FINAL REPORT ON THE PROJECT

OF

A STUDY OF PHEROMONE EFFICIENCY FOR THE DAMAGE REDUCTION CAUSED BY *CONOPOMORPHA SINENSIS* IN ORGANIC LONGAN PLOTS

German Technical Cooperation
(GTZ)
and
Institute of Product and
Standardization (IQS)
Maejo University

TABLE OF CONTENTS

A
LIST OF TABLES

TABLE **Page**

B
LIST OF Figures

FIFURE
Page

B
LIST OF Figures

FIFURE
Page

INTRODUCTION

Rationale

Longan is a main cash crop of Thailand grown in the upper-North of the country. In 2005, Thailand exported longan with a total of 650,000 tons. However, the longan farmers face a problem of yields quality which did not meet the standard required by the markets. The main problem of yields damages is mostly on insects pests particularly the *Conopomorpha sinesis*. It often destroys longan fruits during the early fruit bearing period, causing decayed fruits and very low selling price. In the previous year, the Institute of Product and Standardization (IQS) of Maejo University had collaborated with the German Technical Cooperation (GTZ) to promote longan farmers in the project on organic longan growing to distribute the yields to Top supermarket. Lately, however, the longan farmers faced the problem of damaged yields caused by the *Conopomorpha sinesis.*

Litchi fruit borer, *Conopomorpha sinesis* (Lepidoptera: Gracillariidae) are main pests damaging litchi and longan fruits, particularly litchi. It was found that 65.41 percent of litchi fruits and 9.93 percent of longan fruits were damaged by these pests (Donsophon et.al., 1998). It damages from the early fruit bearing until fruits are ripe. The litchi fruit borer at the last stage of its life cycle usually bores the fruite in order to build the worm net. The chrysalis on old leaves, and leaf residues are usually destroyed by solitary ectoparasitoid which is in the order of Hymenoptera. Examples of this order are *Phanerotoma sp., Colastes sp., Pholestesor sp., Paraphylax sp.,* and *oryphus sp. (Incheumonidae).* These solitary ectoparasitoid had high efficiency in controlling *Conopomorpha Itchiella (Gracillariidae)(Donsophon et.al., 1997).*Hwang and Hung reported that *Chelonus chailini sp. (Braconidae)* in Taiwan is the same kind as those found in Malaysia.

Conopomorpha sinesis can exist across the seasons. It damages young leaves and stalks (Bradley, 1986) leaving the occurrence of black pith when the branches get older. The 1-2 years old branches of litchi and longan trees usually have the occurrence of black pith for 80-90 percent. Besides, moth larvae also damage the branches and corsages. Flowers of E-dor longan varieties are destroyed for 19.26 percent and those of Haew varieties for 15.91 percent. (Donsophon et.al., 1998)

revealed that 300 moths were trapped in 200 sticky glue traps in August and male ones were mostly found.

The sticky glue traps are used in various forms for trapping insects. It can be used with pheromone traps, light trap, and sticky board colors. This is aimed to explore and conduct random sampling for counting kinds and amount of insect in a particular time. It is used as a basis for decision-making on pesticide spraying to destroy coding moth, *Cydia pomonella,* Yellow peach moth *Conogethes punctiferalis,* Oriental fruit moth, *Grapholita molesta* in the apple, peach, and persimmon orchards. (Van Denventer et.al., 1992; Gleason et.al., 1994; Knight, 2000; Anont, 2001). Sticky board like red, yellow, green, and white boards have different wave length of reflecting color so it attracts different kinds of insects. Pasian and Linquist (1998) stated that yellow and blue sticky board color are preferred. Besides, climate condition is one factor concerning with trap installation and colored sticky glue traps in orchard.

Objectives of the Study

Specifically, this research aimed to do the following:

1. Investigate the pheromone efficiency of *Conopomorpha sinesis*;
2. Investigate the reduction of damages caused by *Conopomorpha sinesis;* and
3. Extend results of the study to organic longan farmers and educational institution

Significance of the Study

Results of the study can be used as guidelines for the investigation of extension methods to organic longan farmers in the application of *Conopomorpha sinesis* prevention. This helps reduce production costs and add value for the yields.

Hypothesis of the Study

Pheromone has an efficiency in the prevention of longan yields damages caused by *Conopomorpha sinesis*

Scope and Limitation of the Study

This research was limited to four organic longan plots of Prokchon Phromkangwan Partnership Limited, Saraphi district, Chiangmai province.

CHAPTER II
REVIEW OF RELATED LITERATURE

Biography

Name Fruit borer, Litchi fruit-borer

Scientific Name *Conopomorpha sinesis* Bradley: Gracillaridae

It is a small night moth with grayish-brown in color. It is 12-15 mm. in width when spreading the wings and 6-7 cm in length and with zig-zag pattern. Tip of the wings is yellowish-brown in color. The area wings are silver gray in color and the tentacles are silver in color and its length is longer than the wings and body. *Conopomorpha sinesis* usually lays a single egg on the fruit. The egg is yellow and oval in shape with hatchery, the worm is 1 mm. in length with creamy-white in color but its skull is brown. The worm has 3 stages: 4.3, 5.7, and 5.3 days, respectively. The worm in the last stage will bore the fruit and stay in the leaf as chrysalis. The chrysalis in 1 mm in width and 7.1 mm. in length with 7-8 days of the chrysalis period. The worm begins to damage the fruit about 1 month before harvesting. The moth usually lay a single egg around the connecting point of the fruit. When the worm come out of the egg, it will eat the lining area between longan pulse and the connecting point. The damage cannot be observed from outside. The damaged fruits eventually fall down from the tree. However, longan fruits are found to have less damage than litchi fruit (*Pest: Conopomorpha sinesis* www.bayercropscience.co.th)

Donsophon and Thasannont (2003) had investigated on the population of *Conopomorpha sinesis* (Lepidoptera: Gracillariidae) by using various stick glue trap

color in longan and litchi orchard. They found that litchi fruit borer. *Conopomorpha sinesis* (Lepidoptera: Gracillariidae) is a small moth.

The period of time that the worm damages the lotchi fruit is longan than that of the longan fruit. It usually occurs during March-August. The team of researchers had investigated the population of *Conopomorpha sinesis* at the Chiangrai Horticulture Reseach Center from October, 1998-December, 2000. The sticky glue plate color used were yellow, white, red, and blue. The plates were place in delta traps and hung beneath the bushes of litchi and longan fruits. It was found that the white trap in litchi orchard (not yet giving the yields) could trapped a big number of moths during the young leaf bearing in May and July and September for longan orchard. It was also found that a number of male moths was much higher than that of the female ones. (95:5 percent). When placing the yellow, white, red, and blue for 10 pieces each in litchi orchard giving the yields, it was found that all of it could trap the moths with different numbers depending on season and growth period. For litchi orchard during the harvest season of May, the moths were caught for 78 heads/40 traps (1999) and 284 heads/40 traps (2000) as a maximum number. For longan orchard in August (1999), the moth were caught for 415 heads/40 traps, respectively. (male: 95, female: 5 percent). When an analysis of the relationship between external variable factors such as temperature (C) sunlight (hours/day), rain amount (mm), and relative humidity (%) and a number of moths to be caught by using Stepwise regression, it was found that sunlight is only one factor effecting flying of the moths (R^2) 0.59

Boontham and Lecksawad (1993) had explored and investigated *Conopomorpha sp.* (Lepidoptera: Gracillariidae) and parasite in an annual report of The Institute of Science and Technology Research and Development Center, Department of Biology, Faculty of Science, Chiangmai University. It revealed that population exploration of fruit borer was conducted both in longan and litchi orchards in Lamphun, Chiangmai and Chiangrai provinces in 1991 and 1992. Dip net and light trap were used for catching fruit borer and only two moths were found. Moth eggs were found in longan and litchi fruits for 2.35 and 12.00 percent whereas chrysalis were found for 97.62 and 88.00 percent, respectively. For fruit borer, the moths lay single egg on the fruits with 3.00 ± 0.50 days for hatchery. The worm will eat the pulse at the lining between the seed and the fruit stalk. The 1-3 worm stages is 4.30 ± 0.45, 5.75 ± 0.43, and 5.30 ± 0.46 days on average, respectively. The worm in the last stage will bite the fruit and get out to build the chrysalis period is 6.08 ± 0.48 days, and matured chrysalis period is 4.80 ± 0.83 days on average. The fruit borer moth is a small night moth with an average width of 1.90 ± 0.20 mm. in width and 5.50 ± 0.50 mm. in length. It has black, white, and brown scales with long tentacles. The male moth has one frenulum and the tip of the abdomen has clear sex organ whereas the female one has two frenulums and the tip of the abdomen is a short tube. However, the reproductive system of the male moth cannot be found due to its tiny size. For the female moth, the each oval is found to have four ovariales. The moth egg is small with oval in shape and it is 0.71 ± 0.06 mm. in width and 0.87 ± 0.09 mm. in length on average. The worm has three stages and its skull is 0.11 ± 0.01, 0.41 ± 0.01, and 0.62 ± 0.02 mm. on width on average. Chrysalis of the object type stays in a transparent chrysalis nest with the size of 1 ± 0 mm. in width and 7.1 ± 0.94 mm. in length. The parasite found is of two types in the Braconidae family and Hymenoptera order. Parasite in the worm chrysalis stages of fruit borer is in the ratio of 1:1 and only 7 parasites were found.

Boonthum and Leksawad (1993) had investigated on fruit damage of *Conopomorpha sp.* (Gracillariidae:Lepidoptera). They found that fruit borer is a main pest of litchi and longan which causes the fruits fall down. Based on a comparison of fruit bunch wrapping and non-fruit bunch wrapping during the early stage until ripe, it was found that light blue net fruit bunch wrapping had a higher level of fruit falling than that of unwrapping for 10 percent. Besides, it was damaged by fruit borer but it was less than the unwrapping for 7 times. About 85-92 percent of fruit falling was caused by the physical anatomy of litchi. When splitting the litchi and longan fruits, it was found that the pulse was damaged by fruit borer when the fruits were 14 and 19 days old, respectively. In addintion, the damage in ripe fruits was found around the fruit stalk only and the pulse was not damaged. However, consumers may not full like to consume it.

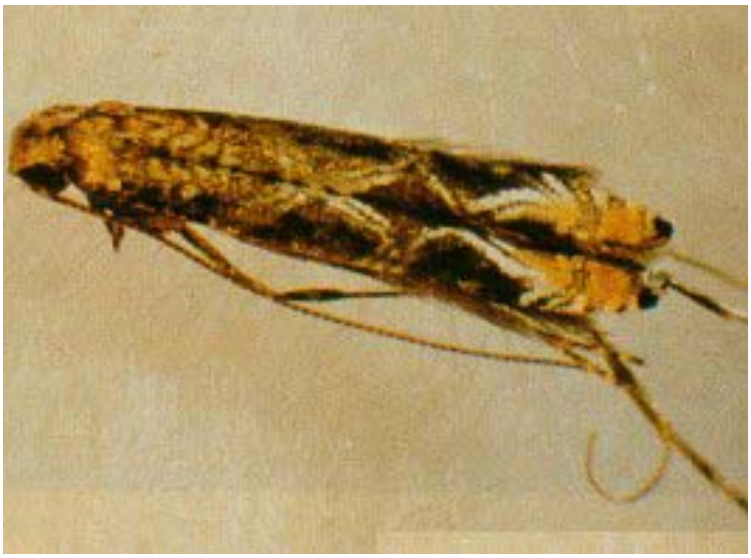


Figure 2.1 Matured *Conopomorpha sinensis* appearance

CHAPTER III
METHODOLOGY

The study of pheromone efficiency for the reduction of damage caused by the *Conopomorpha sinensis* in four organic longan plots of Prokchon Phromkangwan Partnership Limited, Saraphi district, Chiangmai province. This study consisted of three parts as follows:

Part 1. Investigation of pheromone efficiency of *Conopomorpha sinensis*;

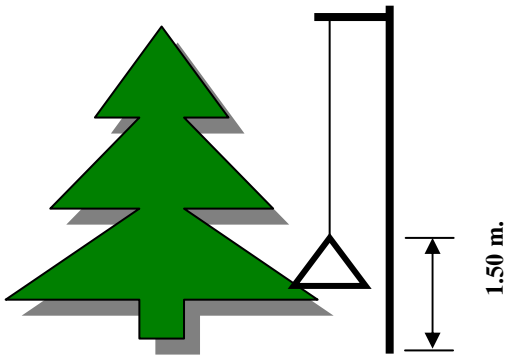
Part 2. Investigation of destructive reduction caused by *Conopomorpha sinensis*; and

Part 3. Extension results of the study to organic longan farmers and education institutions

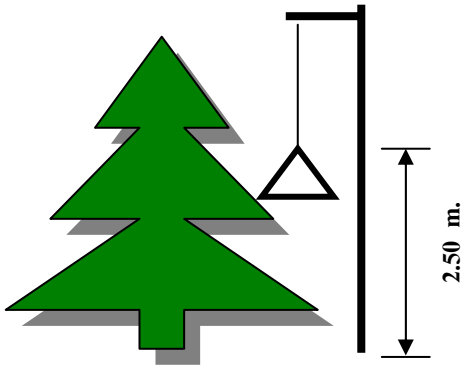
Part 1 Investigation of pheromone efficiency of *Conopomorpha sinensis*

Step 1. Pre-experiment

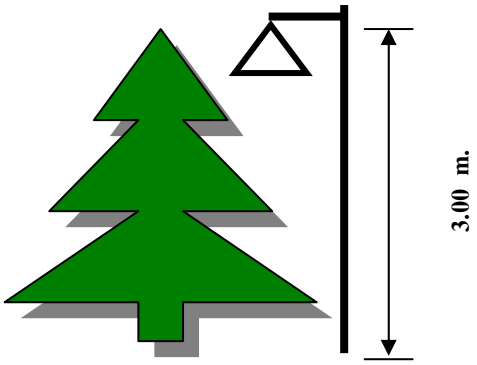
The investigation of pheromone efficiency of *Conopomorpha sinensis* was aimed to examine the pheromone efficiency in attracting *Conopomorpha sinensis* and a level of the trap hanging during March-June, 1999. The trap was divided into two types: the Beween (trees) and the inside (bush). It was installed 30 meters from each other and with three levels: low, medium, and high. Thus, the installation form of the traps in the 4 plots were as in the figures below.



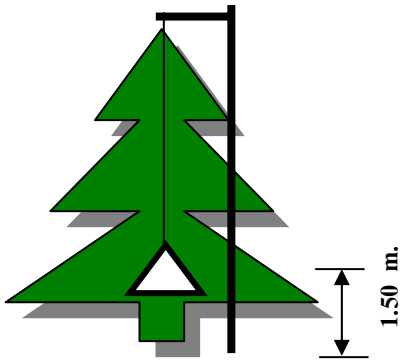
Between / Low



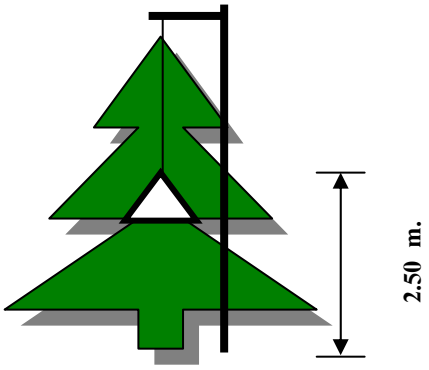
Between / medium



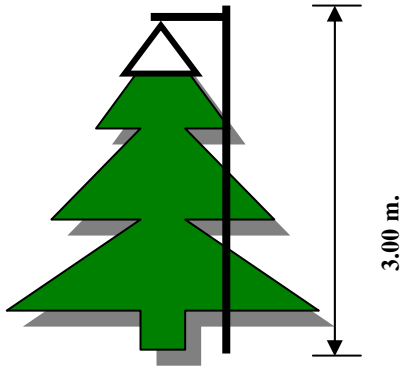
Between / high



Inside / Low



Inside / medium



Inside / high

Form 1 (Between)	**Form 2** (Inside)
Low = 1.50 m.	Low = 1.50 m.
Medium = 2.50 m.	Medium = 2.50 m.
High = 3.00 m.	High = 3.00 m.

Figure 3.1 Specimen of sticky glue traps and installation: **a)** white delta trap, **b)** trap hanging form, **c)** "25x30 cm" sticky glue plate, and **d)** installation of a sticky glue trap

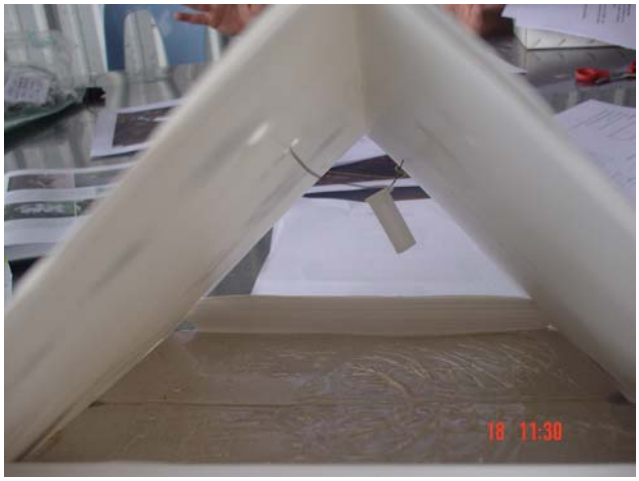


Figure 3.2 Pheromone hanging in a white delta trap model

Figure 3.3 Specimen of trap installation in the actual area of organic longan plot

Plan of the experimental step 1 (Pre-experiment)

In this study, the experimental area consisted of 5 plots together with experimental planning by random sampling of trap installation as follows:

Plot 1 (Crop 1, Plot 1) – 12 traps

(**Crop 1**, **Plot 1**)		
Trap No.	**Treat.**	**A moth**
6	Between/ low	
3	Between/ med	
2	Between/ high	
8	Inside/ low	
9	Inside/ med	
12	Inside/ high	
10	Inside/high	
11	Inside/ med	
7	Inside/low	
4	Between/ med.	
1	Between/ high	

Plot 2 (Crop 2, Plot 5) – 6 traps

(**Crop 2**, **Plot 5**)		
Trap No.	**Treat.**	**A moth**
27	Inside/high	
26	Inside/ med.	
25	Inside/low	
30	Between/ high	
29	Between/ med.	
28	Between/ low	

Plot 3 (Crop 3, Plot 4) – 6 traps

(Crop 2, Plot 5)		
Trap No.	**Treat.**	**A moth**
19	Inside/high	
20	Inside/ med.	
21	Inside/low	
24	Between/ high	
23	Between/ med.	
22	Between/ low	

Plot 4 (Crop 4, Plot 2+3) – 6 traps

(Crop 2, Plot 5)		
Trap No.	**Treat.**	**A moth**
16	Inside/ low	
17	Inside/ med.	
18	Inside/ high	
15	Between/ low	
14	Between/ med.	
13	Between/ high	

Step 2. After doing pre-experiment

The experimental area was obtained by pheromone efficiency examining. The pre-experimental was conducted during March-June, 1999 in which the experimental area was divided into 5 plots. Then, the experiment was conducted during July-August, 1999. The experimental method was as follows:

Plot 1 (Crop 1, Plot 1) and Crop 2, Crop 5 This experimental plot was used for the investigation of pheromone efficiency by hanging the white delta traps with a sticky glue plate and pheromone inside. The traps were installed around the plot with the distance of 30 meters each. Also, the traps were hung in an appropriate level after obtaining results of the pre-experiment.

Plot 3 (Crop 3, Plot 4) and Plot 4 (Crop 4, Plot 2+3) It was used as a control plot. White delta traps with a sticky glue plate without pheromone were installed around the plot with the distance of 30 meters each.

Data Collection

Step 1 Pre-experiment

Researchers of the institute of Product Quality Standardization, Maejo University collected data by counting worms of the *Conopomorpha sinensis* on the traps of the 5 plots and then recorded it every week.

Step 2 After the pre-experiment

Researchers of the Institute of Product Quality and Standardization, Maejo University collected data by counting worms of the *Conopomorpha sinensis* on the traps of the 5 plots and then recorded it every two weeks (twice a month) until the yields were harvested.

Part 2 The investigation of damage reduction caused by *Conopomorpha sinensis*

A damage comparison of longan yields (finding the percentage of damage)

This was done after harvesting longan yields of both the plot having pheromone and the plot having no pheromone aiming at finding an amount of longan representing the total longan yields. After obtaining an amount of longan samples, longan damage was examined by packaging the longans in the same amount and condition as those for selling. After that, percent of damage was computed.

Part 3. Extension results of the study to organic longan farmers and education institutions

After finishing the research, results of the study were extended to organic longan farmers and educational institutes.

CHAPTER IV
RESULTS OF THE STUDY

Results of the study on pheromone efficiency for the damage reduction caused by the *Conopomorpha sinesis* in five organic longan plots of Prokchon Phromkangwan Partnership Limited, Saraphi district, Chiangmai proince were as follows:

Part 1 The investigation of pheromone efficiency in *Conopomorpha sinesis*

Step 1. Pre – experiment

This step was the data of pheromone efficiency in the *Conopomorpha sinesis* and finding and appropriate level of trap hanging during March – June, 2009. The trap installation was divided into two types : the Between and Inside in which the distance each trap was 30 meters.

Form 1 (Between)	**Form 2** (Inside)
Low = 1.50 m.	Low = 1.50 m.
Medium = 2.50 m.	Medium = 2.50 m.
High = 3.00 m.	High = 3.00 m.

Thirty traps were used for luring the *Conopomorpha sinesis* in four experimental plots during March – June, 2009. A number of moth trapped in the pheromone traps is shown in figure 4.1

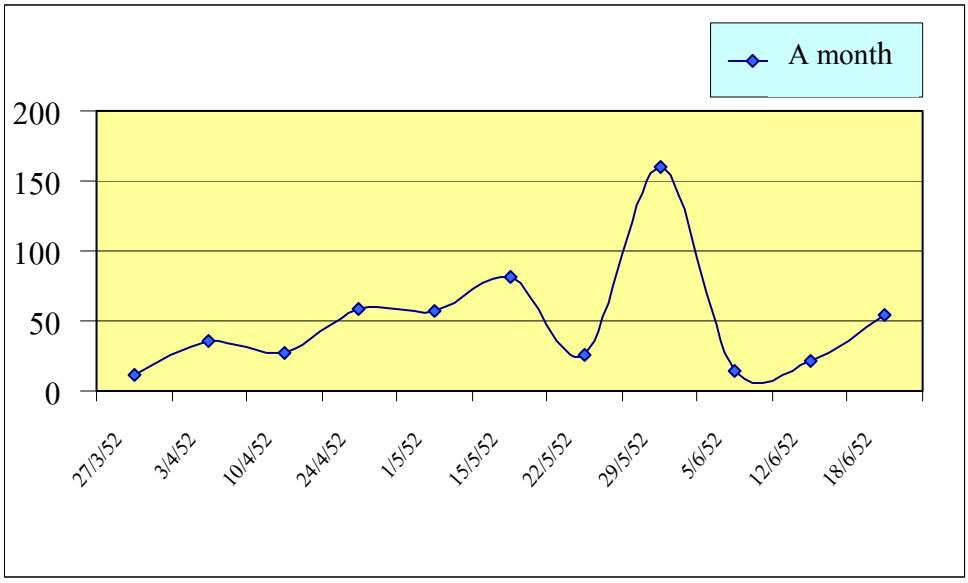


Figure 4.1 A number of *Conopomorpha sinesis* found in 30 pheromone traps of each month

Based on Figure 4.1, it was found that the moths were trapped most in may (160 moths/30 traps), the beginning of the rainy season. During of the time, longan trees bear it leaves, flowers and fruits which are food sources of the *Conopomorpha sinesis*. Results of the experiment conformed to a study of Nantharat and Tasnon (2003) on the population of the *Conopomorpha sinesis* (Lepidopter : Gracillaridar) using vasious colors of sticky glue trapsin Litchi and longan orchards. It was found that there was an increase of moths trapped in the orchards due to less sunlight per day. This was because : 1) it is a night moths which can mate and lay eggs more than usual which there is less sunlight and 2) the moths find a place which can protect it from sunlight and rain. For this experiment, it was found that a number of moths was decreased due to long continual rainfall causing the traps were wet.

Table 4.1 A number moths *(Conopomorpha sinesis)* trapped during March – June 2009

Between (15 traps)				**Inside (15 traps)**			
Treatment	**Trap**	**Moths**	**Mean**	**Treatment**	**Trap**	**Moths**	**Mean**
Low	5	67	13.4	Low	5	10	2.0

Medium	5	168	33.6	Medium	5	54	10.8
High	5	53	10.6	High	5	198	39.6
Total	15	288	19.2	**Total**	15	262	17.4

Table 4.1 shows that there are two types of trap : the between and the Inside. It was found that the moths were trapped most in the Inside traps (Inside / high) for 198 moths ($\bar{x}$ = 39.6) . This was followed by the Inside/medium (54 moths ; $\bar{x}$ = 10.6) and the Inside/low (10 moths : $\bar{x}$ = 2.0) . For the between type , the moths were trapped most in the Between/medium (168 butterflier ; $\bar{x}$ = 33.6). This was followed by the between/low (67 moths ; $\bar{x}$ = 13.4) and the Between/high (53 moths ; $\bar{x}$ = 10.6)

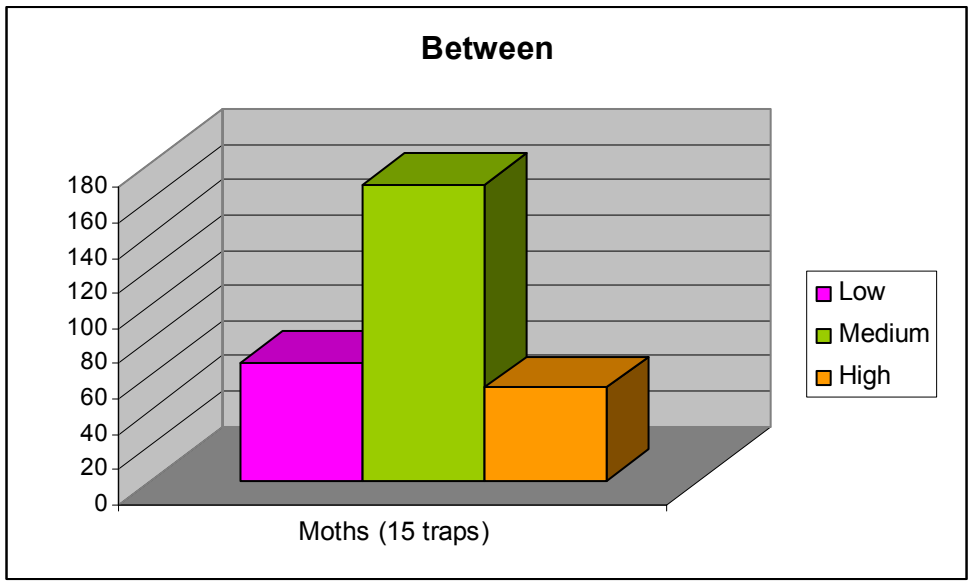


Figure 4.2 A bar chart showing a number of the *Conopomorpha sinesis* found in the first kind of trap installed between the longan trees during March – June, 2009

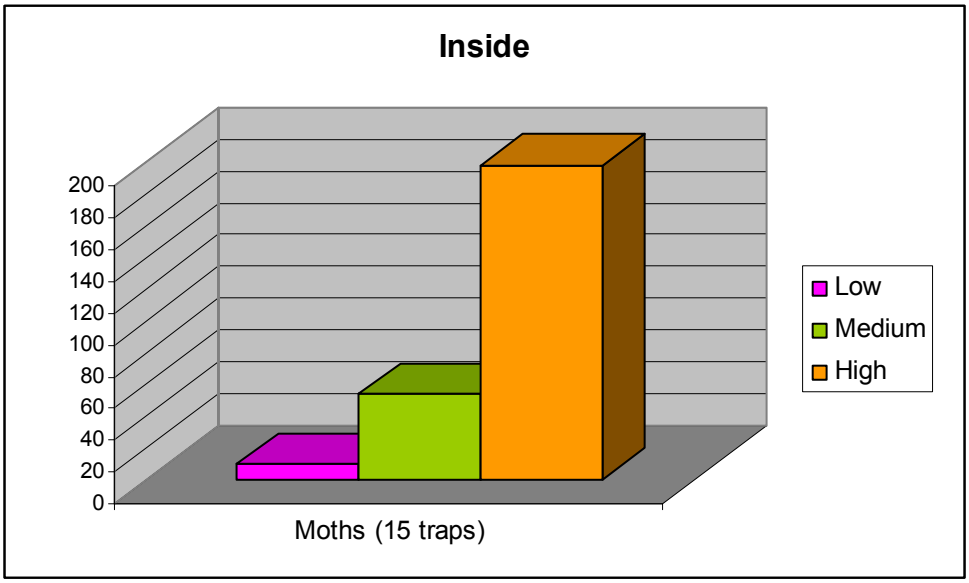


Figure 4.3 A bar chart showing a number of the *Conopomorpha sinesis* found in the second kind of trap installed inside the bush during March – June, 2009

Table 4.2 A number of the *Conopomorpha sinesis* found in the two kinds of trap during March – June, 2009

Total catches 30 traps	
(Between and Inside)	
Treatment	**Moths / traps**
Low	77
Medium	222
High	251
Total	550

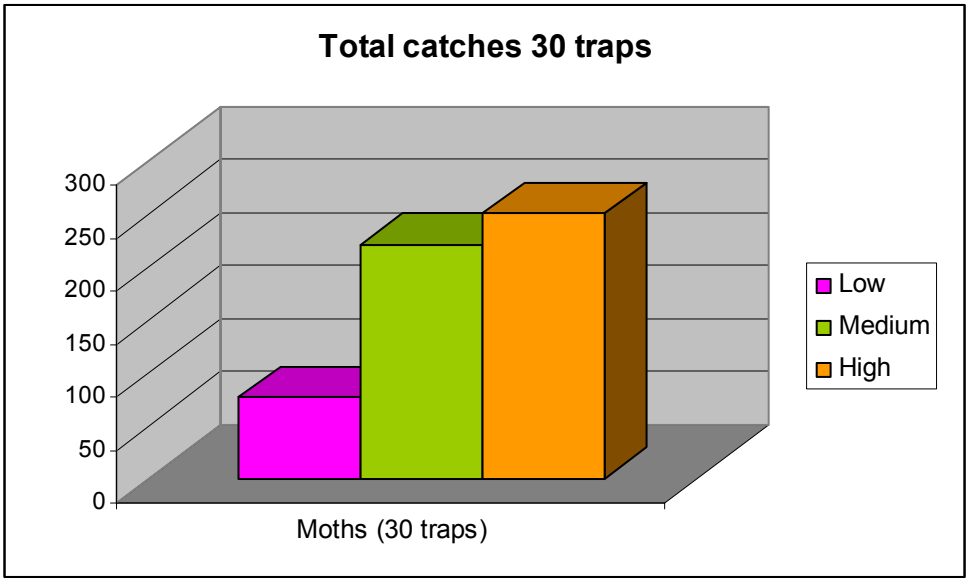


Figure 4.4 A bar chart showing a comaprison of number of insects found in the trap hung in different levels during March – June, 2009

Figure 4.4 shows levels of trap hanging for luring the moths. It was found that the moths were trapped most in the height of 3.00 meters with a number of 251 moths/30traps ($\bar{x}$ = 8.3) . This was followed by the height of 2.50 meters (Medium) with a number of 222 moths/ 30 traps ($\bar{x}$ = 7.40) and the height of 1.50 meters (Low) with a number of 198 moths ($\bar{x}$ = 39.6) . This was followed by the first type (Between/medium) with a number of 168 moths ($\bar{x}$ = 33.6)

Step 2 After the Pre – experiment

After finishing the Pre–experiment, it was found that the second type of trapping (Inside/high) and the first type (Between/medium) could trap the moths in almost the same numbers. This conformed to a study of Donsophon and Thasanon (2003) that male moths like to fly and look for female ones for breeding whereas female moths look for a place to lay eggs such as young leaf, flower, and young fruit. An average height of longan trees in the experimental orchard is 2 – 3 meters.

The second step of this experiment was done by dividing the orchard into 5 plots and conducted the experiment during July – August, 2009 . The following was the detail abtained from the

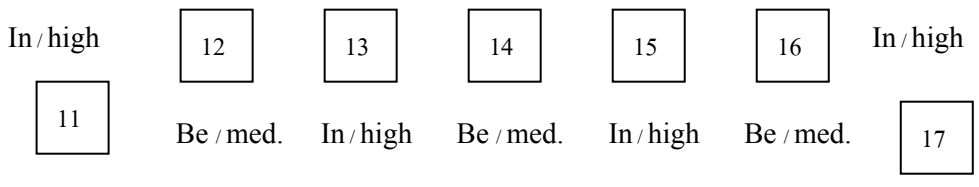
Pre – experiment:

Treatment 1 (Crop 1 , Plot 1) = 26 Traps with pheromone

Treatment	2 (Crop 2 , Plot 5)	=	11 Traps with pheromone
Control	1 (Crop 4 , Plot 2,3)	=	29 Traps with pheromone
Control	2 (Crop 3 , Plot 4)	=	24 Traps with pheromone

Treatment 1 (Crop 1, Plot 1)

The researchers employed both types of the trap installation : Between/medium and Inside/high. The two types were installed every other one with the distance of 30 meters (26 traps) around the plot. The height of longan trees in the plot was different and each one had a big bush with was close to each other in a big plot. The method of trap installation is shown in Figure 4.5



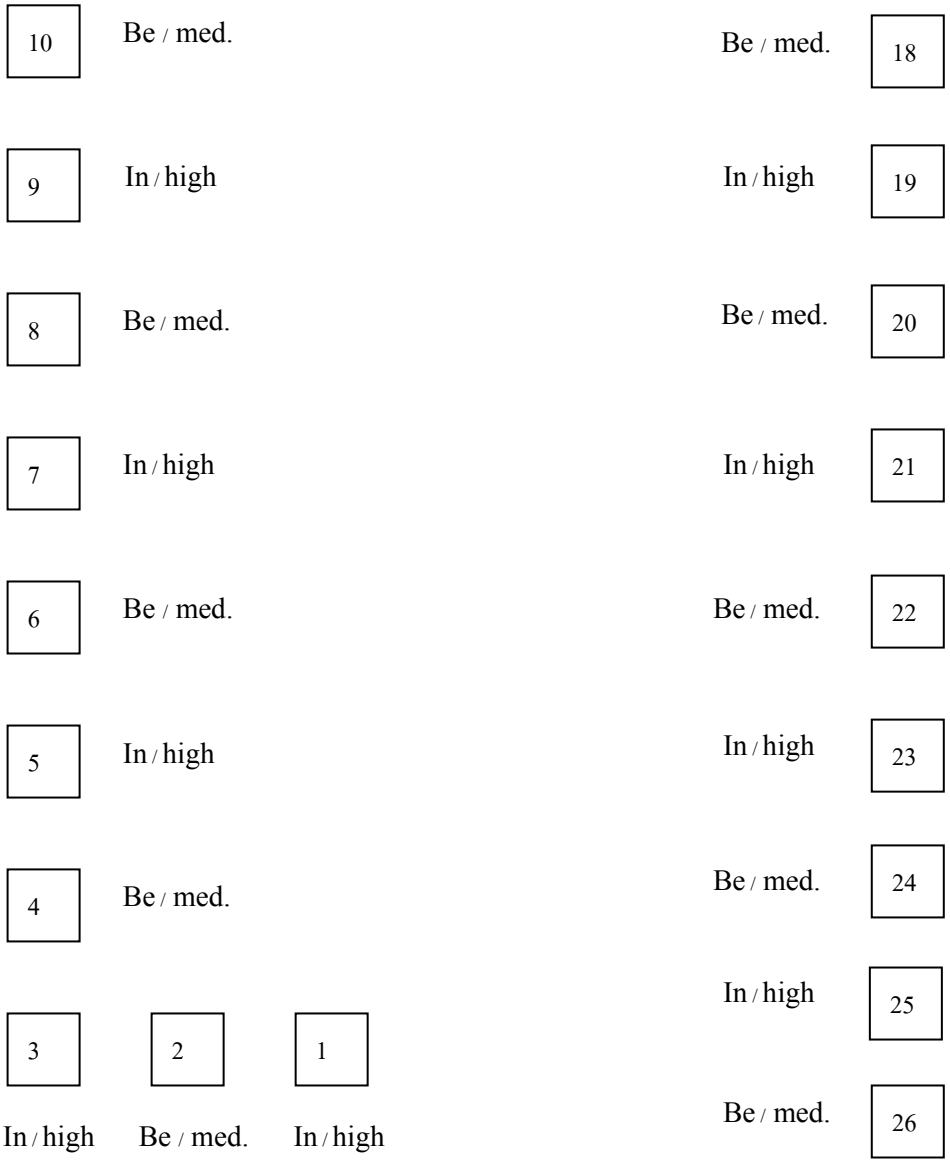
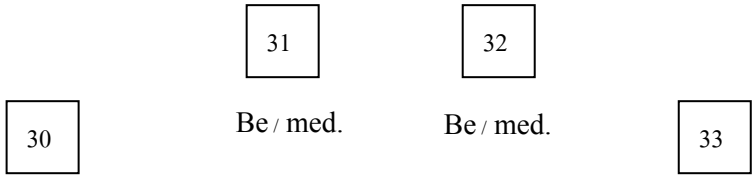


Figure 4.5 A figure showing the installation of traps around the longan orchard **Treatment 2**. (Crop 2, Plot3) together with traps number (Crop 1, Plot 1)

The researchers chose the Between/medium installation done around the plot and eash trap was 30 meters indistance (11 traps). An average height of longan trees in this plot was not more than 3 meters and its bushes were far from each other. The method of trap installation is shown in Figure



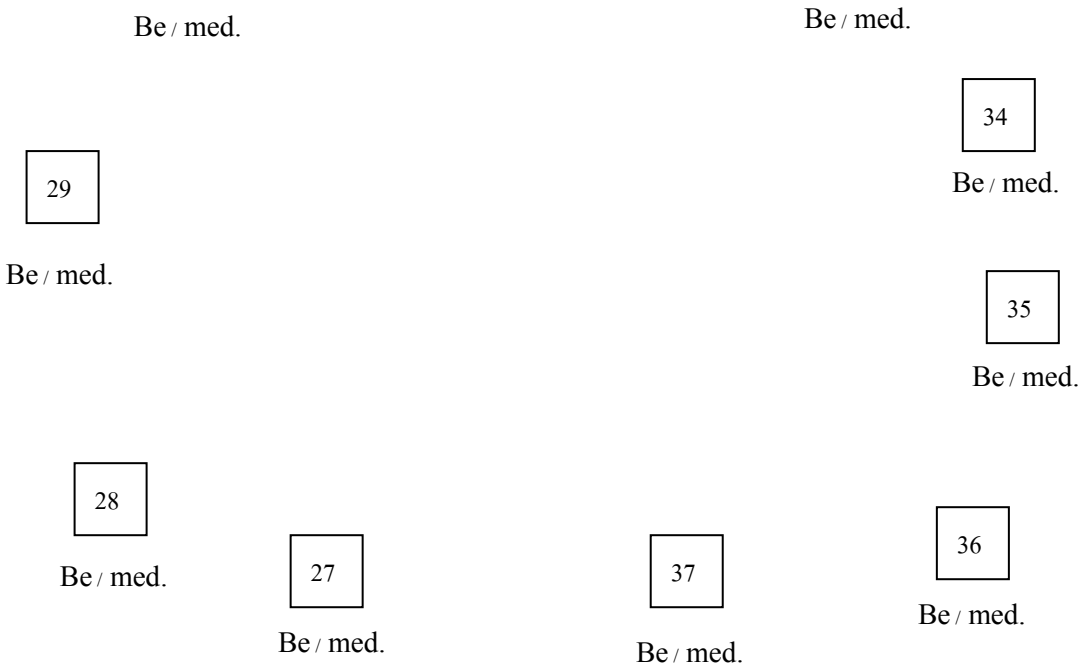


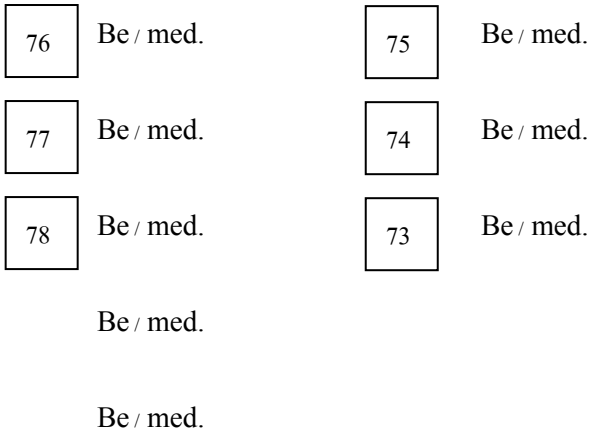
Figure 4.6 A figure showing the installation of traps around the longan orchard together with traps number (Crop 2, Plot 5)

Figure 4.7 Specimens of longan plots having longan trees with an average height of not more than 3 meters and having far bush distance (Crop 3, Plot 4)

Figure 4.8 The trap installation between longan trees with an average height of not more than 3 meters and having far bush distance (Crop 3, Plot 4)

Control 1 (Crop 4, Plot 2,3)

The researchers chose the Between/medium installation around the plats, each trap was far from each other for 30 meters (29 traps). An average height of longon trees in the plots was not more than 3 meters and its bush was far from each other. The method of trap installation is shown in figure 4.9



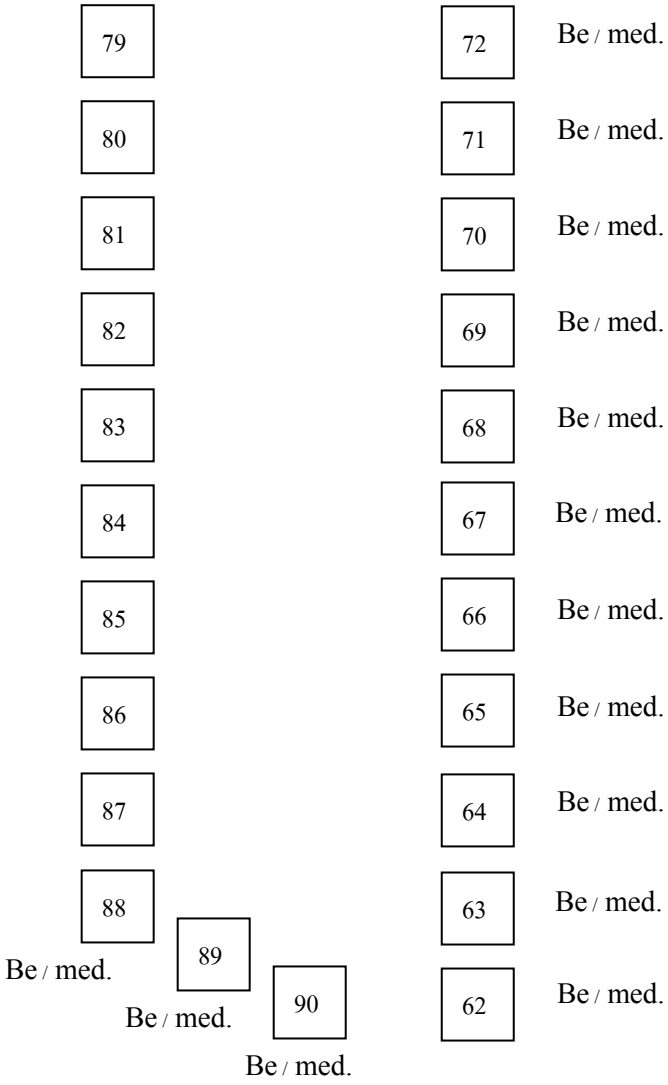


Figure 4.9 The trap installation around the longan plots together with the trap number

Control 2 (Crop 3, Plot 4)
(Crop 4, Plot 2, 3)

The researchers chose the Between/installation around the plot, each trap was 30 meters in distance (24 traps). An average height of longan trees in the plot was not more than 3 meters and its bush was far from each other. The method of trap installation is shown in Figure 4.10

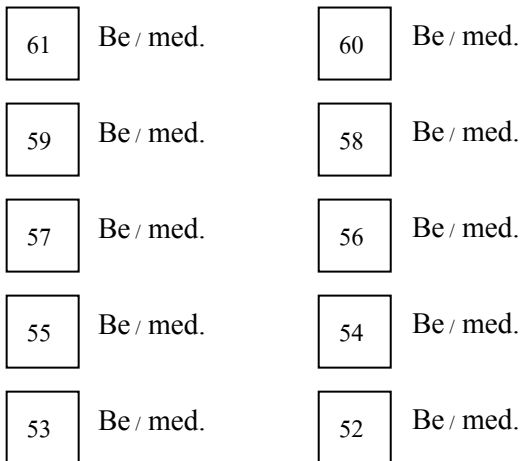


Figure 4.10 The trap installation around the longan plots together with the trap number (Crop 3, Plot 4)

Data collction on a number of moths trapped in various crops once per two weeks during July – August, 2009 is shown in Table 4.3

Table 4.3 : A number of moths trapped in each experimental plot

Date	**Treatment 1** (Crop 1, Plot 1)		**Treatment 2** (Crop 2, Plot 5)		**Control 1** (Crop 4, Plot 2,3)		**Control 2** (Crop 3, Plot 4)	
	moths / 26 traps	moths / traps (Mean)	moths / 11 traps	moths / traps (Mean)	moths / 29 traps	moths/ traps (Mean)	moths / 24 traps	moths / traps (Mean)
10 July 09	258	9.92	32	2.90	46	1.58	48	2.00
24 July 09	105	4.03	13	1.18	98	3.37	104	4.33
6 August 09	76	2.92	4	0.36	84	2.89	78	3.25
21 August 09	77	2.96	3	0.27	46	1.58	67	2.79
Total	516	19.83	52	4.71	274	9.42	297	12.37

Data shown a number of moths (*Conopomorpha sininsis*) trapped in each plot is presented in the form of linear graph for finding a relationship between the time duration of investigation (x) and a number of moths trapped (y) in order to analyze a tendency of a number of moths and time span, the findings of relationship are shown is Figures 4.7 – 4.10

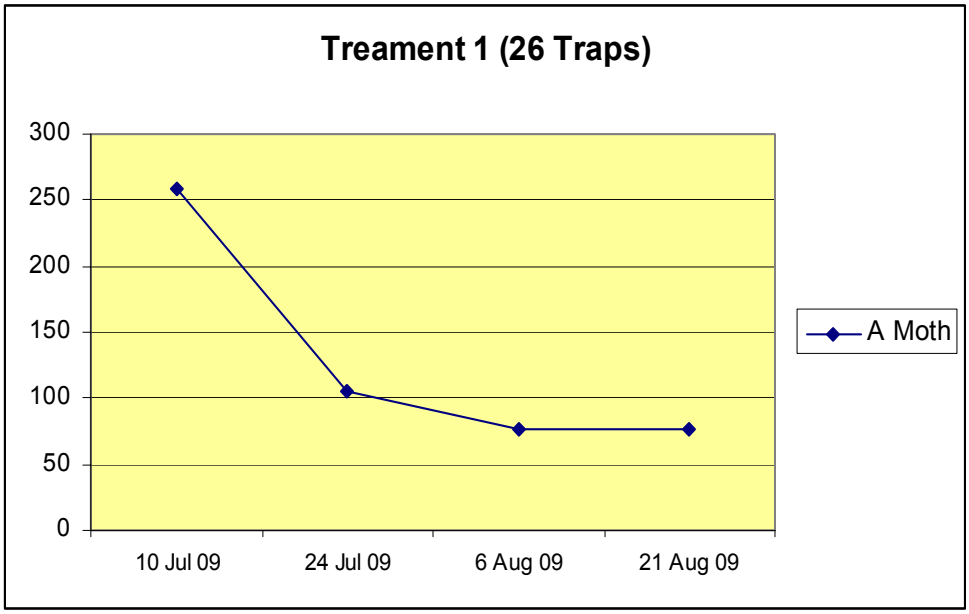


Figure 4.11 A graph showing a number of the *Conopomorpha sinesis* found in the 26 traps of Treatment 1 during the period of 8 weeks

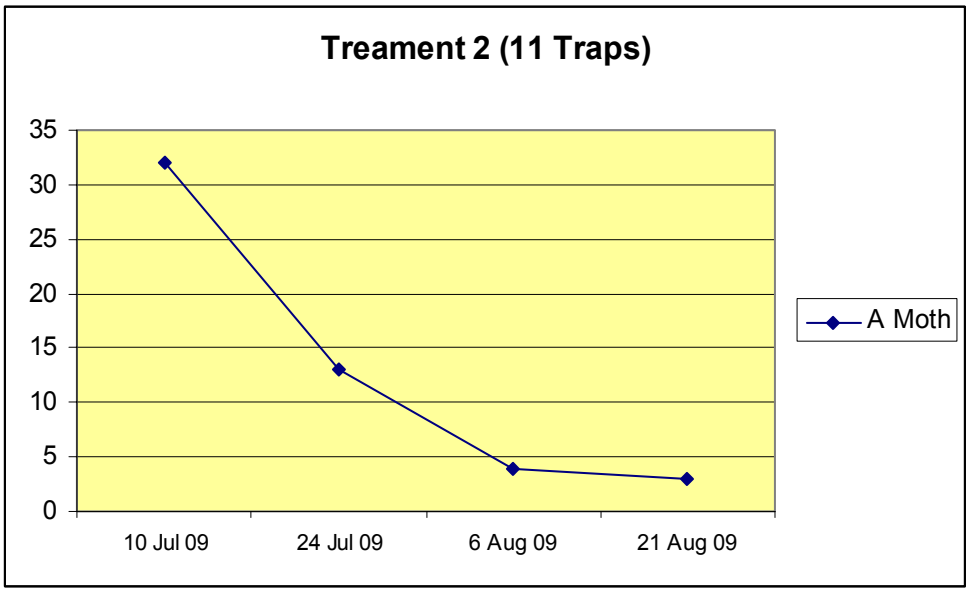


Figure 4.12 A graph showing a number of the *Conopomorpha sinesis* found in the 11 traps of Treatment 2 during the period of 8 weeks

Figures 4.11 and 4.12 show that both Treatments 1 and 2 could trap a high number of moths during the initial stage (July, 2009) but it had a tendency to decrease in August, 2009. This might be because of weather condition and a higher remperature during the experimental period and this might affect the efficiency of pheromone's time of using. Meanwhile, the experimental plots might not be the spreading place of these moths because the plots of Treatments 1 and 2 were least close to other longan plots.

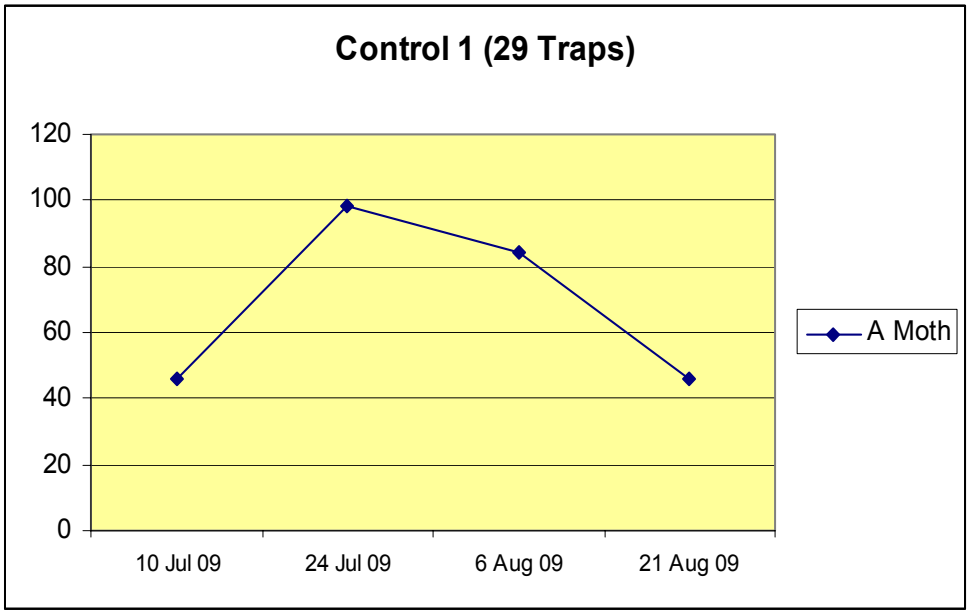


Figure 4.13 A graph showing a number of the *Conopomorpha sinesis* found in the 29 traps of the Control plot 1 during the period of 8 weeks

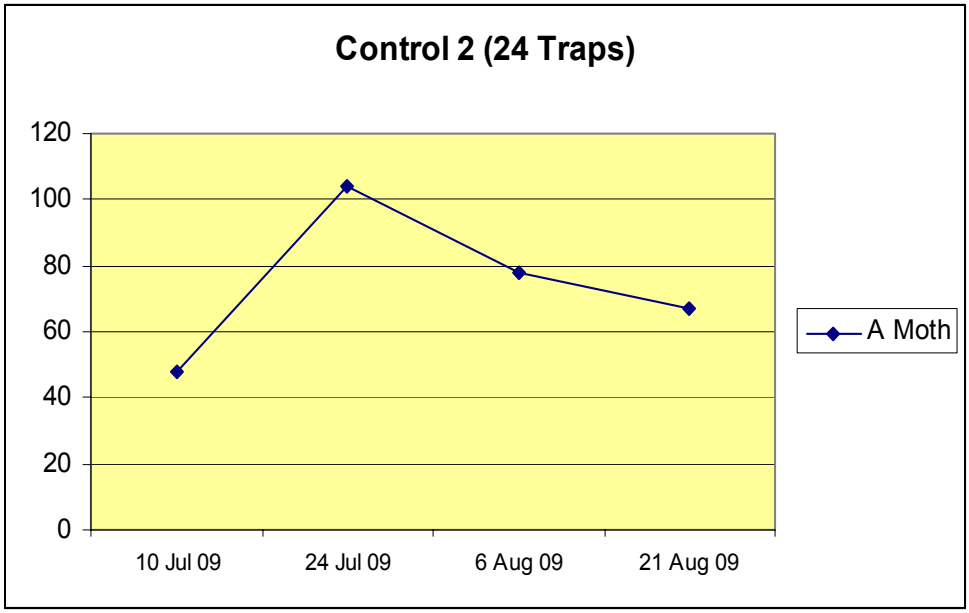


Figure 4.14 A graph showing a number of the *Conopomorpha sinesis* found in the 24 traps of the Control plot 2 during the period of 8 weeks

Figure 4.14 Figures 4.13 and 4.14 show that there was not much dfferent in a number of moths trapped in the two plots in the initial stage and the number of moths trapped

was higher in July, 2009. This might be because it is the time that the longan fruits are ripe and ready to be harvested. Thus, it is a good source of food for moths and other insects. Besides, the Control 1 and Control 2 plot is close to another farmer's longan orchard using chemicals. It could be observed that a number of moths trapped in August was decreased. It might be because the longan farmers began to harvest the yields during this time but the nearby longan orchard were not havested yet. Therefore, there were some more moths trapped in the experimental plot which had already been harvested,

Figure 4.15 The longan trees begin to give ripe fruits and are ready to be harvested in August, 2009

Figure 4.16 The researchers and his assistants were counting the insects found in the traps

Figure 4.17 The *Conopomorpha sinesis* found in the trap

Part 2 A Study of damage reduction caused by the *Conopomorpha sinesis*

After harvesting the yields in the experimental plots, all of the four plots were randomly divided into five zones each (A, B, C, D, and E). Then, longan fruits were randomly collected for 10 bags (1 kg.each) of each zone (10 replitcations) and them the obtained longans were packed with thw same Type of package, amount, and condition. The longans were kept in a room with the temperature of 25 °C for 10 days (Figure 4.22). The damaged longans in the experiment is shown below.

N = 50

Treatment (10 replication)				
Zone A	**Zone B**	**Zone C**	**Zone D**	**Zone E**
A1	B1	C1	D1	E1
A2	B2	C2	D2	E2
A3	B3	C3	D3	E3
A4	B4	C4	D4	E4
A5	B5	C5	D5	E5
A6	B6	C6	D6	E6
A7	B7	C7	D7	E7
A8	B8	C8	D8	E8
A9	B9	C9	D9	E9

The researchers conducted random sampling for obtaining an area for zone dividing in each experimental plot as shown in Figure 4.18-4.21 as follows.

Treatment 1 (Crop 1, Plot 1)

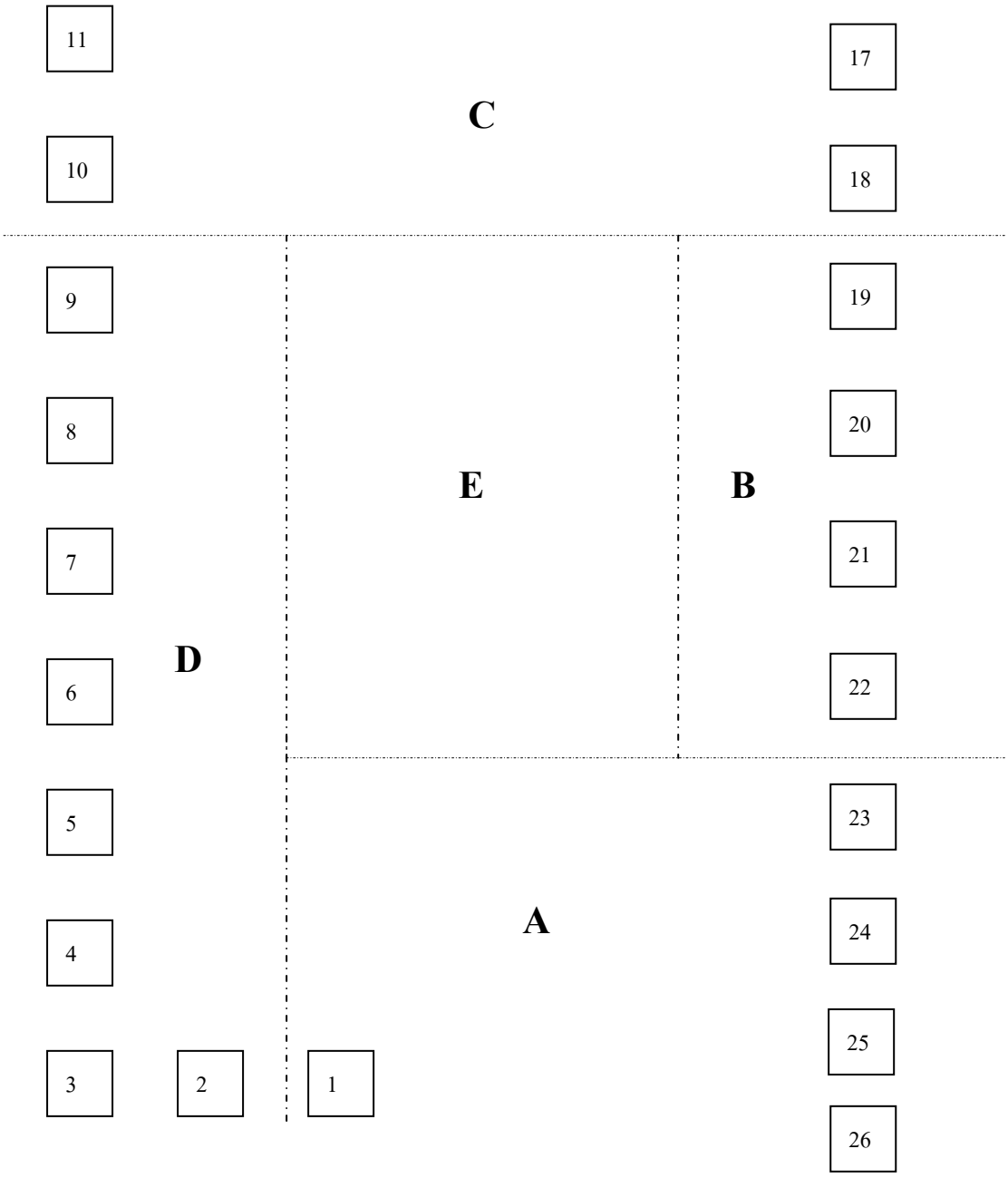


Figure 4.18 Random sampling for dividing the area into 5 zones of Crop 1, Plot 1

Treatment 2 (Crop 2, Plot 5)

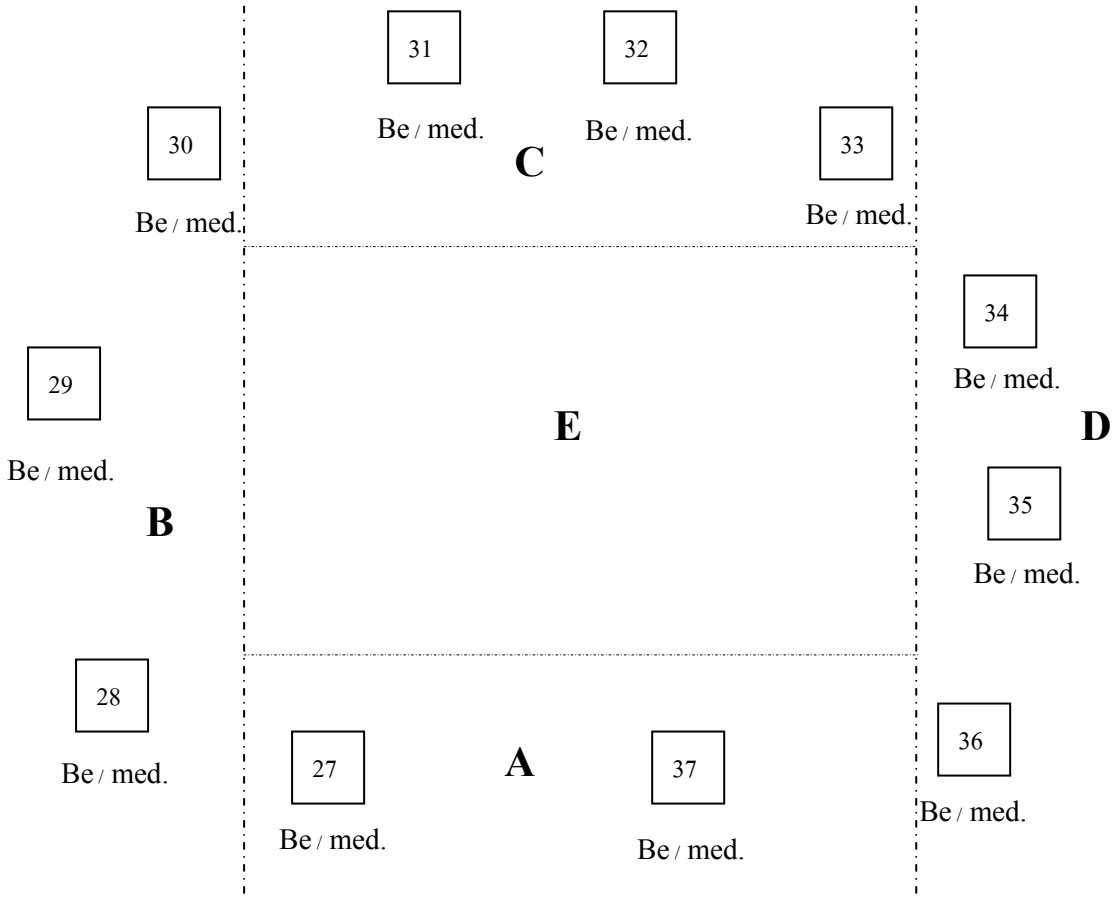


Figure 4.19 Random sampling for dividing the area into 5 zones of Crop 2, Plot 5

Control 1 (Crop 4, Plot 2,3)

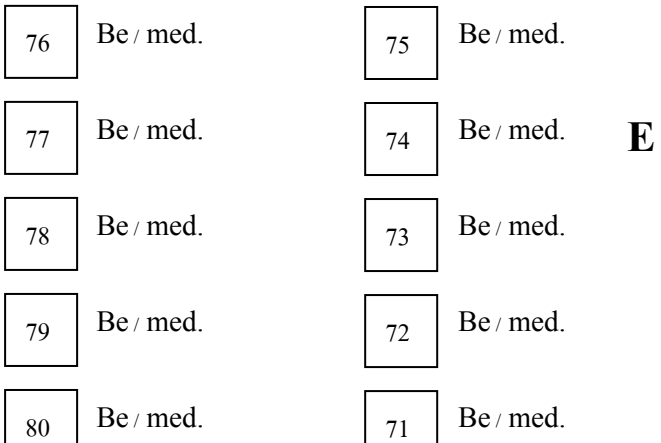
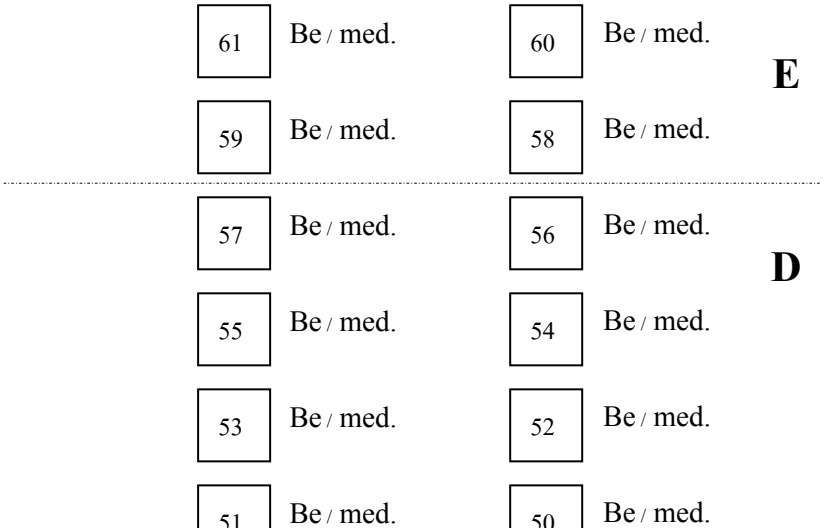


Figure 4.20 Random sampling for dividing the area into 5 zones of Crop 4, Plot 2, 3

Control 2 (Crop 3, Plot 4)



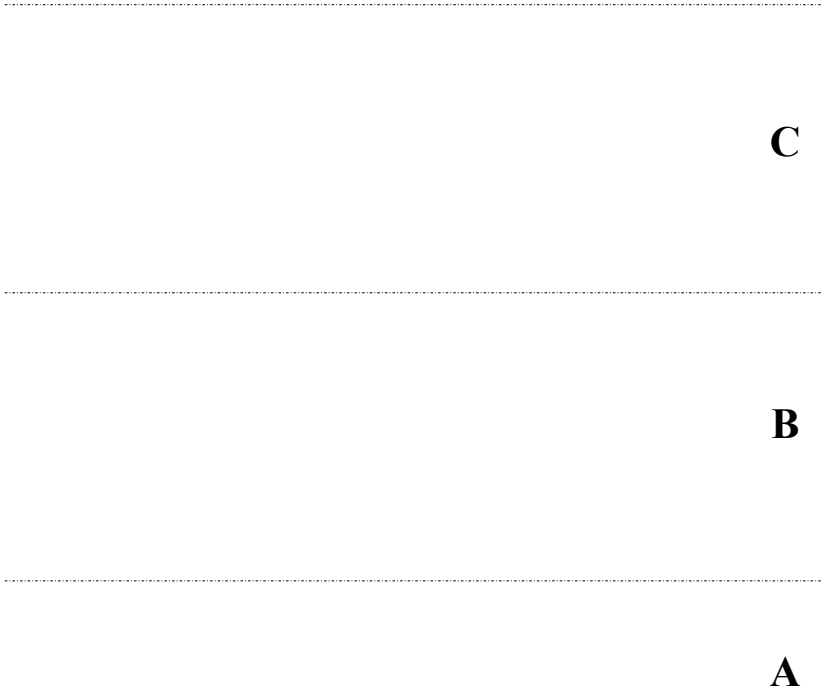


Figure 4.21 Random sampling for dividing the area into 5 zones of Crop 3, Plot 4

Figure 4.22 Random sampling of longan collection in the area of each zone

Longans obtained from the random sampling of each plot (4 plots), 50 bags each (1 kg./bag) were counted for finding the percentage of damaged longan caused by the *Conopomorpha sinesis.* The following are shown in Table 4.4-4.7

Table 4.4 A table showing a number of longans (bag) damaged by *Conopomorpha sinesis* in treatment 1 (Crop 1, plot 1)

Zone	**Treatment 1** (Crop 1, Plot 1)
	Number of damaged longans (bag)
A	1
B	0
C	1
D	1
E	1
Total	**4**
Damage (%)	**8.0**

N = 50

Based on Table 4.4, fifty bags of longan obtained by the random sampling of each zone in Treatment 1 (Crop 1, Plot 1) were found to be damaged by the *Conopomorpha sinesis* for 4 bags or 8.0 percent of damage.

Table 4.5 A table showing a number of longans (bag) damaged by *Conopomorpha sinesis* in treatment 2 (Crop 2, plot 5)

Zone	**Treatment 2** (Crop 2, Plot 5)
	Number of damaged longans (bag)
A	1
B	1
C	1
D	4
E	1
Total	**8**
Damage (%)	**16.0**

N = 50

Based on Table 4.5, fifty bags of longan obtained by the random sampling of each zone in Treatment 2 (Crop2, Plot 5) were found to be damaged for 8 bags 0n 16.0 percent of damage.

Table 4.6 A table showing a number of longans (bag) damaged by *Conopomorpha sinesis* in Control 1(Crop 4, plot 2, 3)

Zone	Control 1 (Crop 4, Plot 2,3)
	Number of damaged longans (bag)
A	0
B	3
C	0
D	2
E	5
Total	**10**
Damage (%)	**20.0**

N = 50

Based on Table 4.6, fifty bags of longan obtained by the random sampling of each zone in Control 1 (Crop4, Plot 2,3) were found to be damaged for 10 bags 0n 20.0 percent of damage.

Table 4.7 A table showing a number of longans (bag) damaged by *Conopomorpha sinesis* in Control 2(Crop 3, plot 4)

Zone	Control 2 (Crop 3, Plot 4)
	Number of damaged longans (bag)
A	4
B	5
C	0
D	4
E	2
Total	**15**
Damage (%)	**30.0**

N = 50

Based on Table 4.7, fifty bags of longan obtained by the random sampling of each zone in Control 2 (Crop 3, Plot 4) were found to be damaged for 15 bags 0n 30.0 percent of damage.

Table 4.8 A table showing percentage of longans yields damaged by the *Conopomorpha sinesis* in Treatment1(Crop 1, plot 1) and Treatment 2 (Crop 2, plot 5)

Experiment	**NO. of damaged longan (bag)**	**Damage (%)**
Treatment 1 (Crop 1, Plot 1)	4	8
Treatment 2 (Crop 2, Plot 5)	8	16

Total	**12**	**24**
Mean	**6**	**12**

Based on Table 4.8, it was found that the longans were damaged for 12 percent on average in Treatment 1(Crop 1, Plot 1) and Treatment 2 (Crop 2, Plot 5)

Table 4.9 A table showing percentage of longans yields damaged by *Conopomorpha sinesis* in Control 1(Crop 4, plot 2, 3) and Control 2 (Crop 3, plot 4)

Experiment	NO. of damaged longan (bag)	Damage (%)
Control 1 (Crop 4, Plot 2,3)	10	20
Control 2 (Crop 3, Plot 4)	15	30
Total	**25**	**50**
Mean	**12.5**	**25**

Based on Table 4.9, it was found that the longans were damaged for 25 percent on average in Control 1(Crop 4, Plot 2,3) and Control 2 (Crop 3, Plot 4)

With regards to the comparison of damage caused by the *Conopomorpha sinesis*, it was found that the percentage of damage in Treatment 1 (Crop 1, Plot 1) and Treatment 2 (Crop 2, Plot 5) was 12 percent on average based on 12 bags of damaged longans. For Control 1 (Crop 4, Plot 2, 3) and Control 2 (Crop 3, Plot 4), the longan were damaged for 25 percent on average based on 25 bags of damaged longans which was higher than that of the Treatment 1(Crop 1, Plot 1) and Treatment 2 (Crop 2, Plot 5)

Figure 4.23 The researchers were counting the *Conopomorpha sinesis* damaging longans

Figure 4.24 Longan in plastic bags after harvesting for ten days

Figure 4.25 *Conopomorpha sinesis* chrysalis damaging the yields in organic longan bags

Additional data found in this study

The researchers had investigated yields damage in the 4 plots of organic longan orchard and randomly collected falling longan fruits for finding the cause. It was found that there was another important pest of longan orchard-Common Cornlian, *Deudorix epijaras* (Moore): Lycaenidae. The moths suck the sap from the litchi and longan flows and fly around

the orchard for finding an inflorescence in order to lay eggs. Then the litchi or longan fruit bores will eat pulse or young seed which causes damage to the yields.

Figure 4.26 The threat of *Deudorix epijaras*

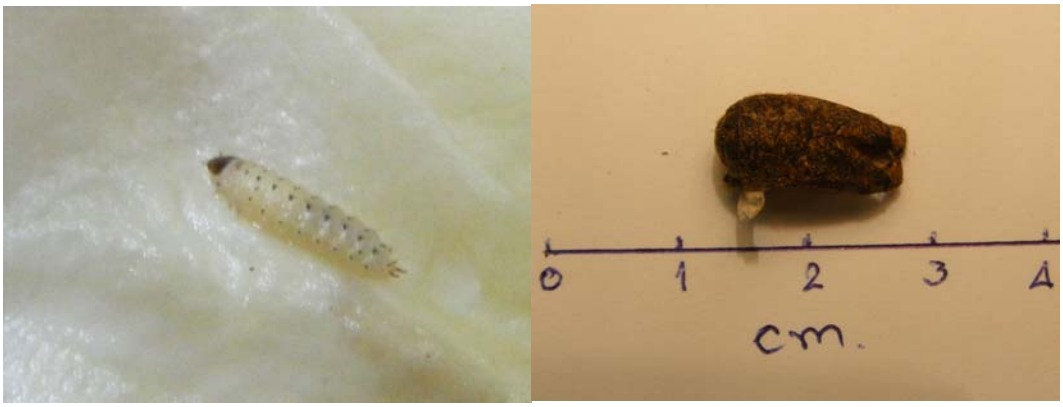


Figure 4.27 Life cycle of *Deudorix epijaras*

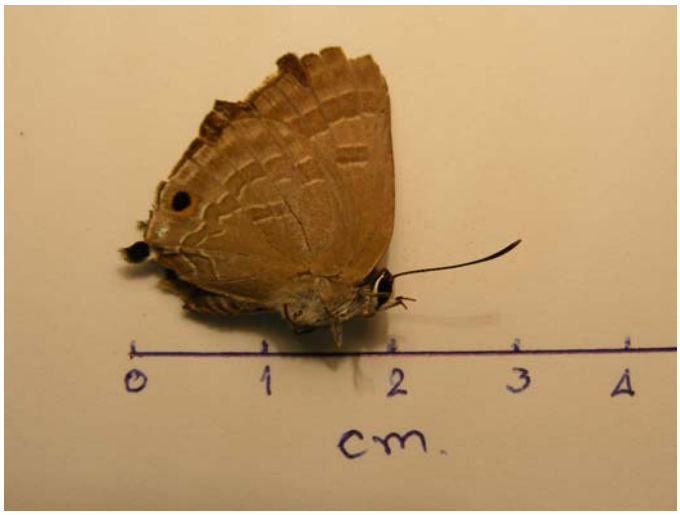


Figure 4.28 Matured *Deudorix epijaras*

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This study was conducted to investigate pheromone efficiency used for the damage reduction of longans caused by the *Conopomorpha sinesis* in four plots of an organic longan orchard of Prokchon Phromkangwan Partnership Ltd., Saraphi district, Chiangmai province.

Specifically, this study was aimed to do the following:

1) Investigate pheromone efficiency of the *Conopomorpha sinesis*;
2) Investigate damage reduction caused by the *Conopomorpha sinesis*;
3) Extend results of the study to organic longan farmers and educational institutions.

Based on the results obtained from the study, the following conclusions were drawn:

1. An investigate of pheromone efficiency of the *Conopomorpha sinesis*

Step 1. Pre-experiment

In using pheromone for luring the *Conopomorpha sinesis* during March-June, 2009, it was found that the moths were trapped most in May (160 moths/30 traps). This month is the early of the rainy season so longan trees begin to bear young leaves and flowers which are food sources of the *Conopomorpha sinesis* moths using sticky glue traps with different colors. They found that a number of moths will increase if there is less sunlight which might be because:1) they are night moths so if the sunlight is less, the moths will fly around to breed and lay eggs; and 2) the moths want to hide from the sunlight and rain. It was found that a number of moths decreased in June due to continual rainfall for many days and this made the traps have less efficiency because it was wet. However, it had a high tendency to trap more moths when new pheromone and stick glue plates were put into the traps.

Based on the pre-experiment on the pheromone efficiency, it was found that insects or moths were trapped most (198 moths) in the second type of trapping (Inside/high) with an average mean score of 39.6. This was followed by the first type of trapping (Between/medium)-168 moths or with an average mean score was 33.6

Step 2 After the pre-experiment

For a number of the trapped *Conopomorpha sinesis* moths in Treatment 1 and Treatment 2, it was found that both treatments had rather high level of trapped moths during the initial period (July, 2009) of the experiment but decreased in August, 2009. This might be because of the factors on weather conditions and higher temperature which affected a decrease of pheromone efficiency. Meanwhile, both of the experimental areas might not be the spreading sources of the moths because Treatment 1 and Treatment 2 area were least close to other longan plots.

For a number of the trapped moths in Control 1 and Control 2, it was found that there was not so different in a number of trapped moths in the initial stage of the experiment and it tended to increase in July 2009. This might be because this month was the harvest time of longans so it was a good food source of insect pests and moths. Besides, the areas of Control 1 and Control 2 wereclose to longan orchards of other farmers using chemical. A

number of moths decreased in August and it might be because it was the time the longan farmers began harvest the yields. Thus, the moths began to move to the organic longan orchard.

2) An investigation of damage reduction caused by the *Conopomorpha sinesis*.

To find the percentage of damaged caused longans by the *Conopomorpha sinesis,* the researchers randomly divided each of the 4 plots into 5 zones: A, B, C, D, and E. Then the researchers randomly collected longans in each zone for 10 bags (1 kg./bag) each and packed it with the same kind of package, amount, and condition. The longans were kept in a room of 25 °C for 10 days and the researchers counted damaged longan fruits caused by the *Conopomorpha sinesis* after 10 days of keeping. Results showed the following:

Treatment 1 (Crop 1, Plot 1) and Treatment 2 (Crop 2, Plot 5) were found to have damaged longans for 12 percent on average.

Control 1 (Crop 4, Plot 2,3) and Control 2 (Crop 3, Plot 4) were found to have damaged longans for 25 percent on average.

After comparing the percentage of damaged longans caused by the *Conopomorpha sinesis,* it was found that the percentage of damage in Treatment 1 (Crop 1, Plot 1) and Treatment 2 (Crop 2, Plot 5) was 12 percent on average whereas that of control 1 (Crop 4, Plot 2,3) and Control 2 (Crop 3, Plot 4) was 25 percent on average. Thus, the percentage of damaged longans in the Control 1 and Control 2 was higher than that of the Treatment 1 and Treatment 2 on average.

Additional data obtained from the study

There is another important pest damaging longan orchard – Common Comelian *Deudorix epirijaras* (Moore): Lycaenidae. The moths suck the sap from the litchi and longan flowers and fly around the orchard for finding an inflorescence in order to lay eggs. Then the litchi or longan fruit borer will eat pulse or young seed which causes damage to the yields.

RECOMMENDATIONS

1. Data on pheromone efficiency using should be investigated in terms of effective duration and an effect of the difference of each factor such as temperature, sunlight, moisture, etc.
2. There are some other researchers conferming that using of the white delta trap with the size of 29x40x8 cm. with a square plastic plate for stick glue grazing (without pheromone) inside the trap can be used for trapping the *Conopomorpha sinesis* . Thus,

the feasibility should be studied for the reduction of production costs of longan farmers in the future.

3. Neighboring litchi plots should also be studied for a comparative study of pheromone efficiency and moth spreading in litchi and longan orchards.

CHAPTER VI
Extension results of the study to organic longan farmers and education institutions

After research was completed to bring the group to release to farmers to create organic longan practical. Along with the knowledge that has to include teaching in education by making training on November 23, 2552 who are interested in participating in a total of 84 people lecture topics follows.

1. Special lectures on *"Bio-control"*
   Lecture by Associate Professor Dr. Channarong Dongsa-aad
   Director of National Biological Control Research Center

2. Special lectures on *"Bio-pesticide"*
   Lecture by Assistant Professor Dr. Warunee Sirikajhonjaru

3. Special lectures on general knowledge about pheromone
   Lecture by Mr. Supakij Sornprajak
   Duputy Director of IQS Institute

4. lectures on Extension results of the study to organic longan farmers and education institutions
   Lecture by Mr.Supachai Suttoicharoen
   Scientist of IQS Institute

Participants register for training seminars and lectures .

Special lectures on *"Bio-control"*
Lecture by Associate Professor Dr. Channarong Dongsa-aad
Director of National Biological Control Research Center

Special lectures on general knowledge about pheromone
Lecture by Mr. Supakij Sornprajak
Duputy Director of IQS Institute

An atmosphere of seminars.

lectures on Extension results of the study to organic longan farmers and education institutions
Lecture by Mr.Supachai Suttoicharoen
Scientist of IQS Institute

Special lectures on *"Bio-pesticide"*
Lecture by Assistant Professor Dr. Warunee Sirikajhonjaru

Appendix