FIELD RELEASE OF THE PARASITOID DIADEGMA SEMICLAUSUM (HELLEN) (HYMENOPTERA: ICHNEUMONIDAE) AGAINST PLUTELLA XYLOSTELLA (L.) (LEPIDOPTERA: YPONOMEUTIDAE) IN SEED PETCHAY IN NORTHERN LUZON

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ABSTRACT

The purpose of the study was to evaluate the feasibility of an integrated pest control strategy in petchay seed production (Brassica chinensis L.). The major pest in this crop is Plutella xylostella (L.) (Lepidoptera: Yponomeutidae). The strategy comprised the larval parasitoid Diadegma semiclausum (Hellen)(Hymenoptera: Ichneumonidae) and biological insecticides based on Bacillus thuringiensis (Bt). As control threshold level (CTL) which would incite the Bt applications, 1 larva/plant was defined.

In November 1991 on six out of 86 farms engaged in contract farming for a seed company. The farms were located about 50 km north of Baguio covering an area of approximately 5375m) between 1820m and 2200m above sea-level. D. semiclausum was released in weekly intervals until establishment. One to three weeks after the initial release of the parasitoid the first Diadegma cocoons could be detected and three to five weeks later mass propagation occured on all the farms. Parasitization ratios increased from 0% at the beginning of the trials to 60%-90% at the time of the mass propagation of D. semiclausum an remained on this level up to the harvest. Dispersal of to other fields in the area could be established. The CTL was not exceeded by the DBM larvae, therefore no insecticides were applied. The absence of such control measures created favourable conditions for other lepidopterous pests like Heliothis armigera, Heliothis peltigera, Pieris rapae, Trichoplusia ni and Spodoptera litura, which built up in density. Despite damage caused by this pests the seed yields on the six farms were between 244 kg/ha and 332,5 kg/ha. The other 80 farms reached a mean yield of 288 kg/ha with the use of conventional pest control strategies.

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INTRODUCTION

Plutella xylostella (L.) (Lepidoptera: Yponomeutidae) commonly known as diamondback moth (DBM) is a major pest in cruciferous vegetables in Southeast Asia. Its control seems to come to a halt because the overuse of insecticides led to the development of resistance to a wide range of these chemicals (Sun 1992). New approaches to this problem are directing to integrated pest management (IPM) programs. Encouraging results of IPM-strategies are reported from Indonesia (Sastrosiswojo and Sastrodihardjo 1986), Malaysia (Ooi 1992) and Taiwan (Talekar et al. 1992). The permanent establishment of natural enemies of DBM in these countries and both the use of selective insecticides and economic threshold levels (ETL) have reduced spraying frequencies and thus resulted in lower insecticide usage.

In Benguet Provinc in Northern Luzon, where market oriented production of cruciferous vegetables is important, a high pesticide input is common (Magallona 1986). The Philippine-German Biological Plant Protection Project (PGBPPP)[3] started research focusing on the biological control of DBM in 1987 (Pag 1990).

The strategy currently tested within the framework of this project comprises the use of a natural enemy of DBM, the larval parasitoid Diadegma semiclausum (Hellen) (Hymenoptera: Ichneumonidae) and biological insecticides based on Bacillus thuringiensis (Bt) which are selective to lepidopterous pests and have a low toxicity to man (Krieg and Franz 1989). The strategy also inclues the use of threshold levels, which still have to be defined for the particular conditions in Benguet.

MATERIALS AND METHODS

In November 1991 trials were conducted in cooperation with four out of 86 farms producing petchay seeds (Brassica chinensis L.) for a seed company. In the course of the trials two more farms were included. The six farms were located around Sayangan, approx. 50km north of Baguio City. Four of these farms were located side by side on the same mountain slope, the other two lay apart from each other and at some distance from the four others as shown in Table 1.

3 This study was carried out in the framework of the Philippine-German Biological Plant Protection Project (PGBPPP), Deutsche Gesellschaft fuer Technische Zusammenarbeit (GTZ) GmbH

Table 1: Characteristics of the farms included in the trials on integrated pest management against DBM

Location[1]		Altitude	Area planted (in m^2)	No. of terraces	No. of plants
Farm 12	KM 46	1970	700	9	-
Farm 2	KM 47	1880	475	3	72
Farm 3	KM 47	1860	1000	5	145
Farm 4	KM 47	1860	1000	3	140
Farm 52	KM 47	1820	1000	6	
Farm 6	KM 53	2200	1200	9	172

1 location north of Baguio along the Halsema Highway (Mountain Trail)

2 farms were included in the course of the trials

On each terrace one sample plant per 7m} was tagged. The total number of DBM larvae, DBM pupae, cocoons of D. semiclausum and other lepidopterous larvae per sample plant were counted in weekly intervals. For the calculation of the parasitization ratio the following formula was used:

$$\text{parasitization ratio in \%} = \frac{\text{No. of Diadegma-cocoons}}{\text{No. of DBM-pupae} + \text{No. of Diadegma-cocoons}} \cdot 100$$

In the later stage of the crop, when it was not possible to enter the fields without causing much damage to the standing crop, parasitization ratios were estimated. This was done by walking along the terrace borders and comparing the numbers of Diadegma cocoons and DBM pupae at the tips of the petchay plants. This was possible because at this crop stage DBM larvae were feeding predominantly on the buds and pods of the petchay and pupating at the same part of the plants.

On the two farms included later in the trial no sample plants were tagged and only parasitization ratios were estimated.

Releases of D. semiclausum in the fields of the cooperating six farmers started by the end of November 1991 and were continued weekly until a permanent population seemed to be established. We released only adult wasps to ensure control over the sex ratio of the released parasitoids which was 2 females/1 male. Experiences from the mass rearing had shown that a ratio of 2 females/1 male results in 96-98% parasitization of DBM larvae. The insect material used for the field trials is reared at rearing facilities of the PGBPPP at the Benguet State University in La Trinidad.
The actual number of females released on the individual farms are listed in Table 2.

Table 2: Dates of release of Diadegma semiclausum and number of female wasps released on each farm

Date	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6
11/28	-	-	-	-	-	50
12/03	-	10	-	-	-	63
12/10	-	36	75	-	-	72
12/17	-	40	75	-	50	72
12/23	-	40	50	-	-	72
12/30	-	45	75	-	-	63
01/08	-	-	75	30	20	-
01/14	140	-	-	70	-	-
01/21	108	-	-	-	-	-
01/28	63	-	-	-	-	-

With biological control it is difficult to gain an instant control over the pest population (Krieg and Franz, 1989). Effects of the parasitization of DBM in our trials can be seen only in the next generation of the pest. To evaluate the efficacy of D. semiclausum for the determination of a threshold we considered the CTL (control threshold level) as more important than the ETL since the CTL puts the time until a control measure affects the pest population into consideration (Finch, 1987).

Since there were no pevious information on a realistic CTL in the area where the trials took place we defined a CTL by ourselves which we considered appropriate at this time. The decision was to spray DelfinR when the average exceeded one larva/plant.

RESULTS

The population dynamics of the pest and beneficial insect population during the trial period are shown in Figures 1 and 2 for Farm 2 and Farm 6, respectively.

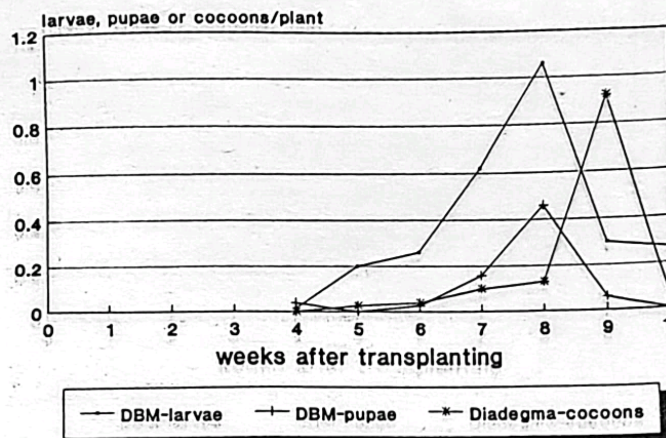

Fig.1: Dynamics of Diadegma and the larval and pupal stages of DBM on Farm 2

Eight weeks after transplanting (December 30), the number of DBM larvae/plant surpassed the assumed threshold of 1 larva/plant on Farm 2. However, we decided not to spray because the larvae had caused only minor damage to the leaves so far. Already one week after the initial release of the parasitoids, D. semiclausum could be found in the field building up in density as shown in Figure 1.

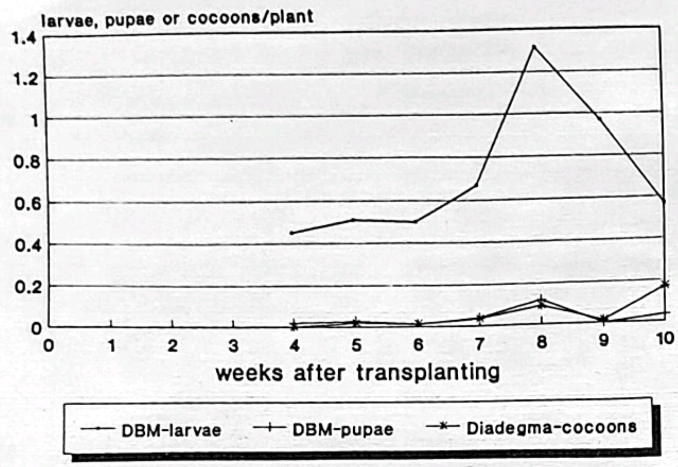

Fig.2: Dynamics of Diadegma and the larval and pupal stages of DBM on Farm 6

On Farm 6, the assumed CTL was exceeded in the eighth week (figure 2). Even though no Bt was applied either, the number of DBM larvae decreased during the following weeks. Unlike on Farm 2, the build up of D. semiclausum on these terraces was slow.

On the other farms the DBM larvae did not surpass the threshold. The parasitization ratios on all farms increased during the trial period and remained constantly between 60% and 90%, although the absolute number of DBM pupae and Diadegma-cocoons decreased (table 3).

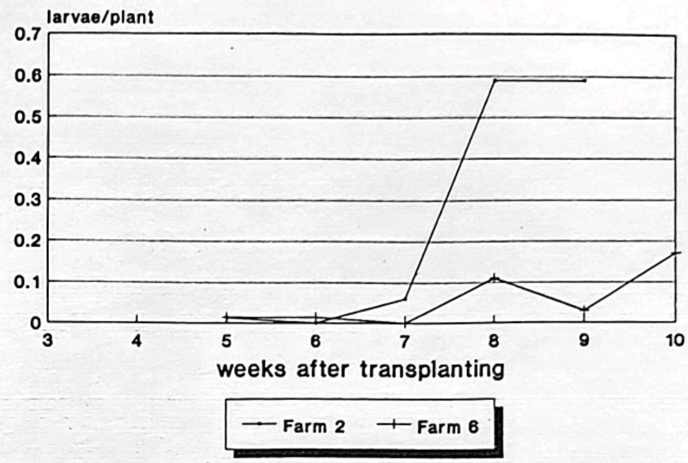

Fig. 3: Dynamics of the populations of other lepidopterous pests on Farm 2 and Farm 6

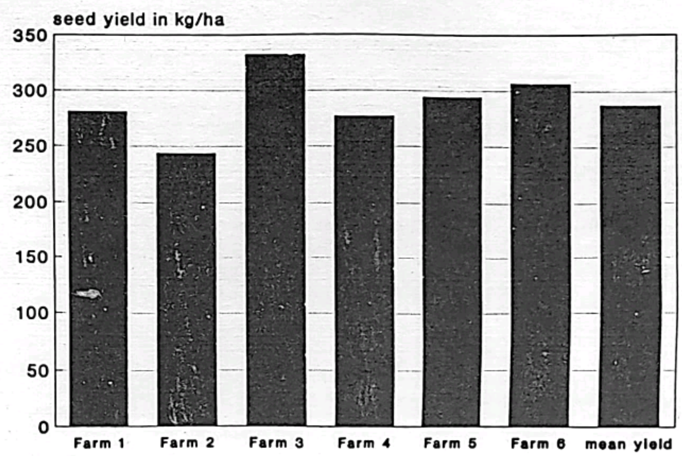

Fig. 4: Seed yield obtained by the six farmers and the mean yield of 80 farms

Tab.3: Development of the parasitization ratios, dates of transplanting and harvesting on the farms

Date	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6
11/02					T	
11/05		T	T			T
11/12						
11/19						
11/26						
12/03		0[1]	0[1]			0[1]
12/10		100[1]	24.2[1]			0[1]
12/17		60.6[1]	25.8[1]		0-10[2]	40[1]
12/23		38.5[1]	21.9[1]		10-20[2]	50[1]
12/30		22[1]	100[1]	T	20-30[2]	46[1]
01/08	T	93.9[1]	60-70[2]	0[1]	50-60[2]	43.2[1]
01/14		100[1]	60-70[2]	69.9[1]	70-80[2]	100[1]
01/21	20-30[2]	60-70[2]	50-60[2]	90.9[1]	70-80[2]	82.5[1]
01/28	50-60[2]	60-70[2]	60-70[2]	60-70[2]	70-80[2]	70-80[2]
02/04	60-70[2]	H	H	66.6[1]	H	50[2]
02/11	80-90[2]			70-80[2]		70-80[2]
02/18	80-90[2]			H		H
02/24	80-90[2]					
03/03	H					

T: date of transplanting H: start of harvest, end of monitoring

1 calculated data 2 estimated data

Other lepidopterous pests started to cause damage to the crops after several weeks without insecticide applications. Their numbers were steadily increasing until harvest as shown in Figure 3. The species found causing damage are mentioned in decreasing order of importance: Heliothis armigera, Heliothis peltigera, Pieris rapae, Trichoplusia ni and Spodoptera litura.

By the end of March 1992, all farmers completed harvesting and yield data became available. As shown in Figure 4, the six farms included in the trial obtained yields ranging from 244 kg/ha to 332,5 kg/ha. In comparison, the other 80 farms in the area, producing under the same conditions but using chemical pesticides for pest control, were harvesting an average of 288 kg/ha. Yet on these farms insecticides were sprayed between four to eight times uring the cropping season.

DISCUSSION

The rate of development of Diadegma semiclausum on the six farms was different during the trial period, especially when Farm 6 is compared to Farm 2. While D. semiclausum seemed to establish rather fast on Farm 2 at an altitude of 1880m, the development of a parasitoid population was slow on Farm 6 at an altitude of 2200m. Subsequent trials at the same altitude (2200-2300m) resulted in a comparatively slow establishment of the parasitoid. It seems likely that lower temperatures related to higher altitudes adversely affect the beneficials, at least during the initial stage after the release (Talekar, 1992, Happe, 1988). Several weeks after the initial release, more cold tolerant wasps might have been already selected as the constant and high parasitization on Farm 6 indicates. In general, the parasitization ratios were higher than those observed by Poelking (1992) in trials in the same area in 1990. This might be due to a more aggressive strain of D. semiclausum that we are currently using.

On the four farms located at KM 47, we observed the spreading of D. semiclausum to neighboring fields. In opposition to common believe in field sanitation we realized the importance of harvested cabbage fields for the dispersal of the parasitoid. On the leftover plants in these fields, DBM larvae were still feeding and served as hosts for parasitization by D. semiclausum. From there the next generation of wasps emerged and dispersed to other fields. On 11th of March 1992 we counted more than 1800 Diadegma cocoons on 12 cabbage plants in a field located between Farm 1 and Farms 2. Sastrosiswojo and Sastrodihardjo (1986) reported similar results about the ability of the wasp to disperse.

For the development of an integrated control strategy, the determination of a threshold level seems to be a very important step. For our experiment we had to assume a threshold since no accurate information was available for seed petchay. As we realized during the trial we placed the threshold level too low. The threshold level depends on various factors such as production objective among others (Cammell and Way, 1987). For seed petchay healthy, undamaged pods are more important than spotless leaves. Larvae feeding on leaves can be tolerated to a higher extent than on head cabbage or leaf petchay. As our trials have shown, in the early stage of petchay development when there is enough leaf tissue and the plant has not yet started flowering, the CTL can be higher than 1 larva/plant if an effective natural enemy is present. However, as the crop grows denser and starts flowering the leaves start to get yellow and dry up. Consequently the DBM larvae resort to buds and pods. This shift of preference in larval feeding negatively affects the expected yield. Therefore the CTL has to be lower at that stage. Based on our resultd we assume that with the presence of an effective parasitoid like D. semiclausum, for seed petchay during the vegetative stage a more realistic CTL would be about 4-5 larvae/plant and 2-3 DBM larvae/plant during the flowering stage. But research is still necessary to confirm the threshold levels and especially to develop a monitoring scheme which meets farmers' capabilities (Theunissen, 1984).

The appearance of other lepidopterous pests which were previously not anticipated complicates the problem and is probably asking for a multi- threshold approach (Cammell and Way, 1987). The regular insecticide applications against DBM seemed to have controled these pests effectively in the past. When spraying frequencies will be reduced due to D. semiclausum, other pests may occure and IPM strategies should respond. Therefore, studies on the biology, behaviour and susceptibility to insecticides are necessary and the potentials of natural enemies of these lepidopterous pests have to be evaluated. Such studies may contribute to a sound biological control scheme for this whole pest complex.

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