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Management of Diamondback Moth with *Cotesia plutellae*: Prospects in the Philippines

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Abstract

An indigenous *Cotesia plutellae* Kurdjumov was recorded for the first time in 1982 in Baguio City, Benguet and Mountain Province. The low level parasitism (1.9-16.5%) of diamondback moth (*Plutella xylostella* (L.)) by this parasite is due to the hyperparasite (*Trichomalopsis* sp.), and the entomophagous fungus, *Erynia* sp. and frequent insecticidal applications. Indigenous *C. plutellae* was absent in the lowland cruciferous farms in Laguna, Cavite, Misamis Oriental and Bukidnon from August 1989 to July 1990. Three to four releases of *C. plutellae* imported from Taiwan at the rate of 3000/release/ha and integrated with 1-2 sprayings of *Bacillus thuringiensis* Berliner based on economic threshold level (ETL) reduced the population of diamondback moth in two successive plantings in Nagcarlan. The average parasitism was 17.4% and 36.5% in the first and second planting, respectively. Parasite cocoons were found in the nearby fields where the parasite was not released. The demonstration field is being maintained while other demonstration fields are to be set up in other towns. Our available data indicated that *C. plutellae* can be integrated with *B. thuringiensis* in controlling diamondback moth. The establishment of *C. plutellae* could be delayed by hyperparasite and infection by *Erynia* sp. Therefore, there is a need to introduce other parasitoids to supplement *C. plutellae*, preferably ones that could also parasitize *Crocidolomia binotalis* (Zeller).

Introduction

Cruciferous vegetables, cabbage (*Brassica oleracea* var *capitata* L.), petchay (*Brassica campestris* var. *chinensis*), raddish (*Raphanus sativus* L.) and mustard (*Brassica juncea* L.) are economically important in the Philippines. The area devoted to these vegetables in 1986 was 14,400 ha with a production of 135,130 t (Valmayor and Tiamzon 1988). Other crucifers grown are broccoli (*Brassica oleracea* var. *botrytis* L.) and cauliflower (*Brassica oleracea* var. *botrytis* L.).

One of the constraints in the production of cruciferous vegetables is the infestation of a group of insect pests; diamondback moth (DBM), *Plutella xylostella* (L.) (Lepidoptera: Yponomeutidae), the cabbage moth (*Crocidolomia binotalis* L.), the flea beetles (*Phyllotreta* spp.), common cutworm (*Spodoptera litura*), aphids and others. These insects greatly reduce both yield and quality of the produce.

DBM is the most important limiting factor in the production of cruciferous vegetables in the Philippines. The larva feeds on the foliage from seedling to harvest causing 100% yield loss if not controlled. Farmers rely mainly on chemical pesticides for its control resulting in the development of resistance to practically all insecticides used. The heavy usage of pesticides kills the predators and parasites which used to contribute to the reduction of the DBM population and other pests. The destruction of the natural enemies causes the resurgence of the minor pests. These problems are becoming more severe each year, hence, restoration of the active role of biocontrol agents is seen as one way to minimize the present dependence on chemical pesticides.

Cotesia plutellae Kurdjumov (Hymenoptera: Braconidae), a solitary and DBM-specific larval parasitoid is found in subtropical and tropical countries. Results of various studies in other countries showed that the parasitoid disrupts the population of DBM in the field (Lim 1982; Feng and Wang 1984). In Taiwan it regulates the DBM population by supplementing with *Bacillus thuringiensis* var. *kurstaki* (AVRDC 1990).

This paper will discuss the presence of indigenous *C. plutellae* and its potential as a component in the management of DBM in selected lowland and mid-elevation areas in the Philippines.

Presence of Indigenous *C. plutellae*

Velasco (1982) documented the presence of *C. plutellae* for the first time in Baguio City and La Trinidad, Benguet, at an elevation of 1800 m. Poelking (1989) found this parastioid in Atok, Mountain Province. Velasco (1983) assessed its field performance along with that of fungus *Erynia* sp. in Baguio where it has so far been reported. Parasitization rate in the field ranged from 1.9 to 16.5% in the Velasco (1983) study, whereas in Poelking's (1989) study it was 0.2-50% in Benguet. Velasco attributed the low parasitism of *C. plutellae* to the presence of a hyperparasite (*Trichomalopsis* sp.) and the parasitic fungus *Erynia radicans* (Bufeld), and to the frequent insecticidal applications.

A survey was conducted from August 1989 to July 1990 to determine the presence of indigenous *C. plutellae* in selected lowland and mid-level crucifer-growing areas (Fig 1). Fifty cabbage plants at various locations were examined and the number of *C. plutellae* cocoons recorded. Likewise, 50 fourth instar DBM larvae were collected randomly from the field and reared in the laboratory. The number of parasitoid cocoons recovered from the culture was noted.

No parasitoid cocoons were collected or recovered from the cabbage/petchay farms in Laguna (Nagcarlan, Liliw, Majayjay, Los Baños, and Cabuyao), Cavite (Silang and Tagaytay), Misamis Oriental (Claveria) and Bukidnon (Lantapan). These areas showed heavy populations of DBM. Generally, plantings during May-September were less infested by DBM than those planted from November to March.

The use of insecticides is the only means utilized by farmers to control this pest. Most of them spray their cabbage/petchay at least once a week and even 2-3 times a week if the DBM population is extremely high for a total of 10-16 times/cropping. The repetitive and heavy application of insecticides employed by farmers appears to be the main reason why the indigenous *C. plutellae* was not encountered in the surveyed farms.

Importation and Mass Production

Taiwan strain of *C. plutellae* was introduced from AVRDC and reared at the Department of Entomology, University of the Philippines at Los Baños (UPLB), Philippines.

The distinguishing characteristics of *C. plutellae* from Taiwan and the local strain are: the Taiwan strain is yellowish whereas the local strain is dirty white and the size of the former is 3.1 mm while that of indigenous one is 2.5 mm. Based on Poelking's (1989) laboratory study, the imported strain also gave better parasitism (17.3-40%) compared to the local strain (13.8-33%).

The imported parasitoid was mass-reared for at least one generation (F_1) before being released in the field. Based on the series of mass-rearing, the developmental period of the imported parasitoid in the laboratory ranged from 7 to 10 days (egg to pupae). This is similar to the report of Lim (1982) of an average period of 9 days. Presently, the mass production/rearing capacity is only 1000-2000 cocoons/week but it has to be increased to expand the release area.

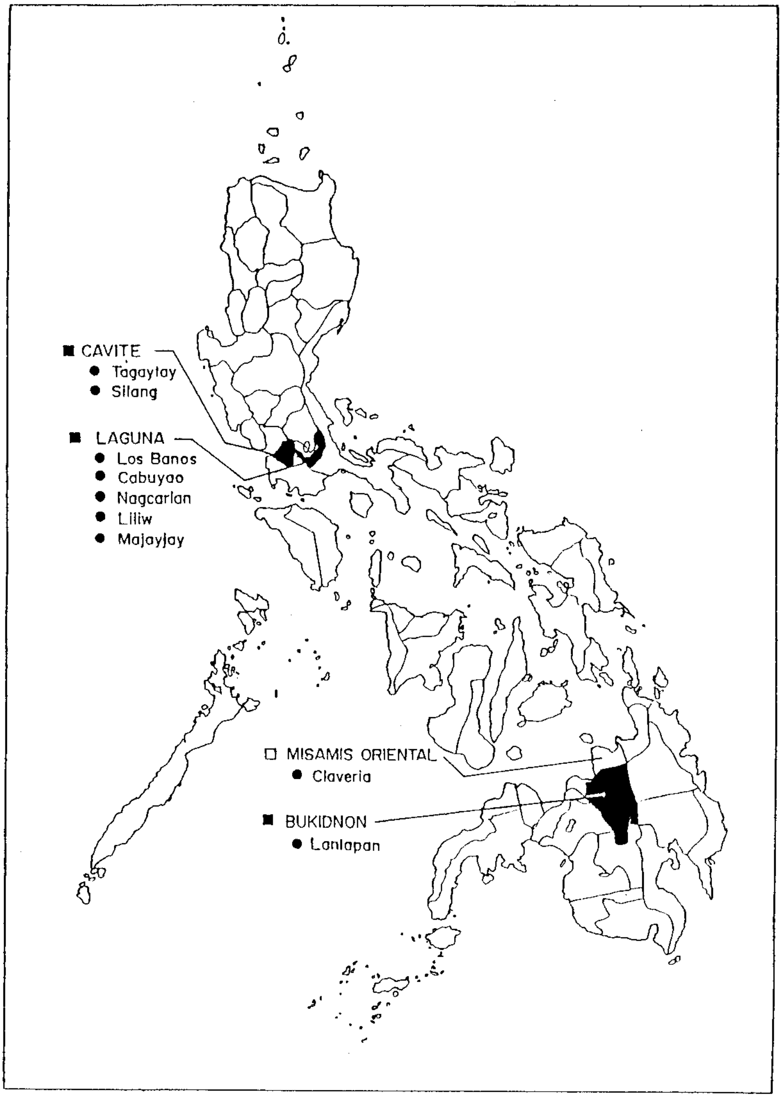

Fig. 1. Areas surveyed for indigenous *C. plutellae*.

Our problems in mass-rearing are: diseases, and abnormal development of the parasitoid and DBM host because of continuous rearing. These may affect the vigor and activity of the parastitoid. To minimize these problems, the culture stocks of the host (DBM) and the *C. plutellae* are periodically changed by new stocks, collected from the release areas or imported from AVRDC. On the other hand disease infection was prevented through proper sanitation in the laboratory.

Field Releases of Taiwan Strain *Cotesia plutellae*

A demonstration field is located at Nagcarlan, Laguna (Fig. 2), at an elevation of 600-800 m. The temperature ranges from 15 to 30°C, the lowest during November-January and the highest

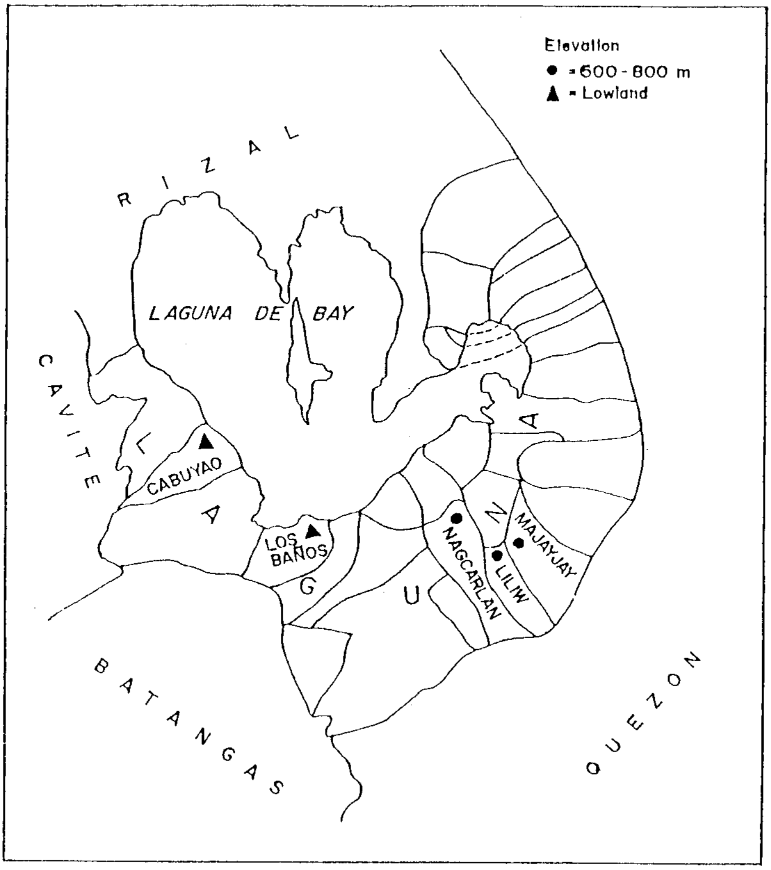

Fig. 2. The parasitoid release area in Laguna. Existing area Future.

during March and April. Cruciferous vegetables are grown sporadically and the area devoted to these crops is about 216 ha/year, including the nearby towns of Liliw and Majayjay (PAO 1990). They are planted in the traditional growing areas or newly cleared forest throughout the year. However, more cabbage is planted during October-February than in other months.

The 1000-2000 m^2 demonstration field was set up at Barangay Bukal, Nagcarlan (Fig. 3). The field was planted with cabbage (Scorpio and Kabuko) for two croppings. The cocoon or adult parasitoids were released starting at 3-4 weeks after the first planting and ending about 8 weeks after the second planting. Three and four releases were made during the first and second plantings, at the rate of 3000 cocoons/release/hectare. *Bacillus thuringiensis* was applied when the population of DBM increased above the recommended economic threshold level (more than 2 (3rd or 4th instar) larvae/plant at early stage and more than 5 (3rd or 4th instar) larvae/plant before heading).

The population buildup and parasitism of the introduced *C. plutellae* were monitored three weeks after the first release. Population buildup was determined by examining 50 plants with cocoons at 10-15-day intervals. For parasitism, 50 fourth instar DBM larvae were collected and reared in the laboratory. The number of parasitoid cocoons recovered were expressed in percent.

From the 2000-2500 cocoons introduced in the first planting (demonstration field) a total of 62 cocoons were recovered from six samplings but only two cocoons from farmers' fields (Table 1). The average parasitism in the demonstration field was 17.4% while in farmers' fields

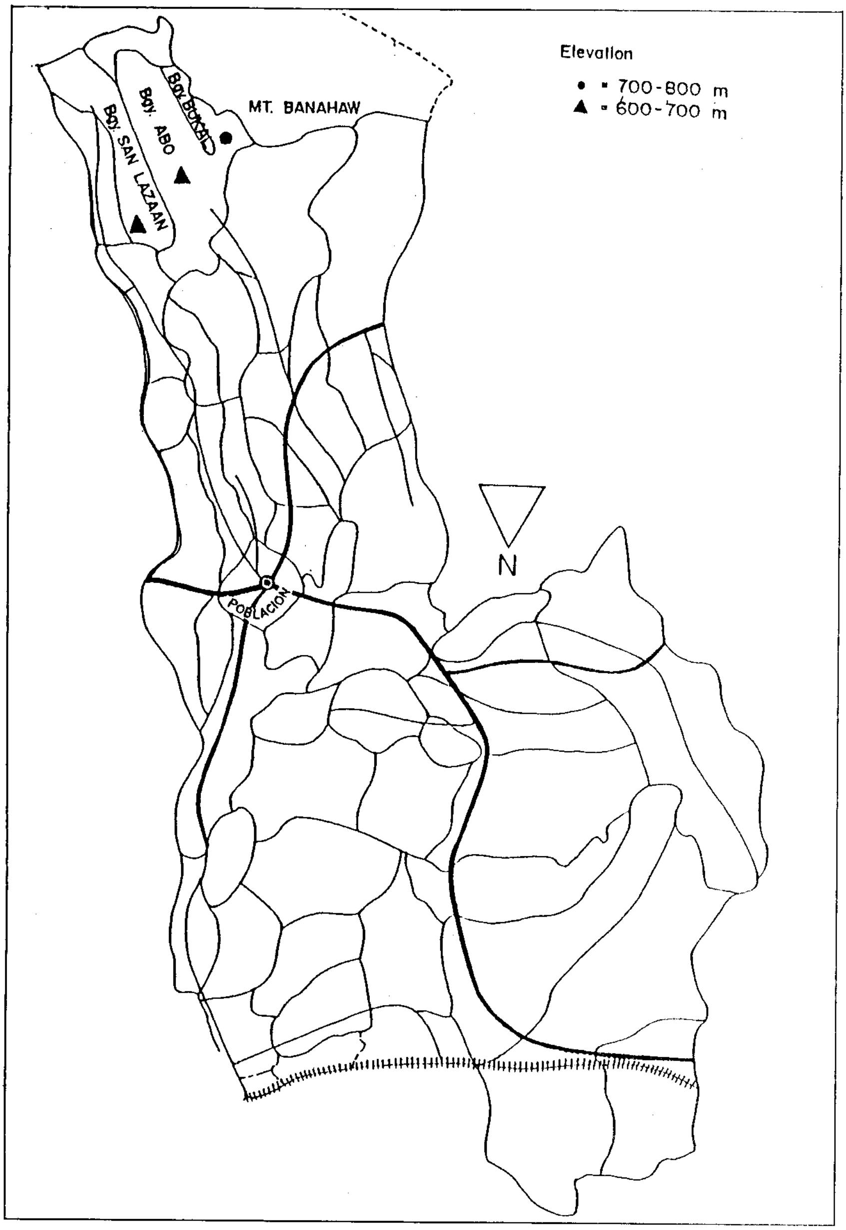

Fig. 3. The parasitoid release area in Nagcarlan. ● Existing area ▲ Future.

it was 0.7%. The low parasitism in farmers' fields was attributed to the intensive application of broad-spectrum insecticides.

Relatively more cocoons were recovered from the four releases during the second planting both from demonstration and farmers' fields. From the 2800 to 3000 cocoons introduced into the demonstration field, 140 and 134 cocoons were recovered from demonstration and farmers' fields, respectively. The total number of collected cocoons from both fields was almost the same at this planting but the average parasitism was still higher in the demonstration field with 36.5% but only 17.4% parasitism from farmers' fields. In the second planting, the number of cocoons

Table 1. Number of *C. plutellae* collected from cabbage fields at Nagcarlan, Laguna.

Observation date	Cocoons/50 plants and % parasitism			
	Demonstration field	% parasitism[a]	Farmers' field[b]	% parasitism
First Planting (8 Oct 1989)				
09 Nov 89*	0	0	0	0
21 Nov 89*	4	4.0	0	0
01 Dec 89*	6	16.3	0	0
15 Dec 89	14	20.8	0	0
22 Dec 89	6	20.8	0	0
03 Jan 90	32	42.5	2	4.2
Total	62	17.4	2	0.7
Second Planting (28 Dec 1989)				
16 Jan 90*	6	32.6	4	10.4
22 Jan 90*	30	53.2	24	8.0
01 Feb 90*	42	30.0	34	17.8
15 Feb 90*	34	32.0	37	26.7
01 Mar 90	28	35.0	35	24.0
Total	140	36.5	134	17.4

*Date of parasitoid releases (700 cocoons/release).
[a]Based on direct counting (50, 4th instar larvae) from the field. [b]200-300 m away from the demonstration field.

collected increased to 134 from three adjacent farmers fields 200-300 m away from the release site, compared to two cocoons in the first planting.

These farmers switched from chemical insecticides to *B. thuringiensis* during the second planting after seeing our demonstration plots. However, the parasitism in the farmers' fields was still lower than the demonstration field because of their intermittent *B. thuringiensis* sprayings. The DBM and *C. plutellae* populations and parasitism from the first planting (October 1989) to the third planting (March 1990) are shown in Fig. 4.

Generally, DBM populations in the demonstration field was lower than in farmers' fields (Fig. 4A). The presence of *C. plutellae* and the timely application of *B. thuringiensis* contained the population of DBM. With 11 parasitoid releases (from 1st to 3rd planting), a considerable increase of cocoons and parasitism were observed in demonstration and farmers' fields (Fig. 4B and C). The peak of parasitism was recorded in the first week of January (42%) and in May (78%). During these months, the application of insecticides ceases because the cabbage are about to be harvested. With the decrease of DBM population in the field the population of cabbage moth and cutworms (*Spodoptera* spp.) increased. This was followed by the low population of DBM in June. Also the plants during this period were stunted and infected with black rot disease. All the cabbage planted in Nagcarlan in July and August 1990, including our demononstration field, were destroyed by these pests and disease.

Constraints in Field Establishment of *C. plutellae*

Although the parasitism from the demonstration and nearby farmers' fields suggest that continuous introduction of *C. plutellae* with supplementary application of microbial insecticides could regulate the population of DBM, the establishment of this parasitoid in the field will be markedly affected by the following:

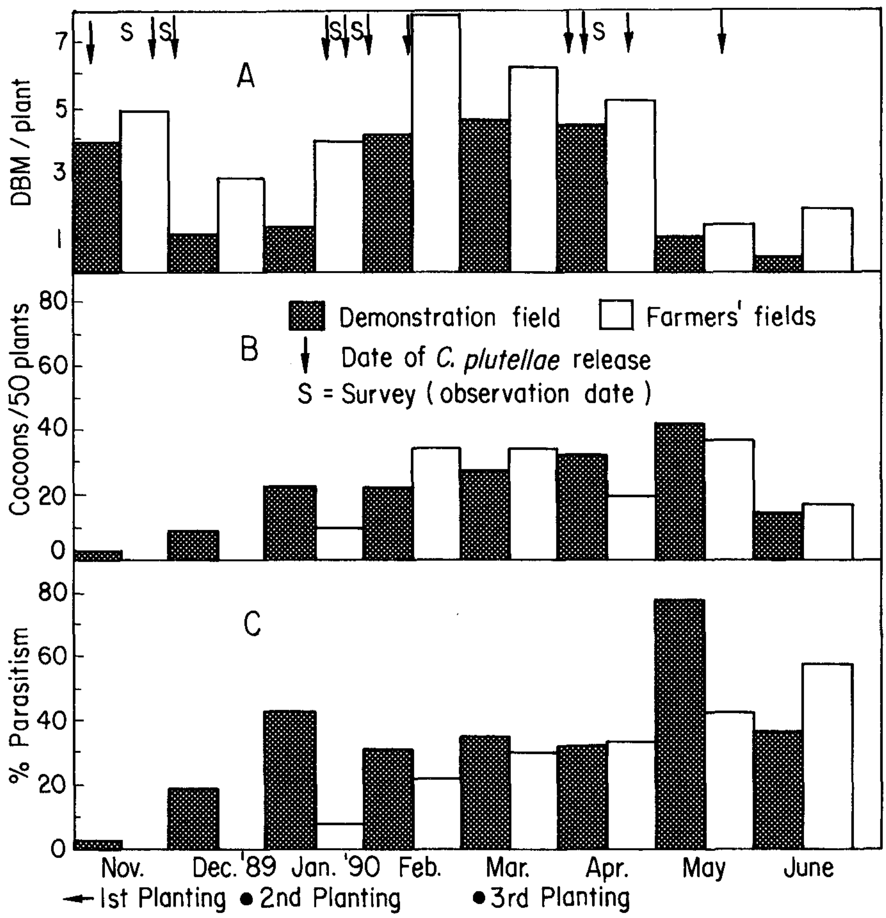

Fig. 4. Population of diamondback moth (A) and *Cotesia plutellae* (B) and parasitism of *C. plutellae* (C) in cabbage at Nagcarlan, Laguna.

1. The propensity of the farmers to use insecticides with knockdown effect, e.g. cartap, rather than slow-acting insecticides and the use of fungicides to control diseases of crucifers. For example copper oxychloride is slightly toxic to *C. plutellae* adults and lowers the parasitization rate (Salazar 1990).

2. The effect of microbial and insect growth regulator sprays in the development of the parasitoid on DBM larvae. These insecticides did not affect the parasitoid adult but considerably reduced adult emergence from the treated host (Salazar 1990).

3. The incidence of parasitic fungus (*Erynia radicans*), presence of hyperparasites (*Trichomalopsis* sp.) and climatic factors that affect the development of the host and the parasitoid.

4. The seasonal planting of cruciferous crops especially in the lowland which caused the disruption of the life cycle of the DBM host.

Recommendations

To hasten the adoption of the technology and the establishment of *C. plutellae* in the field, the following steps are recommended:

1. Set up more demonstration fields with continuous introduction of the parasitoids and conduct training seminars for farmers, emphasizing the importance and methods to preserve the parasitoid in the field.
2. The use of selective insecticides at minimum effective dose to allow the survival of not more than 50% of DBM for parasitization. Studies along this line should be conducted.
3. Develop a low-cost and efficient mass-rearing technique for the host and parasitoid for large-scale production.
4. Breed and select strains of parasitoids resistant to insecticides.
5. Import and search for more potent biocontrol agents to augment *C. plutellae* not only for DBM but also for *C. binotalis* and other cruciferous pests.

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