Present Status of Insecticidal Control of Diamondback Moth in Thailand

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Abstract

This paper gives a brief history of insecticide use against diamondback moth, *Plutella xylostella* (L) in Thailand from 1965 to 1984. Field observations indicated that the insect has developed resistance to all groups of chemical insecticides. High incidence of resistance was common on established vegetable farms where this insect had been exposed to many chemical insecticides over several years. The commercial bacterial insecticide, *Bacillus thuringiensis* Berliner, is also used. Its performance varies, due presumably to the influence of irrigation practices. Two recent (1983-1984) field tests, involving 11 insecticides belonging to various groups, conducted in the central plain where this insect has developed high levels of resistance, indicated that insect growth regulators (Tefluron and Triflumuron) give excellent control while the others are less effective. The bacterial insecticides Bactospeine still gave satisfactory control at two locations.

Introduction

Cabbage, kale, edible rape, Chinese cabbage, leaf mustard, Chinese radish, and cauliflower are common cruciferous vegetables in Thailand. Based on cultural practices adopted, commercial vegetable growing areas of Thailand can be classified into three categories. The first category consists of areas where the cruciferous vegetables are planted year-round and suburban areas where the majority of growers have been earning their living by the sale of the vegetables to urban markets for a number of decades. The second category includes the highland areas of the country. Cruciferous vegetables grown at high elevation are mostly cabbage, Chinese cabbage, and cauliflowers. Crops are normally planted for six months particularly during the rainy season when vegetables fetch better prices. The third category includes annual crops where a variety of crucifers are sporadically grown during winter season. The problem of diamondback moth (DBM), *Plutella xylostella* L (Lepidoptera: Yponomeutidae), in Thailand varies according to the cropping pattern described above. This paper describes the status of DBM and its control by insecticides in Thailand from the early 1960s and discusses the present status of insecticidal control and examines remedy for the pesticide use problem in the country.

Seasonal Occurrence and Pest Status

Normally DBM in Thailand is prevalent from February to April when optimum climatic conditions and food plants are more readily available. However, in many areas of the central plain where crucifers are planted year-round, DBM damage can be observed throughout the year and it is in this area that the insect has been the most serious threat to cruciferous crops for many years. The problem in this area is the excessive use of insecticides which has resulted in the build-up of resistance to various chemicals and makes control of this insect difficult. Crucifers grown in the highlands are subjected to a lesser degree of damage except during the brief peak outbreak periods of the year. In the lowlands the DBM problem is much less severe as compared to the other areas, possibly due to rotation with other crops.

Insecticide Use 1965-1984

Insecticides of both chemical and non-chemical origin have been introduced and evaluated extensivety since the early 1960s. A summary of field screening tests (Table 1) indicated that during 1965-1968, malathion, mevinphos, endrin, naled, azinphos-ethyl and carbaryl were tested in the northern area. All products, except carbaryl, showed good efficacy against DBM. Efficacy of mevinphos and parathion, as well as the newly introduced quinalphos, were evaluated between 1969 and 1971 in the central region where good DBM control was obtained. A few years later, based on field studies, methamidophos, acephate, and cartap gave better DBM control while quinalphos and mevinphos still retained effectiveness. The first field test of methomyl was carried out in the early 1970s. The product failed to give adequate control. Excellent control of DBM by triazophos and prothiophos was first obtained in 1974 in the northern area (Table 1). These two chemicals were also excellent in DBM control in the central region for a number of years (1975-1978). Recent field evaluation (1982-1984) has indicated that the efficacy of prothiophos was reduced in the central area but it still gave satisfactory control of DBM infesting annual crucifer crops.

Insecticidal control of DBM in Thailand entered the new era of synthetic pyrethroids in 1976 when fenvalerate and permethrin gave impressive control of the pest in Bangkok suburban areas. Cypermethrin and deltamethrin were among other pyrethroids that were introduced later. These four insecticides were used extensivety for two to three years before DBM showed resistance to them. From recent field tests (1982-1984) it appears that those four synthetic pyrethroids are no longer effective in the central area but still give fair control in areas where crucifers are grown once a year. Profenofos, another new insecticide introduced in the late 1970s, showed excellent effectiveness in the central area during 1977-1978 tests but gave rather poor control in the same area in 1983. Insecticide control of DBM in the central area during 1978-1982 mostly involved the spraying of mixtures of pyrethroid and other chemicals. At this time the latest generation of chemical insecticides, insect growth regulators (IGRs), were introduced to vegetable growers. Diflubenzuron was the first to be released directly to growers, followed by triflumuron. The efficacy of the four insect growth regulators diflubenzuron, trifluron, triflumuron and chlorfluazuron was therefore evaluated in the field in 1983. Two newer products, tefluron and chlorfluazuron, were very effective in DBM control at much lower rates as compared to triflumuron and diflubenzuron. Tefluron became a leading IGR for DBM control in the central plain.

The microbial insecticide *Bacillus thuringiensis* (*Bt*), has been used in DBM control since 1972. Most commercial *Bt* products available belong to strain HD-1, variety *Kurstaki*, serotype 3a 3b. Field evaluation of these products in 1982 (Table 1) showed most promising results in the northern area while in the central plain the efficacy was rather erratic. Among the major factors that could contribute to the successful utilization of this microbial insecticide in Thailand, as pointed out by Rushtapakornchai et al (1984), are loss of efficacy prior to application and irrigation practices, as well as extreme climatic conditions after the treatment. Rustapakornchai et al (1982) have developed action thresholds for DBM on cabbage in the north by using *Bt*. It was found that if a decision to spray is made at three larvae per plant before heading, and 10 larvae per plant from heading to harvest, the number of treatments can be reduced without loss of marketable yield.

Table 1. Summary of results of field screening of various insecticides in Thailand during 1965-1984

Insecticides	Year of introduction and use[a]																			
	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
Malathion	3C	3N	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mevinphoos	4C	4N	—	—	—	—	4C	4N	—	2N	3N	—	—	—	—	—	—	—	—	1C
Naled		3N	—	—	—	—	—	2N	—	—	—	—	—	—	—	—	—	—	—	—
Quinalphos					4C	—	—	—	—	4C	—	—	—	—	—	—	—	—	—	—
Parathion							2C	—	—	—	—	—	—	—	—	—	—	—	—	—
Methomyl								2N	—	—	—	—	—	—	—	—	—	—	—	—
Methamidophos								3N	—	3N	2N	—	—	—	—	—	—	—	—	—
Acephate								3N	—	—	2N	—	—	—	—	—	—	—	—	—
										3N	—	—	—	—	—	—	—	—	—	—
Biotrol								3N	3N	2C+	—	—	—	—	—	—	—	—	—	—
Disidrin									2N	2C	—	—	—	—	—	—	—	—	—	—
										2N+	—	—	—	—	—	—	—	—	—	—
Dipel									2N	2N	—	—	—	—	—	—	—	—	—	—
										1C	—	—	—	—	—	—	—	—	—	—
Cartap										3N	—	—	—	—	—	—	—	—	—	—
										3C	—	1C	—	—	—	—	—	—	—	—
Triazophos										3N	3N	3C	4C	4N	—	—	—	—	—	—
Prothiophos											4C	4N	—	4C	—	—	—	4N	—	1C
Monocrotophos											1N	—	—	—	—	—	—	—	—	—
Fenvalerate												4C	3C	4N	—	—	—	3N	—	—
														2C	—	—	—	—	—	—
Permethrin												4C	—	2C	—	—	—	—	—	—
Cyanofenphos													3C	3C+	—	—	—	—	—	—
Profenofos													3C	3C	—	—	—	—	2C	—
Cypermethrin														2C	—	—	—	—	1C	—
Deltamethrin														2C	—	—	—	—	2C	1C
Thuricide															2C	—	—	3N	2C	—
Bactospeine																		3N	2N	2C
Agrona																		2N	2C	—
Diflubenzuron																		3N	3C	—
																			1C+	—
Triflumuron																		3N	2C	1C
Tefluron																			3C	4C
Chlorfluazuron																			4C	—

[a] 1 = poor control, 2 = fair control, 3 = good control, 4 = excellent contorl. C = central region including Bangkok suburbs, N = northern region. + Mixed with other insecticides.

Present and Future Trends in Insecticide Use for DBM Control

Results of the field test in 1984 in the central vegetable area involving 11 insecticides belonging to six chemical groups emphasised the present and future status of insecticide use for the control of insecticide-resistant DBM strains. Data in Tables 2 and 3 shows that IGRs give excellent DBM control. Tefluron, at the rate of 0.05 kg AI/ha and Triflumuron, at 0.375 kg AI/ha performed well. Triflumuron was excellent at one location but did not do well at another. The synthetic pyrethroid deltamathrin

Table 2. Evaluation of insecticides for control of DBM on Chinese cabbage at Kumpangsan Campus, Kasetsart University, Nakornpathom Province[a-f]

Insecticides	Rate kg AI/ha	No. DBM larvae/10 plants at DAT[g] 13	22	31	40	Yield t/ha
Rotenone	5.00	102.00	41.60abc	26.30ab	31.00ab	15.61
Tobacco (extract)	84.00	100.60	49.60bcd	48.00bc	43.00abc	18.68
Nevinphos 24EC	1.00	102.30	88.30def	61.00cd	58.30bcd	15.24
Prothiophos 50EC	1.00	99.60	122.30f	101.00e	101.30f	15.12
Carbaryl 43.4SC	2.00	111.30	96.30ef	102.00e	185.00g	12.17
Methomyl 90SP	0.50	119.30	120.60f	87.60de	98.30ef	12.78
Deltamethrin 3EC	0.025	70.60	104.60ef	94.00de	86.00def	14.50
Tefluron 5EC	0.05	108.60	6.66a	1.30a	5.30a	19.42
Bactospeine[h] SC	1.50	108.30	12.60ab	6.30a	6.00a	13.28
Triflumuron 25WP	0.375	96.30	4.00a	7.00a	8.30a	17.33
ENZ#1 50EC[i]	1.00	102.30	43.30abc	26.00ab	40.60abc	16.47
Control	—	130.30	63.00cde	50.00bc	59.60bcd	14.87

[a] Cultivar: Local. [b] Transplanting date: 15 May 1985. [c] Insecticides applied: 30 May, 4, 8, 12, 16, 20, 24, 28 June and 2 July 1984. [d] Harvested: 7 July 1984. [e] Data are mean of three replicates. Means in each vertical column followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test. [f] Plot size: 17.50 sq m. [g] Days after transplanting. [h] *Bacillus thuringiensis*. [i] Code number given by Entomology and Zoology Division, Department of Agriculture, Thailand.

Table 3. Evaluation of insecticides for control of DBM on Chinese cabbage at Paseejaroen District, Bangkok[a-f]

Insecticides	Rate kg AI/ha	No. of DBM larvae/10 plants at DAT[g] 24	35	46	Yield t/ha
Rotenone	5.00	0.00	8.25h	43.75e	12.47
Tobacco (extract)	84.00	0.00	7.25ef	24.00cd	12.60
Mevinphos 24EC	1.00	0.50	8.50h	29.25d	12.75
Prothiophos 50EC	1.00	0.00	7.50g	26.75d	14.06
Carbaryl 43.4SC	2.00	0.25	7.75g	22.25cd	11.92
Methomyl 90SP	0.50	0.75	7.75g	31.75d	11.09
Deltamethrin 3EC	0.05	0.00	7.50g	30.25d	12.91
Tefluron 5EC	0.05	0.00	0.00a	1.50a	13.69
Bactospeine[h] SC	3.00	0.00	6.25e	17.50bc	14.34
Triflumuron 25WP	0.373	0.00	5.50d	22.50cd	14.50
ENZ#1 50EC[i]	1.00	0.00	6.75f	12.50b	14.15
ENZ#1 50WP[i]	1.00	0.00	0.75b	3.25a	14.61
ENZ#1 1.8LC[i]	0.18	0.00	4.50cd	25.50cd	12.46
ENZ#1 1.8LC[i]	0.36	0.00	2.00bc	16.00bc	12.34
Control	—	0.00	8.50gh	26.25d	11.77

[a] Cultivar: Local. [b] Sowing date: 25 June 1984. [c] Insecticides applied: 20, 24, 28 July, 1, 5, 9 and 13 August. [d] Harvested: 84/8/17. [e] Data are mean of four replicates. Means in each vertical column followed by same letter are not significantly different at the 5% level according to Duncan's multiple range test. [f] Plot size: 10 sq m. [g] Days after transplanting. [h] *Bacillus thuringiensis* Berliner. [i] Code number given by Entomology and Zoology Division, Department of Agriculture, Thailand.

when applied at 0.025 kg AI/ha gave poor DBM control at both locations. Two organohposphorus products, mevinphos and prothiophos, which in the past were used extensively, afforded poor control. Carbamates such as methomyl and cabaryl also gave poor control. ENZ -1, an organophosphorus insecticide, gave fair control when applied at the rate of 1 kg AI/ha. The two botanical insecticides, rotenone and nicotine sulphate (tobacco leaf extract), when applied at high rates gave fair control in one location but failed at another. The only bacterial product, Bactospeine, when applied at the rate 1.50 and 3.0 kg product/ha gave good DBM control in both tests. For the present and near future, in the highlands and in the areas where crucifers are grown once a year and where insecticide pressure is generally lower, the DBM control by insecticides is less complicated as certain commonly used insecticides still give good control. This trend can be observed from 1982 field reports described in Table 1. A number of chemicals that failed to control DBM in the central area performed better at other areas. In areas of continuous crucifer cultivation, however, only IGRs show promise in DBM control.

Present Research to Tackle the Pesticide Use Problem in Thailand

Since the tropical climate and the continuous cultivation of crucifers in Thailand is conducive to DBM infestation and rapid multiplication, this pest has been a serious problem for the past several years. Because of the rapid turnover of generations, DBM develops resistance to chemical insecticides rather quickly. In order to combat the DBM pest problem, the following long range research projects are presently being under taken by the Department of Agriculture.

1. Studies of control thresholds for DBM on major cruciferous crops. 2. Studies of the dynamics of DBM and its parasite populations on cabbage in the highlands. 3. Studies of the effect of insecticides on the parasites of DBM in the field. 4. Studies into improving the potential of commercial products of *B. thuringiensis* in the field. 5. Studies into the potential use of sex pheromones for mass trapping of DBM adults. 6. Studies of the potential of insect growth regulators for integrated control of DBM.

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