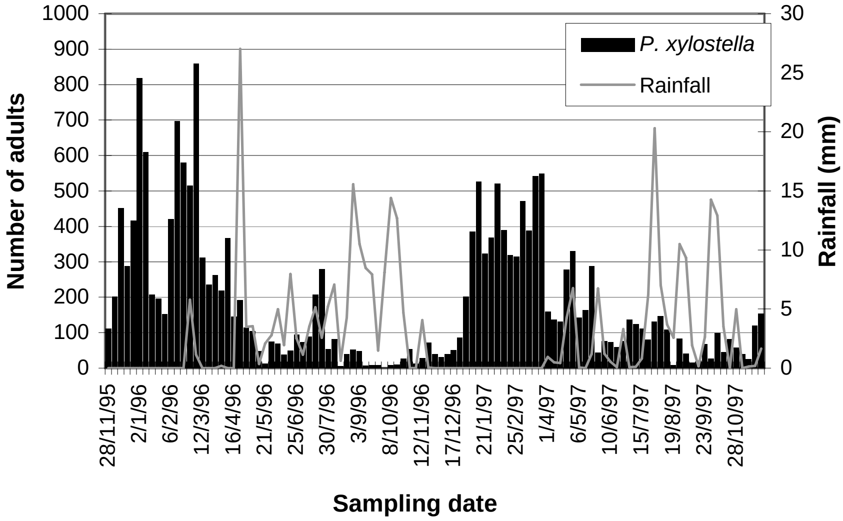

Figure 3 **Number of *P. xylostella* adults collected from pheromone trap at weekly intervals in relation to rain precipitation, during 1995-1997, Sarapee, Chiang Mai.**

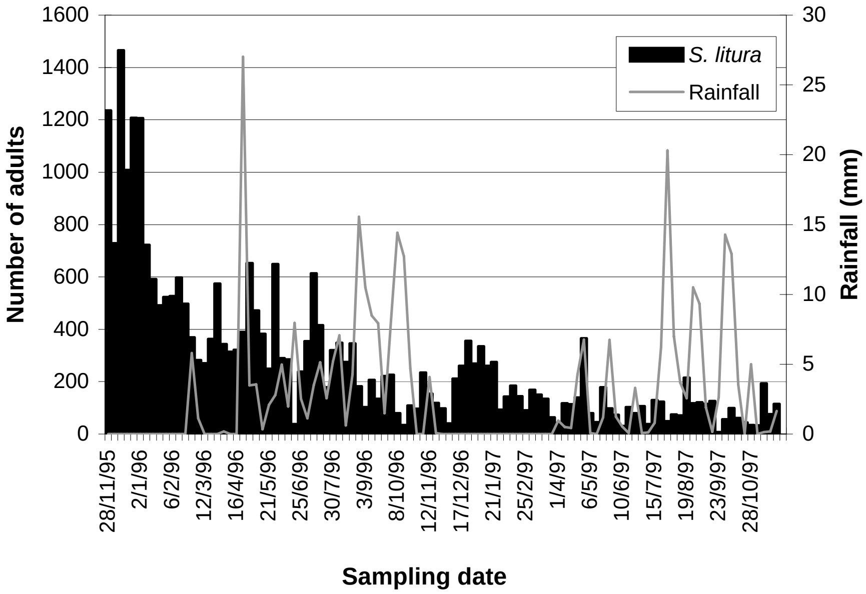

Figure 4 **Number of *S. litura* adults collected from pheromone trap at weekly intervals in relation to rain precipitation, during 1995-1997, Sarapee, Chiang Mai.**

The relationship of DBM and CW adult populations to the rain precipitation are graphically illustrated in Figures 3 and 4, respectively. Although the temperature, relative humidity, and the rainfall exhibited inconsistently correlated with the DBM and CW adult populations, the rain precipitation seemed to exert the negative correlation with the DBM adult population. This insect population remained low throughout the rainy seasons of both 1996 and 1997 growing seasons.

The DBM and CW synthetic sex pheromones provided significantly detection of the adult insect pest population dynamics in accordance with the meteorological factors, hence, the proper treatment procedures can be instituted to prevent the key pests from reaching the economic injury level. The application of sex pheromone-baited trap has been instrumental in increasing the effectiveness of both monitoring insect populations and in providing adequate information to enable implementation of cost effective control.

Research works on pheromonal control of DBM and other cruciform pests are currently very active in Japan. Nemoto *et al.* (1992) stated the insect pests which were resistant to insecticides could be controlled by pheromones. The pheromone reduced the frequency of insecticide applications to control DBM, though they could not control other pests. Pheromone and chitin synthesis inhibitors which are harmless to beneficial arthropods are regarded as main chemicals acceptable in management of cruciform pests. Ohbayashi *et al.* (1992) reported all synthetic sex pheromone has no insecticidal action; therefore, if the insect pest population increases during the application of sex pheromone, use of insecticides may be necessary. They also added that sex pheromone usage can reduce the need for insecticide application to less than a half. Ohno *et al.* (1992) concluded the total dose of the synthetic sex pheromone released from the dispenser (SSPD) is high in summer than in winter, hence, the efficacy of controlling DBM by the communication disruption method using SSPD is not affected by meteorological or topographical conditions. Wakamura and Takai (1992) discussed the evaluation techniques on the effects of sex pheromone treatment and the feasibility of using as a communication disruption agent for controlling the beet armyworm, *Spodoptera exigua* (Hübner). Recently, Howse *et al.* (1998) provided excellent detailed information on insect pheromones and their application in insect management. Little works on this subject area have been observed in Thailand; hence, additional researches in this interested field should be further evaluated in the future.

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