5. Simple and Effective Integrated Pest Management Technique for Vegetables in Northeast Thailand

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Introduction

Insect pests are one of the major constraints to increase food production and higher agricultural productivity. On a global level, pests are reported to destroy a significant part of the agricultural harvest. A comprehensive study (Oerke et al. 1999) showed that crop losses due to insect-pests range from 25% to over 50%, depending on the crop and agroclimatic conditions. About five million tons of pesticides are used annually in agriculture world-wide and there is ample evidence to show that pesticide use can often aggravate rather than reduce the pest damage in many crops.

In Thailand, the crop and monetary losses due to insect-pests have been substantial particularly on the high-value crops, vegetables and fruits. The use of pesticides has been on increase, particularly during the last 12 years (Figs. 1 and 2) (OAE 2006). Inspite of increase in pesticide use, it is disturbing to note that over the last two decades, the losses in all major crops, vegetables and fruits have increased in relative terms. Inspite of this trend in Thailand, pesticides have become an integral component in sustainable agriculture. However, being inherently toxic, excessive and non-judicious use of pesticides has raised several environmental issues. Contamination of agricultural commodities, environmental pollution, toxicity to non-target and beneficial organisms as well as emergence of resistance in insect-pests and pathogens are a few issues that still are of great concern. The use of pesticides also implicates risk to consumer health, especially when good agricultural practices are not followed. In Thailand, vegetables and flowers are cultivated on 0.5 million ha, which generate an annual income of US$ 326 million. Pesticides constitute the major portion of production cost, which is currently about 40–60% of the total production cost. Many of these agricultural products are being exported to other countries. Due to more stringent regulations on pesticides content in these products along with long-term environmental issues, the Thailand government has planned to reduce the use of pesticides by 30%. Integrated pest management (IPM) is an ecology-based pest management system that promotes the health of crops and humans, and makes full use of natural and cultural control processes and methods. Several IPM efforts through use of nematodes, nuclear polyhedrosis virus (NPV), predatory insects, natural bio-extract, Bt and black light are being promoted (OAE 2006).

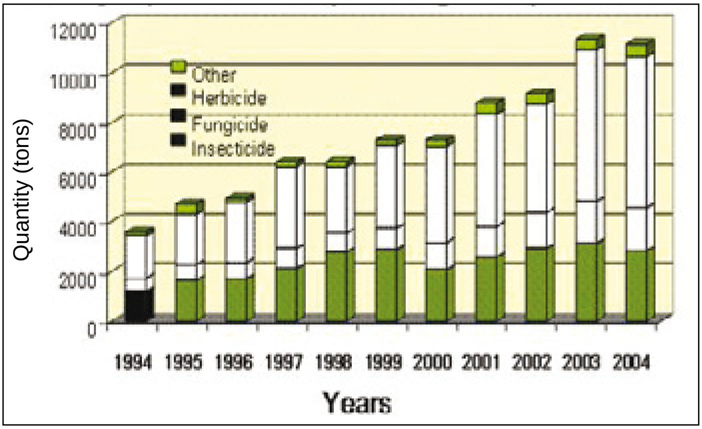

Figure 1. Amount of pesticides used in Thailand during 1994–2004.

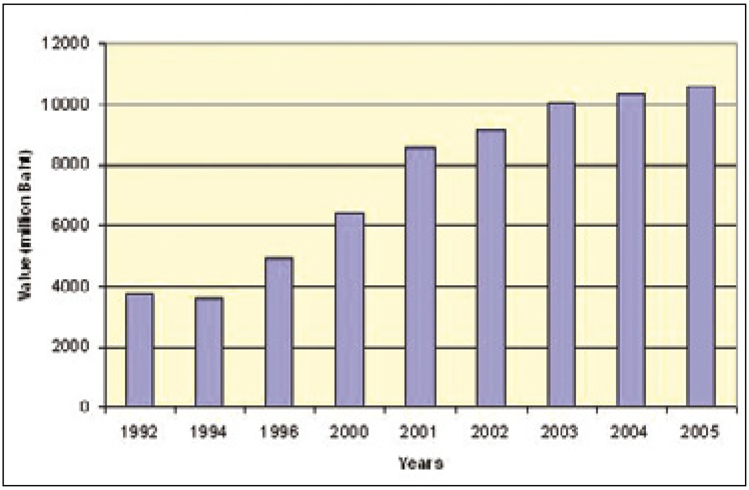

Figure 2. Import of pesticides in Thailand during 1992–2005.

Innovative IPM System for Vegetables: Use of Sugarcane By-product (Molasses)

In 2001, the senior author Mr Somchai Chuachin, Scientist, Department of Agriculture, OARD-3 region, while working on a farmer's field, observed that insects were getting attracted to a farmer's hands, who earlier worked with sugarcane molasses. Later he found many dead insects in a container with waste molasses, which was unintentionally left near the asparagus fields for two days. This gave him an idea that the sugarcane molasses could be used to control the insects. Mr Somchai then started working with several designs of insect trap bottles with various concentrations of molasses to attract insects in asparagus fields under "Participatory Technology Development" (PTD) program in Kalasin project area. In this area, common cutworm was the major insect problem that affected vegetable cultivation. Every year farmers used to spend substantial money on insecticide sprays to control the insect. In 2001, for the first time, Mr Somchai introduced the new IPM system on vegetables to control the insect. In this IPM system, white plastic bottles of 700 ml capacity with two side openings and filled with molasses were placed at about 30 cm from the ground surface on a bamboo stick (Fig. 3). The insects were attracted by the molasses kept in the plastic bottle, and got trapped and killed (Fig. 4).

Figure 3. Simple IPM system installed in a cabbage field in Northeast Thailand.

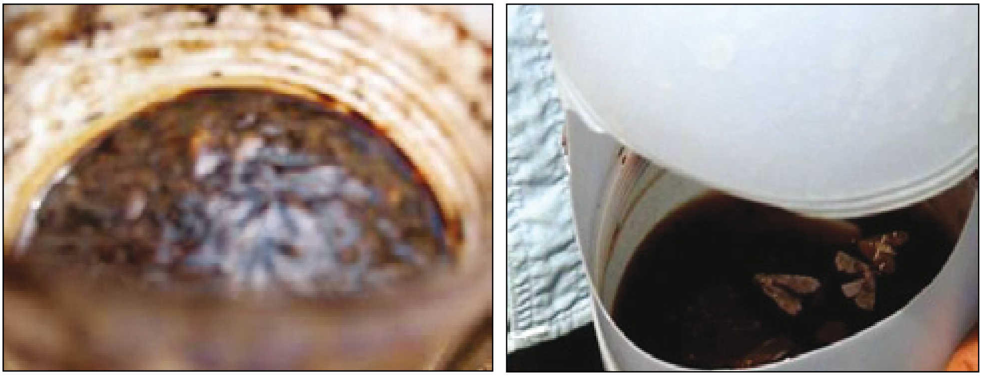

Figure 4. Insects trapped in the plastic bottles with molasses.

Mr Somchai along with farmers found molasses IPM system quite effective in controlling the insect population and damage, particularly in cabbage, resulting in reduced cost of insecticides by 30 to 50%. In this system, chemical pesticides are used only when the pest attack exceeds critical damage level. Any additional interventions are made based on the need and this minimizes the total cost and undesirable side-effects.

Refinement and Evaluation of the Molasses IPM System

The newly identified IPM system was further refined and evaluated in two ADB-ICRISAT project watersheds, viz, Tad Fa and Wang Chai in Northeast Thailand. Cultivation of vegetables is quite prominent in both these watersheds. In Tad Fa watershed, the farmers earn about 45% of the annual income from the vegetables grown during the rainy and postrainy seasons. The major vegetables grown in Tad Fa watershed are cabbage, Chinese kael, Chinese cabbage, coriander, shallots and lettuce. These vegetables are generally grown in yearly rotation to reduce the pest and disease problems. At Wang Chai watershed, most of the vegetables such as long yarn bean, cabbage and others are grown in the winter season. At both the watersheds, farmers were using heavy dose of pesticides to control insects and other pest problems.

During 2002, the newly developed IPM technique using molasses was introduced to control insect damage in vegetables at Tad Fa and Wang Chai watersheds. At both the sites, farmers were trained on various aspects of the new IPM technique. Field exposure visits were also arranged for selected farmers to visit the farms where this technique had been used for the last two years. In a short span of two years, this IPM technique became quite popular with most of the watershed farmers cultivating cabbage and other vegetables (Fig. 5). There is a need to conduct systematic scientific trials on this IPM technique in the farmers' fields to collect data on its effectiveness in controlling different types of insects (Fig. 6). Also, several aspects of this new IPM technique such as height of placing the trap bottles, spacing between the poles on which bottles were to be fixed and other details need to be standardized.

In 2004, on-farm trials were conducted in both Tad Fa and Wang Chai watersheds and detailed data were collected. In Tad Fa watershed, the IPM trial was conducted on three cabbage farms. In each cabbage field, 25 bamboo sticks were placed at a spacing of 5 m x 5 m to fix the insect trap bottles. At each bamboo stick, three

Figure 5. A farmer explains the simple IPM methodology to visitors.

Figure 6. A scientist from the Department of Agriculture checking the insects in the bottle filled with molasses.

plastic bottles which have two side openings and filled with molasses, were fixed at 50, 100 and 150 cm above the ground surface (Fig. 7).

Every three weeks, the bottles were removed from the fields and from each bottle different types of insects were noted and their numbers were counted. The mean values of insects trapped in the bottles at 50, 100 and 150 cm height are shown in Table 1. The bottles kept at 50 cm above the surface were relatively more effective in trapping insects than the bottles kept at 100 and 150 cm above the ground. The total numbers of insects trapped in the bottles kept at 50, 100 and 150 cm height were 8.8, 6.0 and 4.7, respectively. In this area, the major damage to cabbage is caused by four insects, viz, (i) cabbage looper (*Trichoplusia ni*), (ii) common cutworm (*Spodoptera litura*), (iii) cabbage leaf miner fly (*Liriomyza brassicae*), and (iv) leaf eating beetle (*Phyllotreta* sp).

Table 1. Insect population in the IPM trap bottles placed at different heights in cabbage fields in Tad Fa watershed in 2004.

Insect	No. of insects trapped per bottle			Total no. of insects trapped per bottle
	50 cm	100 cm	150 cm	
Cabbage looper	2.8	2.3	1.4	6.5
Cabbage cutworm	1.2	2.7	0.7	4.6
Cabbage leaf miner fly	1.7	1.0	1.4	4.1
Leaf eating beetle	3.2	-	1.1	4.3
Total	8.9	6.0	4.6	19.5

Figure 7. An experimental plot where the IPM technique was evaluated in Tad Fa watershed.

The results clearly show that this technique was effective in trapping all the four major insects that damage cabbage. Most of the insects in the bottles were adult female insects, which had major impact in reducing the further multiplication of these insects (Table 2). Based on earlier research work and farmers' experience, the possible damage to cabbage crop without using IPM technique was estimated (Table 2). This estimation is based on the hypothesis that if the female insects would not have been trapped and killed by the IPM technique, they would have produced several thousands new worms/eggs, which could have seriously damaged the cabbage crop. For example, 165 cabbage loopers were trapped and killed through IPM technique. If they had not been trapped/ killed, they would have produced about 123,750 new worms/eggs, which could have damaged about 15% of the cabbage crop. The maximum damage could have been caused by cabbage cutworm, which would have damaged about 73% of the crop. In total, 92% of the cabbage could have been damaged if the IPM technique was not effective in trapping the female insects in the molasses bottles.

Table 2. Estimation of damage to cabbage crop by insects without using IPM technique[1].

Adult insects	No. of insects trapped in bottle	Total larvae (eggs) could have been produced by trapped insects	No. of larvae to potentially damage one plant completely	Degree of damage without IPM (%)
Cabbage looper	165	123,750	150	15
Cabbage cutworm	115	28,750	7	73
Leaf eating beetle	108	15,050	100	3
Total	388	167,550	257	91

1. Based on 25 IPM trap sets used in 5,600 cabbage plants.

At Wang Chai watershed, vegetables are grown mostly in the winter season and agroclimatic conditions of this area are quite different than those in the Tad Fa watershed. The IPM trial was conducted in 2004 at Non Thong village, where most of the farmers grow cabbage. A study was conducted to monitor the pattern of trapping of various insects during different growing periods of cabbage. At weekly interval, all the IPM bottles were observed from the fields and various insects and their numbers trapped in the bottles were counted. During the early stage of cabbage growth, relatively few insects were trapped in the IPM bottles (Table 3). Mainly diamondback moths (*Plutella xylostella*) and cabbage looper moths (*Trichoplusia ni*) were trapped in the IPM bottles. The number of insects trapped in bottles during 3rd and 4th weeks of cabbage crop was low. During the first four weeks of crop growth, a total of 37 insects were found in the IPM bottles. During the mid growing period (5^{th} to 8^{th} week), more number of insects were found trapped in the IPM bottles (Table 4). During this period not only the number of insects but also insect species found in the trap bottles increased drastically. The first insect trapped was cabbage webworm moth (*Hellula undalis*), followed by cutworm moth (*Spodoptera litura*) and other insects.

Table 3. Insect population in the IPM trap bottles during the early stage of cabbage crop growth (seedling) in Wang Chai watershed, 2004.

	No. of insects trapped per bottle				
Insect	Week 1	Week 2	Week 3	Week 4	Total
Diamondback moth	8	6	5	4	23
Cabbage looper	5	4	3	2	14
Total	13	10	8	6	37

Table 4. Insect population in the IPM trap bottles during the mid growth stage (transplanting) of cabbage crop, in Wang Chai watershed, 2004.

	No. of insects trapped per bottle				
Insect	Week 5	Week 6	Week 7	Week 8	Total
Diamondback moth	8	4	3	2	17
Cabbage looper	4	3	2	1	10
Cabbage webworm	3	3	3	2	11
Common cutworm	-	-	-	5	5
Total	15	10	8	10	43

During the last phase of crop growth, the proportion of insect population of various species in the IPM bottles was different than the earlier crop growth phase (Table 5). Common cutworm was the dominating insect found in the IPM bottles. About 65% of insects in the IPM bottles were common cutworm. During this period very low numbers of cabbage loopers and cabbage webworm were trapped in the IPM bottles.

Table 5. Insect population in the IPM trap bottles during the vegetative and pre-harvest stages of cabbage in Wang Chai watershed in 2004.

Insect	No. of insects trapped per bottle				Total
	Week 9	Week 10	Week 11	Week 12	
Diamondback moth	1	3	6	8	18
Cabbage looper	1	-	-	-	1
Cabbage webworm	3	1	1	-	5
Common cutworm	5	10	15	15	45
Total	10	14	22	23	69

Data from the IPM trial clearly show considerable variation in insect species and their population during the cabbage growing period. During the early and mid growing period, diamondback moth appears to be the dominant insect whereas during the main vegetative and harvesting period common cutworm was the dominant insect on the cabbage crop. The population of various insects trapped in the bottles also shows the effectiveness of this IPM technique in trapping major insects that damage the cabbage crop. According to the farmers in Wang Chai watershed, diamondback moths are quite damaging particularly during the early seedling stage of the cabbage crop. Often, farmers have to re-transplant cabbage due to heavy damage by diamondback moths. The behavior of common cutworm is highly unpredictable; therefore, they are difficult to control with pesticides. Often their attack is sudden, and in large numbers and mostly during night. Some of the traditional methods, viz, smoking, irrigation and other methods are not very effective in protecting the cabbage crop. Farmers using this simple IPM technique, reported that generally there was no need to apply pesticides for cabbage, except in some unusual situations where one or two sprays were found necessary. The results in Table 6 show the comparison of cost and benefits of the conventional insect control method (pesticide sprays) with the molasses IPM technique on cabbage. The net profit to farmers who used IPM technique to grow cabbage increased by 51% compared to those who used conventional chemical-based insect control method.

Table 6. Economics of simple IPM and conventional insect control methods on cabbage, in Wang Chai watershed, in 2004.

Item	Cost (Baht ha^{-1})	
	Conventional chemical insect control	IPM technique
Land preparation	3000	3000
Seeds	1620	1620
Fertilizer (16-20-0)	7560	7560
Green fertilizer (25-8-8)	1800	1800
Insecticides (Lannat, Abamactin, Atabon)	21000	1200
Fuel cost for irrigation	3000	3000
Transportation	12000	12000
Total cost	49980	30180
Yield (kg ha^{-1})	37200	38100
Price of cabbage (Baht kg^{-1})	2.50	2.50
Income (Baht ha^{-1})	93000	95250
Benefit (Baht ha^{-1})	43020	65040

1. US$ 1 = 37 Baht.

Scaling-up of the Molasses IPM Technique

In a short span of time, the simple IPM technique has become quite popular with cabbage growing farmers in NE Thailand. Also, pesticide-free cabbage is preferred by consumers when sold in the market (Fig. 8). Many farmers have adopted this new IPM technique on their own for growing the cabbage crop.

Figure 8. Good quality cabbage grown with IPM being transported to the market.

The Department of Agriculture, Region-3 has already conducted several short training programs, field visits and farmers' days to popularize the molasses IPM technique for the protection of cabbage and other vegetables (Fig. 9).

Figure 9. IPM Field Day organized by the scientists from OARD-3 during 2005: (a) Registration for IPM Field Day 2005; (b) IPM Field Day posters and other display items.

Conclusions

Even though the ever increasing use of pesticides in Thailand has led to increased food, feed and fiber production as well as improved public hygiene, it has also brought into focus several health hazards and pertinent environmental issues. To minimize farmers' over dependence on pesticides in crop protection and to avoid harmful effects on human and ecosystems, the Government of Thailand is encouraging IPM methods. The simple molasses-based IPM system reported in this paper has shown high potential in controlling insects on cabbage and other vegetables. Some of the key advantages of this IPM system are:

- Simple technique and easy to adopt;
- Uses locally available materials (bamboo sticks, molasses and plastic bottles);
- Low cost;
- Increases net profits; and
- Environment-friendly, with no harmful effects on humans and ecosystem.

References

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