CHAPTER VII

STRATEGIES IN INSECT PEST MANAGEMENT

In insect pest management, it is necessary to identify an effective strategy to lower maximum of the pest's damage to the crop and increase the benefit. So economic efficiency, practices in management, and surrounding factors affecting on the strategy are essential to identify the effective strategy.

7.1 Classification of the strategies

The pest management is the development of an overall plan to exclude, alleviate, or eliminate a real or perceived pest problem (Hammon, 2002). The pest management strategy is the plan developed to lower pest status to a tolerable level. The strategy developed will depend on the biology of the insect and the cropping system involved. There are some types of the strategies used such as no-intervention strategy, single strategy, and combined strategy, in which the combined strategy is considered as an effective strategy in insect pest management (Thomas and Hein, 2003).

In litchi orchards, by local knowledge the litchi farmers strove to manage and control the insect pests in the litchi orchards by their own strategies. So it is necessary to identify effective strategy among them to make the premise for applying in production practice in the province as well as the whole country. As mentioned, all of the litchi farmers have applied insecticides to control the pests. However in each their insecticide-based strategy, many of them also applied some other methods in combination with the insecticides to control the pests such as the pruning, the removal. So the strategies applied by the litchi farmers can be classified into the following groups:

1 . The insecticide only (IO): the litchi farmers apply the insecticides only to control the insect pests.

2 . The insecticide-based insect management strategy and the pruning (IP): the litchi farmers apply the insecticides in combination with the pruning method to control the insect pests.

3 . The insecticide-based insect management strategy and the removal (IR): the litchi farmers apply the insecticides in combination with the removal method to control the insect pests, and

4 . The insecticide-based insect management strategy in combination with the pruning and the removal methods to control the insect pests (IPR).

From the classification of the strategy, distribution of the litchi farmers in both districts was quite different; the result was shown in Table 7.1.

Table 7.1 Distribution of the growers in the strategies

District	IO	IP	IR	IPR
Thanhha	5	12	2	20
Chilinh	9	10	6	15

Source: farmer interview, 2003

Note: IO: insecticide only; IP: insecticide and pruning; IR: insecticide and removal; IPR: insecticide, pruning, and removal.

Up to now, the litchi farmers in both districts had 4 different strategies to manage and control the insect pests. The grower applied strategy IPR most with 20 and 15 growers in Thanhha and Chilinh districts, respectively. This proved that the grower preferred this strategy than others. Besides this, many growers also applied strategy IP, then was strategy IO and IR.

7.2 Effectiveness of strategy

To identify the effective strategy in insect management, it is necessary to base on criteria that build up the effective farms. These can include yield, local knowledge, composition of the insect pests, cropping systems (Ha *et al*., 2003), cost for labor used for controlling the insect pests, cost for insecticides to get ratio of the profitability. It couldn't base on the yield only that is the highest in each strategy (Noda *et al*., 1998).

7.2.1 Inputs used for managing insect pests in the strategies

7.2.1.1 Costs of labor applied in insect pest management

In order to identify efficiency of a strategy, as mentioned besides outputs, it is necessary to calculate inputs for that strategy. One of important input types need to identify is the cost of labor employed in the effective strategy in both districts. The labor costs in the strategy include the cost of spraying, the cost of pruning, and the cost of removal (Table 7.2).

Table 7.2 Distribution of the labor costs in managing the insect pests

Strategy	Cost of spraying		Cost of pruning		Cost of removal	
	Thanhha	Chilinh	Thanhha	Chilinh	Thanhha	Chilinh
	......................VND million/ha......................					
IO	1.15	1.14				
IP	0.87	0.89	0.46	0.48		
IR	1.04	1.07			0.30	0.15
IPR	0.76	0.83	0.40	0.43	0.16	0.09

Source: farmer interview, 2003

Note: IO: insecticide only; IP: insecticide and pruning; IR: insecticide and removal; IPR: insecticide, pruning, and removal.

The Table 7.2 showed that different strategies invested a quite different amount of money in managing the insect pests. The strategy IO costed the highest amount of money, VND 1.15 millions and VND 1.14 millions in Thanhha and Chilinh districts, respectively. The strategy IPR had the lowest expense for the spraying, VND 0.76 millions and VND 0.83 millions in Thanhha and Chilinh districts, respectively. However the strategy IPR must use another amount of money to manage the insect pests by the pruning and the removal. Besides these, the strategies IP and IR also costed a certain amount of money in managing insect pests by the pruning or the removal, but the expenses for insecticide spraying were also lower than that of the strategy IO.

A long with the labor costs, the cost of insecticides applied in each strategy was extracted in order to identify the total costs or inputs for managing the insect pests. This was shown in Table 7.3. The findings stressed again that the different strategies asked for investing both labors and insecticides in quite different level. The strategies combining the pruning costed a smaller amount of money for insecticides than the strategies without the pruning, less than VND 1.2 millions in the strategies with the pruning, and up to VND 1.54 millions in the strategies without pruning. And as a result, the total cost of labor and insecticides also lowered in the strategies with the pruning over the strategies without the pruning. These costs were less than VND 2.55 millions in the strategies with pruning, and more than VND 2.63 millions in the strategies without pruning

Table 7.3 Total cost of insecticides and labor for managing insect pests

Strategy	Labor cost		Cost of insecticides		Total costs	
	Thanhha	Chilinh	Thanhha	Chilinh	Thanhha	Chilinh
	……………………VND million/ha……………………					
IO	1.15	1.14	1.51	1.54	2.65	2.68
IP	1.33	1.37	1.04	1.17	2.37	2.54
IR	1.34	1.21	1.30	1.43	2.64	2.65
IPR	1.32	1.35	1.00	1.08	2.32	2.42

Source: farmer interview, 2003

Note: IO: insecticide only; IP: insecticide and pruning; IR: insecticide and removal; IPR: insecticide, pruning, and removal.

Total costs of labor and insecticides were relatively different between two districts. Normally per ha costs for insect pest management varies from VND 2 millions to VND 5 millions according to real situation of each orchard and insect pests' pressure (Nguyen, 1999a). So the costs in these strategies are considered in average level.

However the difference in the total cost among the strategies could result in the difference in profitability of the strategies. This depends completely on efficiency of the costs or income the growers spent and achieved.

7.2.2 Total income and efficiency of the strategies

To identify the efficiency in insect pest management, it means that the ratio between of total benefit and total cost for insect pest management must be included, so in connection with total cost above, total benefit and efficiency ratio was calculated (Table 7.4). If the higher this ratio is, the more efficient the strategy is. The finding showed that the efficiency of 4 strategies in both districts was more than 10 times over total cost of insect pest management – a relatively high ratio over rice cultivation. Rice cultivation's efficiency estimated to fluctuate from 3 to 6 times higher compared with the total cost of insect pest management (Nguyen, 1999a).

Table 7.4 Benefit – cost for insect pest management ratio in the strategies

Strategy	….Total benefit….		…..Total cost…..		Benefit-cost ratio	
	Thanhha	Chilinh	Thanhha	Chilinh	Thanhha	Chilinh
	…………VND million/ha…………..					
IO	27.33 ±6.4	27.10 ±9.2	2.65 ±0.2	2.68 ±0.6	10.30	10.10
IP	29.52 ±8.2	28.72 ±11.4	2.37 ±0.5	2.54 ±0.6	12.48	11.30
IR	30.50	28.97 ±9.0	2.64	2.65 ±0.5	11.55	10.97
IPR	30.96 ±9.1	31.40 ±16.9	2.32 ±0.5	2.42 ±0.6	13.36	12.95

Source: farmer interview, 2003

Note: IO: insecticide only; IP: insecticide and pruning; IR: insecticide and removal; IPR: insecticide, pruning, and removal.

These findings reconfirmed that the strategies with the pruning (strategies IP, IPR) that had lower cost of labor and insecticide brought about a total income and the ratio higher than the strategies without the pruning (strategies IO, IR). Meanwhile the strategies without the pruning had the ratio of 10.3 and 10.1 in strategy IO, and 11.6 and 11.0 in the strategy IR in Thanhha and Chilinh districts, respectively. The strategies with the pruning had a higher ratio, 12.5 and 11.3 in the strategy IP and 13.4 and 13.0 in the strategy IPR in Thanhha and Chilinh districts, respectively. So the strategy IO in both districts had the lowest ratio, the strategy IPR had the highest ratio among 4 strategies.

7.3 Effective strategy in insect pest management

7.3.1 Weight of each strategy

In order to identify the effective strategy, a series of criteria was identified to weigh by the scoring method (section 3.4.3). It is necessary to weigh the strategies to get the score. From the findings above (Table 7.1, Table 7.3, Table 7.4), the strategy with highest total score would be considered as effective among the strategies. The findings were shown in Table 7.5.

Table 7.5 Weight of each strategy in both districts

Strategy	District	IC	LC	BCR	ME	SOS	FP	Total score
IO	Thanhha	1	7	1	1	1	3	14
	Chilinh	1	7	1	1	1	3	14
IP	Thanhha	5	3	5	3	3	5	24
	Chilinh	5	1	5	3	3	5	22
IR	Thanhha	3	1	3	3	3	1	14
	Chilinh	3	5	3	3	3	1	18
IPR	Thanhha	7	5	7	5	5	7	36
	Chilinh	7	3	7	5	5	7	34

Notes: IC: insecticide cost; LC: labor cost; BCR: benefit-cost ratio of each strategy; ME: mutual effects among the methods; SOS: sustainability of strategy; FP: farmer's preference.

Each criterion is given with 4 scoring levels in relationship to 4 strategies. The score high or low depends on the character of each criterion. Some criteria such as IC, and LC in each strategy will receive a lower score if the cost is higher over other strategies. The criteria BCR and FP will receive a higher score if the benefit-cost ratio and farmer's preference, respectively, are higher over other strategies. The criteria SOS and ME will receive a higher score if number of applied method and mutual effect of methods are much more and effective, respectively.

Through Table 7.5, total score was quite different among strategies in both districts. Strategy IO had the lowest total score in both districts – 14 score only. Strategy IP had the second highest total score, 24 in Thanhha district and 22 in Chilinh district. Strategy IR had the third highest total score, 14 in Thanhha district and 18 in Chilinh district. Strategy IPR had a highest total score, 36 in Thanhha district and 34 in Chilinh district. Order of the strategies in both districts was completely similar; they were from strategy IPR, to IP, IR and IO downward.

7.3.2 IPR – an effective strategy

From the results of analyzing process in Table 7.5, strategy IPR got total sore highest in both districts, so this was the effective strategy in insect pest management rather than other strategies. This could be elucidated more by the following reasons:

1 . In terms of theory

This is an advantageous approach because if one of the methods is failed, other methods are in place to help manage the pest population. So extensive use of a single strategy, such as an insecticide over a broad area, can bring about a gradual or abrupt failure of the strategy. The effective life of a control strategy can be increased if it is used in conjunction with other methods. The use of multiple strategies and methods is a basic principle and essential in insect pest management programs (Thomas and Hein, 2003).

2 . Efficiency of the pruning

As known, many insect and mite pests seek shelter or attempt to over-winter in plant residues. In litchi's insect pests, adults of the litchi stinkbug would stop the activities after August, and hibernate on the bushy parts of the tree canopy and other areas (Tran, 1999). In the case of the litchi fruit borer, larvae employed tree leaves to roll into the nest, and pupate inside and exist on the tree (Tran, 1999). So removing dead branches or canes from trees and shrubs and raking and composting leaves, grasses and other plant debris helps eliminate many over-wintering sites and considerably reduce the source of the insect pests in the spring season when they reactivate (Pandey and Harish, 1998). The orchard pruned would reduce cost in insect pest management because of the reduction of pesticide use and labor cost. The pruned trees with good canopy also get more yield and quality. Besides those, the pruning will help to open the tree to improve air movement, light, and break down the shelters for insect pests. Pruning will allow chemical application easier access and may remove sources of infestation (Duong *et al.*, 2002). So the pruning brought about a considerable effect on the litchi insect pests, especially on the litchi stinkbug's adult and the fruit borer's nymph. It gave an efficacy up to nearly 20% in the case of the fruit borer, nearly 13% in case of the litchi stinkbug, and nearly 5% in case of the looper (Table 6.12).

3 . Efficiency of the removal

The litchi farmer in Vietnam applied much local knowledge to manage insect pests in their orchard. They always remove large or readily visible insects by hand and destroy, or dislodge pests into a can containing a small amount of water and detergent. The egg masses of many insects can be scraped off or smashed (Le *et al.*, 2000). So the removal, like the pruning, also brought about a remarkable effect on the litchi insect pests, especially on the last instar of looper larva and the litchi stinkbug's phases. It obtained an efficacy up to nearly 9% in case of the looper, and nearly 6% in case of the litchi stinkbug (Table 6.12). In case of the looper's larva, the removal gave more significance, because the capture of the looper's larvae when they hibernate inside the soil would reduce the infestation source in the spring season. Capture of the litchi stinkbug's adults at very early stage of the season (early March) also gave a big significance in reducing multiplication source of the litchi stinkbug in the season.

4 . Efficiency of the insecticide

IPR is a combined strategy among insecticide, pruning, and removal methods. Although efficacy of the pruning and the removal achieved a quite significant level in reducing the infestation source of the insect pests in nest season, as known, their efficacy was not able to protect completely the crop from serious damages of the insect pest. For example, the pruning gave very limited efficacy on the looper, and the removal had not any effect on the fruit borer (Table 6.12). Another side, the pruning and the removal could only implement in some stages of the tree and some phases of the insect pests because if misuse of these methods could lead to negative effects such as increase of the cost, and event reduction of the yield (Nghe and Ngo, 1991). In those cases, to keep the crop out of the insect pests' serious damage, insecticide played a utmost important role in restrain and stamp out the insect pests' outbreak and serious damages. So it was considered as a major pillar in the strategy IPR to manage the insect pests. This was proved by its efficacy on the insect pests (Table 6.12). The insecticide gave a quite high efficacy on the insect pests. The highest efficacy on the litchi stinkbug was approximately 95%, and the lowest on the fruit borer – above 88%.

5 . Mutual efficiency and limitation of the risk

This appears only in combined strategies. When many methods apply in a strategy, these methods could have mutual and positive effects making increase of efficacy as well as reduce of costs in insect pest management. Periods of the tree for applying this strategy were shown in Figure 7.1.

The pruning and the removal control defensively the insect pests; meanwhile the insecticide controls the insect pests in time. The pruning makes reduction of infestation source of the insect pests in the spring season, exposition of insect pest that make more condition to kill the insect pests by the removal and insecticide. Another sides, the pruning makes the tree more vigorous that increases the ability to resist the insect pest's attack and more yield. So the pruning has mutual and very significant effects with insecticide on reducing the insect pests' damages and attacks resulting in reducing application of insecticide, so reducing the costs of insect pest management and increasing more profitability.

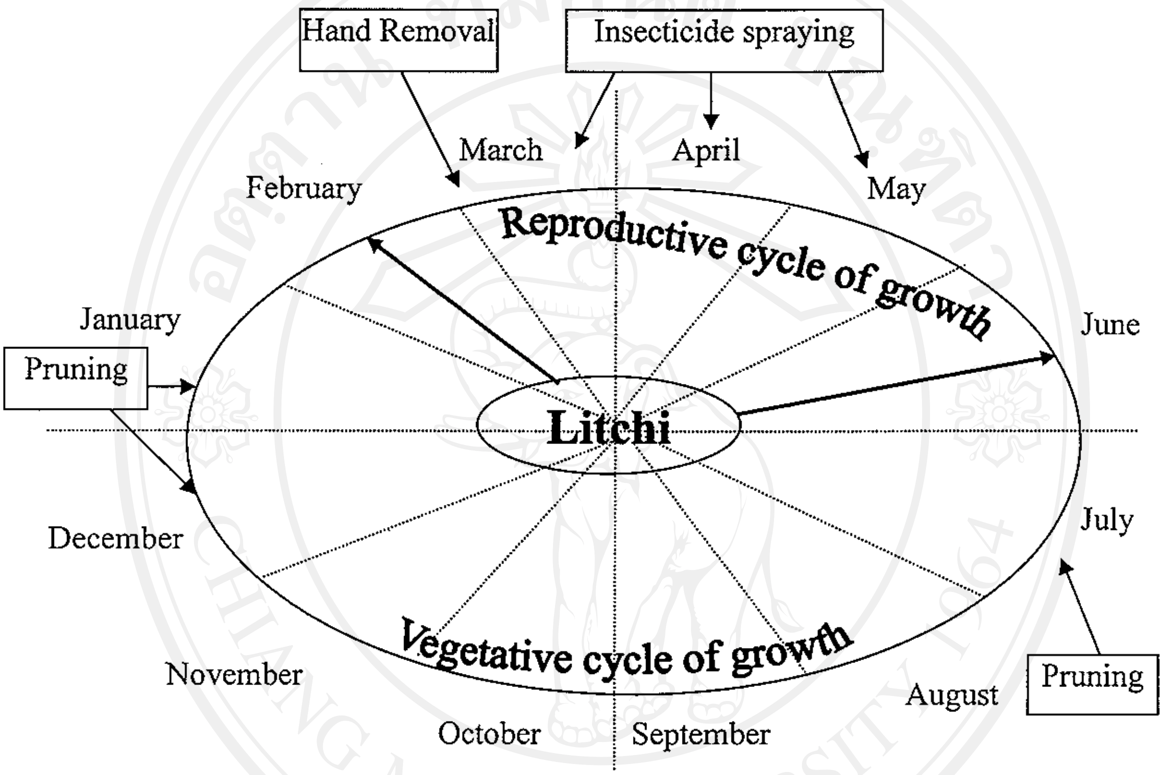

Figure 7.1 Periods of the litchi tree for applying the IPR

The removal, in along with the pruning, has effects on reducing the first multiplication source of the insect pests, so making reduction of the insect pests' pressure on the tree. As a result, application of insecticide reduces resulting in reducing the cost of the insect pest management. The insecticide supports much more for the removal and the pruning by some following reasons:

- Practices of the removal and the pruning. The removal and pruning could only implement in some stages of the tree and some phases of the insect pests. So when the insect pest population is more populous, attacks and damage more strongly and seriously, these methods could not bring into play their effects immediately and stamp out the insect pest. In these cases, the insecticide would play an utmost important role in compensating for the shortcomings of the removal and pruning.

- Composition of the insect pest. The removal and the pruning have a positive effect on only several insect pests in the litchi. The pruning has a very weak effect on the looper, the removal has not effect on the fruit borer. So the insecticide would supplement for these weak points of the removal and pruning. All of these mutual effects would make the strategy more active and effective rather than other strategies.

6 . Agro-ecosystem

Agro-ecosystem has many effects on insect pest management strategies. The more diversifying the agro-ecosystem is, the more numerous and abundant composition of insect pests and place for the insect pests to hibernate (Ha and Duong, 2001). This has special significance in case of Chilinh district, where the agro-ecosystem is more diversifying and surrounding bushy forest (Table 4.1). This is considered as an ideal environment for insect pests' hibernation to damage and attack on the litchi in next season. Because besides hibernation in the litchi crown, the insect pests could hibernate in forest and bushy areas next to the litchi orchards, so the insect pests' source in the litchi orchards was more abundant.

7 . Sustainability under external factors

If an unexpected circumstance takes place, affects on the system and makes some changes that is negative for the crop and positive for insect pest's damages and attacks, the strategy IPR would be more enduring than other strategies. This could take some examples as follows:

- Insect pest resistance to the insecticide: when the grower applies the same insecticides and do not alter the insecticides in a long time resulting in the insect pest resistance to insecticides, so the single strategy IO would be failed in this case. However in the strategy IPR, the pruning and the removal would support for the insecticide to manage the insect pests in the orchard more effective than the strategies IO, IP, and IR.

- Drizzly and frost weather: drizzling rain and frost always take place all day and night in phases of the blooming and fruit set of the litchi. These make considerable limitation of the insecticides' efficacy on the insect pests. So the strategy IPR with the pruning and removal methods would bring into play in managing the insect pests rather than other strategies, especially the strategy IO.

- Fluctuation of the temperature: reactivation of the insect pests after hibernation, early or late, numerous or few depend much on the fluctuation of temperature (Tran, 1999). If at the time (early March) the farmer implements the removal for the litchi stinkbug had a warm weather, the litchi stinkbug adults' reactivation would be very numerous. So in this case, the removal would be reduced the efficacy because the litchi farmer would not be enough labor to catch them, and the litchi stinkbug adult reproduces very fast. So the insecticide and the pruning methods would bring into play the effect on the insect pest population instead of the removal method.