Integrated pest management of diamondback moth: The Philippine highlands’ experience

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Abstract

Through the Asian Vegetable Network (AVNET) collaborative program supported by ADB, AVRDC and PCARRD, a technology on IPM-DBM using Diadegma semiclausum with supplemental application of microbial and selective insecticides based on economic threshold levels accelerated the transfer of technology to other areas of the Cordillera Region.

The technology adoption reduced 61% of pesticide costs with net savings of US$503/ha per cropping season. The technology was disseminated through trainings of technicians and researchers, farmers-participated demo farms, seminars and lectures, field days, radio broadcast and technology fairs.

The success of piloting IPM-DBM technology in Atok also inspired the Department of Agriculture to sustain the activities in other crucifer areas in the highlands. The government also launched the KASAKALIKASAN or the National IPM Program which aimed to make IPM the standard approach to crop husbandry and pest management in rice, corn and vegetables. Also, 1,719 farmer graduates from FFS through the TA 2019 special project of ADB with Department of Agriculture and IIBC in conjunction with KASAKALIKASAN nurtured the parasitoid and reduced pesticide usage by 80%.

Key words: Diamondback moth, technology adoption, National IPM program, Philippines

Introduction

Crucifers production in the Philippines is concentrated in the highlands of the Cordillera. In 1994, the total area devoted to crucifers (cabbage, petchay, broccoli, mustard, cauliflower, and lettuce) was 14,965 hectares with a production of 116,068 MT. About 80% of the total area planted is devoted to cabbage production. The Philippine highlands supply the bulk of semi-temperate vegetables particularly cabbage, broccoli and cauliflower to other areas of the country. However, vegetable production in the Cordilleras is heavily dependent on pesticides and inorganic fertilizers due to occurrence of pests. One of the major pests is the diamondback moth (DBM) which was reported in 1927 (Otanes and Sison, 1927) in the highlands of Baguio, Benguet and Cavite. It was observed to be a destructive pest of crucifers in the highlands in 1960 (Barroga, 1967) and in the lowlands in 1970 (Cadapan and Gabriel, 1972). The pest can cause 65–100% yield loss by voraciously feeding on the foliage of cabbage, petchay, broccoli and other crucifers. Desperate vegetable farmers have resorted to frequent application of pesticides, using higher dosages to achieve control. They also mix and experiment with other chemicals that are more potent than the recommended brands. These widespread practices have led to the development of resistance by the DBM. These unscrupulous practices have been virtually left unnoticed until the use of cyanide against DBM in the Cordilleras became an issue. The practice not only posed and caused damage to public health, it also eventually backfired against the vegetable growers when the public discovered the outrageous practice and refrained from buying Cordillera vegetables. In July 1992, the report of cyanide-laced vegetables from the Cordilleras prompted concerned sectors to look for alternate control measures.

This development provided impetus for the Asian Vegetable Network (AVNET) project on IPM-DBM technology to take off in the highlands. This project started in 1989 with technical assistance agreement between the Asian Development Bank (ADB), Asian Vegetable Research and Development Center (AVRDC), and Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) for a collaborative vegetable network. The project paved the way for the technology of integrated pest management of DBM to be transferred to the Philippines.

Description of IPM-DBM Technology

The technology involves the release of parasitoids Diadegma semiclausum (highlands) and Cotesia plutellae (lowlands) to control DBM. Insect release is supplemented with microbial insecticides, based on economic threshold level (ETL).

The Diadegma parasite effectively controlled DBM in some European countries and in New Zealand. As such, a strain of D. semiclausum was introduced to the Philippines by Dr. Talekar through the AVNET Program. C. plutellae Kurdji., on the other hand, is an indigenous parasitoid that has been recorded in the Philippines since 1982. It was initially found in Baguio and the mountainous province of Benguet. It has never...
been found in the lowland areas, hence a more efficient strain of *C. plutellae* from Taiwan was imported and introduced in selected lowland areas in the country.

**Technology Promotion**

- **Mass Rearing of Parasitoids**
  Mass rearing facilities were established at the Benguet State University (BSU) and at the University of the Philippines, Department of Entomology, to support the intensive mass production of the parasitoids. The parasitoids were distributed for free to vegetable farmers who are interested in availing of the technology, for sustained released in various crucifer growing areas infested with DBM in the highlands and lowlands.

- **Field Releases in Pilot Areas**
  The IPM-DBM technology was transferred to the farmers through farmer-participated demo farms. The cooperators were chosen according to their willingness to adopt the technology and to refrain from using organic insecticides. Cooperators can only use biological insecticides.

  The cocoons of *D. semiclausum* housed in elevated small type ‘A’ release cages were placed in the middle of the cabbage fields. Parasitoid release was done at least 3–4 times for each cooperator proportionate to the number of cabbage plants. The ideal rate was 200 parasitoids for every 500 heads cabbage.

- **Monitoring of the parasitoids**
  Benchmark information was obtained prior to the initial release of *D. semiclausum* in all the release sites. Monitoring was done by sampling 100 3rd and 4th instars of DBM per 100 plants for each cooperator. Monitoring started at 40 days after transplanting repeated at three-week intervals until near harvest or about 3–4 times throughout the cropping season. DBM larvae collected from the field were cultured in the rearing house. The rate of parasitism was computed based on the number of parasitoid cocoons recovered from the total DBM larval samples.

**Popularization and spread of technology**

The technology was also disseminated through the following modes (Table 1):

- **a) Training of technicians and researchers**
  The first training course of the AVNET-IPM-DBM project was sponsored by Japan Shipbuilding Industry Foundation (JSIF) in 1991. It was conducted for one month for technicians and researchers actively involved in crucifer production. The course was designed to: 
  a) enable the participants to understand the principles of IPM and the role of the parasitoids in the management of DBM; 
  b) to know the techniques of mass rearing the parasitoids for field utilization; and, 
  c) learn the technique of field releases and assessment of parasitism for DBM management.

  The training curriculum includes lectures on IPM principles, chemical selectivity, development of resistance of DBM for insecticides, and actual laboratory work on mass rearing, field releases and assessment of parasitism as well as field visits to crucifer growing areas.

### Table 1. Mode of technology dissemination, 1991–1994

<table>
<thead>
<tr>
<th>Activity</th>
<th>Frequency</th>
<th>Participants/Clientele</th>
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<tbody>
<tr>
<td>1. Exhibits/Posters</td>
<td>12</td>
<td>Policy makers</td>
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<td></td>
<td></td>
<td>Scientists</td>
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<td></td>
<td></td>
<td>Researchers</td>
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<td></td>
<td>Technicians</td>
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<tr>
<td></td>
<td></td>
<td>Students</td>
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<tr>
<td>2. Publication in scientific journal</td>
<td>6</td>
<td>Researchers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scientists</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Policy makers</td>
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<tr>
<td>3. Press releases/Radio/TV broadcast</td>
<td>9</td>
<td>Scientists</td>
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<tr>
<td></td>
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<td>Farmers</td>
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<tr>
<td></td>
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<td>Technicians</td>
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<td></td>
<td></td>
<td>Students</td>
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<tr>
<td>4. Flyers/Primers/Comics</td>
<td>more than</td>
<td>Farmers</td>
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<td></td>
<td>1,000 copies distributed</td>
<td>Researchers</td>
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<td>Technicians</td>
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<td>Local community leaders</td>
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<td>5. Field days</td>
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<td>Farmers</td>
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<td>Local community leaders</td>
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<td>Researchers</td>
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<td>6. Trainings</td>
<td>3</td>
<td>Farmers</td>
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<td></td>
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<td>Technicians</td>
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<td>Researchers</td>
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<td>Farmer-cooperators</td>
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</table>
b) Seminars and lectures
   On-site seminars and lectures on the IPM-DBM technology were conducted on farmers’ fields prior to the release of parasitoids. This was organised in collaboration with local government units and the Department of Agriculture (DA).

c) Field Days
   During the harvesting season for cabbage, field days were conducted through cross visits of cabbage farms of cooperators to showcase the success of the parasitoid-based IPM-DBM technology.

d) Popular publications. These were published and distributed as primers, flyers and comics on IPM-DBM technology to farmers and agricultural technicians.

e) Radio broadcast and press releases
   The technology was aired regularly in local broadcast radio to reach out to the local farmers in far flung areas.

f) Participation in technology fairs
   The parasitoid-based IPM technology was exhibited in different technology fairs to promote the technologies to other scientists/researchers.

g) Special hands-on training
   Interested agencies requested special hands-on training on the mass rearing of parasitoids to sustain release of parasitoids in cabbage farms.

Technology Adoption

Field Releases and Efficiency of *D. semiclausum*

During the AVNET Phase I, a total of 144,684 *Diadegma* cocoons were released in pilot areas of 4.94 hectares of cabbage field in La Trinidad, Atok and Buguias.

In 1992, the Department of Agriculture, through the Highland Agricultural Development Program (HADP) and the local government units took the responsibility of *D. semiclausum* releases in Bauko, Kabagan, Mankayan, Buguias. The release sites of the DA-HADP were Bauko, Kabagan, Mankayan and Buguias. The DA-CAR released the parasitoids in three other towns: Tuba, Loo and Buguias.

Initial stage of field releases of *D. semiclausum* in 1991 recorded a parasitism rate of 26–37% in the February to July croppings and 26–40% in the October to July croppings.

In 1992, after two years of continuous releases of the cocoons, parasitism reached 70–100% for the January to March and April to August croppings. Parasitism was consistently high in all locations. The outstanding performance of *D. semiclausum* could be attributed to the ability of the parasitoids to adapt and breed in the area.

Dispersal of *D. semiclausum* from the release sites

The presence of parasitoids was noted 0.7 km away from the previous release site. It was also noted to be present in nearby cabbage areas, which implies that the parasitoid disperses in search for food when the original sources have been depleted after harvest. It was observed that parasitism ranged from 73–93% at a distance 6 km away from the release sites compared to nearby cabbage fields (24–41%). It is therefore presumed that the parasitoid could have dispersed further as indicated by very high parasitization rate even at a distance of 6 km. This is a good determining factor for distance of release points and the number of release sites.

Technology Acceleration

Inspired by the success generated by the AVNET IPM-DBM project in piloting the technology in Atok, the Department of Agriculture signed on October 14, 1992, a Special Order No. 674, creating an Interagency Program for the IPM in the highlands. The program was aimed to properly address the persistent problem of vegetable farmers as well as the cyanide scare through the implementation of the IPM Action Project for DBM. The project accelerated the transfer of technology and spearheaded intensive trainings, information campaigns, mass rearing field releases, and monitoring in the highlands. Release areas were expanded to 22 sites in Benguet and Mt. Province. Through these inter-agency efforts, the success of the technology adoption have evolved into Memo Order No. 176, implementing the “Kasaganaan ng Sakahan at Kalikasan (KASAKALIKASAN), the National IPM program, which supercedes S.O. 674. Spearheaded by the DA, the program aims to make IPM the standard approach to crop husbandry and pest management in rice, corn and vegetables. The KASAKALIKASAN promoted the practice of IPM among farmers through training of farmers in season-long Farmers Field Schools (FFS), training of IPM trainers, and farmers training other farmers.

On May 14, 1994, TA 2019 was approved by ADB and implemented by the Department of Agriculture and IIBC. This special project worked in conjunction with the KASAKALIKASAN in the expansion and sustaining the IPM-DBM in the Cordillera highlands. Through this TA, 1,719 farmer graduates from 65 FFS introduced and nurtured the parasitoid *Diadegma* and reduced pesticide usage by 80%. Also, a total of 119,850 *Diadegma* cocoons were released in nine municipalities from 1994–1996 (TA Final Report, 1996).

Local officials who have witnessed the success of the technology fully support the IPM-FFS as the training encourages farmers to adopt environmentally-friendly and sustainable practices. This approach empowered farmers and enhanced their decision-making towards successful farming.

Potential Benefit of the Technology

A total area of 9,000 hectares are devoted to cabbage production grown each year with potential yield of 25 t/ha. The cost of pesticides per hectare is US$838, hence the total cost of pesticides needed each year to control DBM is US$7,542,000. Using the IPM-DBM...
and parasitoids, the pesticide cost is reduced to US$3.020M. Therefore, the total savings from 9,000 hectares, if all farmers utilized technology would be US$4.52M. This will lessen the drain on the country’s dollar reserves brought about by the importation of pesticides.

Conclusion
As a whole, the technology offers a sustainable and safe means of controlling one of Asia’s most persistent insect pests. By reducing or eliminating the use of pesticides, the technology lessens the risks to human health and helps protect the environment.

References