Field Observation on the Use of Sex Pheromone to Control *Spodoptera litura* on Soybean in Indonesia[1]

Chien-Chung Chiu[2], Ming-Lii Hseu and Liang-Sang Hsu[3]

ABSTRACT

The Agricultural Technical Mission-Republic of China to Republic of Indonesia (Surabaya) introduced a total of 35,000 lures of sex-pheromone from the Taiwan Agricultural Chemical and Toxic Substances Research Institute to test and demonstrate the use of sex-pheromone for controlling*Spodoptera litura* in soybean field in East Java, Indonesia. The field observation and demonstration activities were carried out in 1989-1992. The comparison test of pheromone + chlorpyrifos and chlorpyrifos alone was employed in 1989 at Jombang. Both treatments had very good results on the controlling *S. litura*, but the application of chlorpyrifos was decreased from 7 times to 4 times when pheromone was used together with chlorpyrifos. The leaf damage by insect was about 15-16% for both treatments. Large scale field observation test was conducted at Gresik and Lamongan in 1991, and Ngawi and Jombang in 1992 with a total acreage of about 270 ha. Three sex-pheromone traps were installed one week after seeding and renewed about 35 days later. An average of 417-615 insect/ha were attracted and killed by these sex-pheromone traps. About 65-75% of insects were captured in the first 5 weeks after sex-pheromone trap installment. The test on the effects of number of traps was employed in 1992 at Jombang. It was found that the insects killed increased from 289 insect/ha in the treatment of 2 trap/ha to 1044 insect/ha in the treatment of 10 trap/ha. The economic analysis also indicated that the use of sex-pheromone could significantly reduce the input of pesticides on soybean production. The cost of pesticide was decreased from NT$ 869/ha of check farmers to NT$ 599/ha of demonstration farmers. The net income on the sex-pheromone demonstration farmers was about 15.7% higher than that of the check farmers.

Key words: sex-pheromone, *spodoptera litura*, soybean.

---

[1] Contribution NO. 0314 from Taichung DAIS, Agricultural Technical Mission - Republic of China (ATM-ROC) to Republic of Indonesia (Surabaya), Report No. 93-6.

[2] Associate specialist of Taichung DAIS and former leader of ATM-ROC.

[3] Senior specialist of ATM-ROC.

Introduction

Biological control of agricultural pests is an old but very sound practice. It had bean practiced long before the golden age of pesticides which began just after World War II. Experience with many pesticides has shown that no single arbitrary method will give permanent control. The use of biological agents will be good alternatives in the integrated pest management system, because they neither are toxic nor cause other environmental hazard. In Indonesia, there is a great diversity of crops, farming practices and pests. Biological control in such a diversified and intensified agricultural system is different from that of monocultural crops in other parts of the world. To develop new approaches on biological control, it is necessary to have good working knowledge on sound biological control concepts and agro-ecosystem management, so that natural enemies can be used effectively and the use of pesticides minimized.

Insect pest is generally considered the main constraint to soybean production in East Java. Twenty three species of insects [8] have been found to damage soybean in Indonesia. Among them, soybean root miner (*Melanagromyea centrosematis*) and tobacco cutworm or cotton cutworm (*Spodoptera litura*) are common in East Java area and always inflict severe damages. A mixture of carbosulfan with soybean seed technique [5] was found very effective in controlling soybean root miner by the Mission. However, the damage of tobacco cutworm has been very troublesome by farmers. It usually requires 7-9 applications of insecticides for controlling. The use of sex-pheromone has been proved to be very successful for controlling *S. litura* in Taiwan and many other countries [1,2,3,4,6].

Materials and Methods

The sex-pheromone of *Spodoptera litura* used in these studies was supplied by Taiwan Agricultural Chemicals and Toxic Substances Research Institute (台灣省農業藥物毒物試驗所). All the soybean field management was according to the recommended method (4) which was established by the Agricultural Technical Mission-Republic of China to Republic of Indonesia. The sex-pheromone for *S. litura* controlling was a 10 : 1 mixture of cis-9, trans-11-tetradecadin-1-y1 acetate and cis-9, trans-12-tetradecadin-1-y1 acetate[7]. The sex-pheromone dispenser (5.5 cm x 10 mm diameter PE tube) was used to load 1 mg of this sex-pheromone. Some reseach and extension activities on the sex-pheromone for controlling *S. litura* on soybean was conducted in 1989-1991 in East Java, Indonesia. The sex-pheromone was set in soybean field one week after soybean seeding and replaced about 35 days later.

Experiment 1: Comparison study of pheromone +chlorpyrifos and chlorpyrifos alone

An comparison study between pheromone+chlorpynifos and chlorpyrifos alone to control tobacco cutworm in soybean was conducted at Balai Berik Utama, Teje, Jombang in July-October, 1989. Soybean, variety Willis, was planted by spacing of 60 x 20 cm on July 20, 1989. Two

treatments, pheromone+chlorpyrifos and chlorpyrifos alone, were employed for comparison. The total area for this study was 0.25 ha. A randomized completed block design with two replications was employed. Tobacco cutworm trapping stations were arranged to collect the male insects attracted by sex-pheromone. The damage on soybean leaf was calculated by

$$N\% = \frac{(N0 + N1 + N2 + N3 + N4)}{N \times LAI} \times 100$$

while: N0 = leaf without injury .....index 0

N1 = leaf with injury area 1-5% .....index 1

N2 = leaf with injury area 6-25% .....index 3

N3 = leaf with injury area 26-50% .....index 5

N4 = leaf with injury area above 51% ...index 9

N = number of plant investigated

LAI= leaf area index

Experiment 2: Large scale test on the use of sex-pheromone

A comparison studies were carried out at four locations in the year of 1991 and 1992 to test the efficiency of sex-pheromone trap. In 1991, the test was conducted on county Gresik and Lamongan with 50 hectares at each location, and in 1992 it was conducted on county Ngawi and Jombang with 120 ha at Ngawi and 50 ha at Jombang. Three sex-pheromone traps were installed in each hectare one week after soybean seeding. The insects killed were recorded every week. The soybean yield was also recorded after harvest.

Experiment 3: Testing on the effects of the density of sex pheromone traps.

This study was conducted from June to September 1992 at Diwek, Keras, Mojojejer, Bahjor Agung and Tebel, Kabupaten Jombang. The total test area was 50 hectares. Ten hectares of soybean field were selected at each location for testing the proper density of pheromone traps. Two 4,6,8 or 10 traps per/ha were installed with 2 ha in each treatment to compare the effects of numbers of traps. The traps were installed one week after soybean seeding, and renewed about 35 days later. The number of insects captured was recorded every week.

Experiment 4: Economic study on the use of sex-pheromone

The economic study was conducted at Karanglo, Sukotber, and Jombang on June to September, 1992. A total of 54 ha of demonstration area with 94 farming families and 15 ha of check area with 30 farming families were chosen for this study. All production cost and soybean sales were recorded for analysis.

Results and Discussion

Comparison of pheromone+chlorpyrifos and chlorpyrifos alone

The lifecycle of tobacco cutworm was studied by the Mission[5] in 1988/89. At least three generations of tobacco cutworm were found in each soybean crop season. The population of this insect was very low in the first generation and was slowly increased in the second generation. Finally a heavy population was established in the third generation and caused severe damage during the maturing stage of soybean. However, a quite different phenomena could be found on the variation of female insect population in this study (Fig. 1). The highest insect population was found in first generation and very low population was found in second and thrid generation. There was no heavy insect population established to cause damage during the maturity of soybean. Very good results on the control of *S. litura* were obtained from both treatments, ie., pheromone+chlorpyrifos and chlorpyrifos alone.

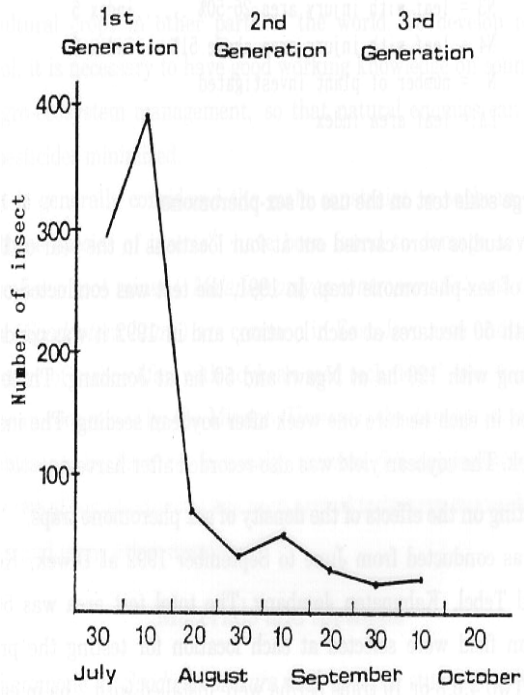

Fig. 1. Variation on the insect population of tobacco cutworm at different generations.

The injuries cause by *S. litura* to soybean leaves were 16.2% and 15.0% (Table 1) for pheromone+chlorpyrifos and chlorpyrifos alone respectively. However, the total sprays of chlorpyrifos was decreased from 7 times in chlopyrifos treatment only to 4 times in pheromone + chlorpyrifos treatment. It was proved that about 3 sprays of insecticide could be omitted in pheromone+chlorpyrifos treatment.

Large scale test on the use of sex pheromone

In 1991, the test was carried out on Gresik at MK I (dry season I) and Lamongan at MK II (dry season II) with 50 ha of each location. Three insect traps per ha were installed. Two different kind of traps were used in this study. The wet type trap was employed at Gresik and

Lamongan in 1991 and Ngawi in 1992, but the dry type trap was used only at Jombang in 1992. These two kind

Table 1. Injury of soybean leaf by tobacco cutworm

Replication	Sex-pheromone + chlorpyrifos			Chlorpyrifos		
	Damage category	No. of plants	Mean (%)	Damage category	No. of plants	Mean (%)
I	N0	11	17.30	N.0	14	16.40
	N1	30		N.1	26	
	N2	3		N.2	5	
	N3	4		N.3	3	
	N4	2		N.4	2	
II	N0	16	15.10	N.0	23	13.60
	N1	24		N.1	19	
	N2	5		N.2	3	
	N3	4		N.3	3	
	N4	1		N.4	2	
Mean	-	-	16.20	-	-	15.00

of traps were made by farmers themselves according to the structure of trap commonly used in Taiwan[1,3]. A total of 417 insect/ha was killed at Lamongan, but it was not recorded at Gresik. The soybean yield (Table 2) on two locations in 1991 was around 1.9-2.0 ton/ha, which was much higher than 1.0-1.2 ton/ha of the check area. Same results were also found in the experiment of 1992 on MK Ⅱ crop season. An average of 615 insect/ha and 591 insect/ha were killed on the testing area of Ngawi and Jombang, respectively. The soybean yields of test area were 1.5-1.6 ton/ha which were higher than 1.3 ton/ha of check area. The cost of wet trap was about Rp. 2500 each, but the cost of dry trap were only Rp. 200 each. Dry traps also have many other advantages over wet traps. In Taiwan, the dry type trap has also been recommended and used by farmers. So, it is suggested that the dry-type trap is to be used for future demonstration and extension projects. More insects were captured by sex-pheromeone trap during the early stage than the late stage of soybean growth period. The insects captured on the first five weeks of sex-pheromone trap installed were about 65-75% of total capture. The remaining 25-35% (Table 3). was captured in the last five weeks.

Table 2. Soybean yield with and without sex-pheromone trap

Location (Year)	Crop season	Area (ha)	Yield (kg/ha)		Trap type	Insect killed(no./ha)
			With-trap	Without-trap		
Gresik (1991)	MKI	50	1901	1281	Wet	-
Lamongan (1991)	MKII	50	1970	1024	Wet	417
Ngawi (1992)	MKII	120	1544	1382	Wet	615
Jombang	MKII	50	1653	1365	Dry	591

Table 3. Insects captured in different soybean growth periods (MK II)

Weeks	Lamongan (1991)		Ngawi (1992)		Jombang (1992)	
	(no./ha)	%	(no./ha)	%	(no./ha)	%
1	50.4	12.1	84.9	13.8	114.6	19.4
2	67.2	16.1	91.7	14.8	101.6	17.2
3	58.2	14.0	89.8	14.0	89.8	15.2
4	53.7	12.9	77.4	12.8	80.9	13.6
5	49.8	12.0	59.1	9.5	64.5	10.9
6	37.8	9.1	55.6	9.0	44.8	7.6
7	36.4	8.7	55.5	9.0	39.2	6.6
8	35.5	8.5	45.3	2.4	18.9	3.2
9	22.8	5.5	34.4	5.8	23.2	3.9
10	4.8	1.1	24.5	3.9	14.0	2.4
Total	417.0	100.0	615.0	100.0	591.0	100.0

Note: The test areas were 50 ha at Lamongan in 1991, 120 ha at Ngawi, and 50 ha at Jombang in 1992.

Effects of number of sex-pheromone traps

The results obtained from villages Diwek, Bahjar, Tebel, Keras and Mojojejer were very similar as the more number of traps installed the higher number of insects captured. The efficiency of insects lured and killed by sex-pheromone trap was greatly influenced by number of traps. In the treatment of 2 traps per ha, an average of 289 insect/ha (Table 4) were captured. Then the number of insects captured by sex-pheromone traps were increased as more traps per ha to be installed. A total of 1044 insect/ha on the average were captured in the treatment of 10-trap/ha, about 3 times higher than 2-trap per ha. Although the insects captured by traps varied at different locations, it was very clear to find that the more traps installed the higher number of insects captured. There was no difference at different villages.

Table 4. Insect captured by different number of traps

Traps (no./ha)	Insects captured (no./ha)							% of total capture
	Diwek	Bahjar	Tegel	Keras	Mojojejer	Total	Mean	
2	166	410	434	131	306	1447	289.4	100
4	265	540	655	214	344	2018	403.6	139
6	310	584	702	378	557	2531	506.2	175
8	499	798	1139	425	707	3568	713.6	247
10	590	1353	1397	815	1064	5219	1043.8	316

According to the data (Table 5) taken from villages Diwek, Bahjar, Tebel, Keras and Mojojejer, the results were very similar despite different number of traps installed at varied locations. The insects captured were much higher during the early stage of trap installation than the late stage. It was very clear to find out that the number of killed insects were decreased with

the time after the setup of traps. More than 77% of insects were captured during the first five weeks after traps installed, and only less than 23% of insects were captured within the last five weeks of traps installed. This phenomenon was almost same among all treatments despite different number of traps installed. The decreased number of insects captured may be caused by the decrease of insect population after large number of insects captured.

Table 5. Insect captured in different soybean growth period

Week	No. of sex-pheromone (trap/ha)					Total capture	Mean	% of total capture
	2	4	6	8	10			
1	66.2	83.2	108.2	150.0	165.2	572.8	114.56	19.37
2	81.0	69.8	75.8	107.4	174.2	508.2	106.64	18.03
3	36.4	59.8	86.8	108.2	157.6	448.8	89.76	15.18
4	23.4	57.6	68.0	88.4	166.0	403.4	80.68	13.64
5	20.4	46.2	35.2	72.8	147.8	322.4	64.48	10.90
6	15.8	31.4	37.4	47.0	93.6	244.2	44.84	7.58
7	21.2	34.0	42.8	50.6	47.6	196.2	39.24	6.64
8	4.6	10.0	14.6	28.2	37.2	94.6	18.92	3.20
9	13.8	6.2	23.4	43.0	29.6	116.0	23.20	3.92
10	6.6	5.4	14.0	19.0	25.0	70.0	14.01	2.38
Total	289.0	404.0	506.0	714.0	1044.0	2957.0	591.00	100.00

The soybean yield was not influenced by the number of traps installed in this study due to the good insect pest control effect. A 3000 ha of soybean integrated cultivation demonstration project was conducted in East Java by the Mission. The experiment areas and Jombang were also covered by this project. Under the suitable field management, the good soybean yield was maintained. This was the major reason to keep all treatments on good yield. The yield of two-trap/ha was 1520 kg/ha (Table 6) which was a little lower than those of other four treatments. The average yield of other four treatments varied between 1676-1699 kg/ha.

Table 6. Soybean yield influenced by different number of traps

Trap/ha	Yield (kg/ha)					
	Diwek	Bahjar	Tebel	Keras	Mojojejer	Average
2	1464	1392	1498	1748	1498	1520
4	1658	1592	1604	1900	1640	1679
6	1687	1598	1569	1924	1604	1676
8	1711	1616	1604	1930	1634	1699
10	1689	1592	1640	1894	1640	1691
Average	1642	1558	1583	1879	1603	1653

Economic analysis

In the economic analysis study, the soybean yield (Table 7) of sex-pheromone demonstration area was 1765 kg/ha, while that of the check area was 1644 kg/ha. The total sale

price of soybean was Rp. 1,290,215/ha and Rp. 1,201,764/ha for demonstration and check areas, respectively. The production cost of demonstration area was a little less than that of the check area, which was caused by a reduction on pesticide inputs. Economic analysis clearly indicated that the usage of sex-pheromone can significantly reduce the financial input of pesticides. The other production inputs were not different between demonstration and check areas. The net income of sex-pheromone demonstration farming families were Rp. 702,413/ha, which was 15.7% higher than that of the check families. The net income of check families was Rp. 607,117/ha.

Table 7. Economic analysis of sex-pheromone demonstration

Item	Demonstration	Check
Area (ha)	54	15
Farmer (family)	94	30
Yield (kg/ha)	1765	1644
Price (Rp/kg)	731	731
Total income (Rp/ha)	1,290,215	1,201,764
Seeds (Rp)	44,593	48,589
Fertilizer (Rp)	53,187	48,354
Pesticide (Rp)	44,976	65,204
Labor cost (Rp)	445,046	432,500
Production cost (Rp/ha)	592,849	604,647
Net income (Rp/ha)	702,413	607,117

Note: The ratio of Rp to NT was 75:1.

References

1. 李新傳 1987 乾式性費洛蒙誘蟲器之誘蟲效果 中華昆蟲 7: 87~94。
2. 李新傳 1989 利用性費洛蒙調查豆類斜紋夜蛾之族群動態與誘蟲效果 中華昆蟲 9: 27~36。
3. 唐立正 蘇宗宏 1988 斜紋夜蛾合成性費洛蒙之田間試驗I・大量誘捕 中華昆蟲 8: 11~22。
4. 許明禮 1989 大豆田間栽培手冊 p.153 駐印尼泗水農技團叢書第五號(印尼文)。
5. 許兩順 1989 駐印尼泗水農技團年報 p.4~7。
6. 鄭允 1989 昆蟲性費洛蒙的田間應用 p.157~181 有機農業研討會專集。
7. 羅致述 洪銘德 黃振聲 洪巧珍 1988 斜紋夜盜蛾性費洛蒙主成分之合成改進研究 中國農業化學會誌 26: 536~544。
8. Botlema, T. V. T., F. Dauphin and G. Gijsbers. 1987. Soybean research and development in Indonesia. CGPRT No. 20 p.477.

在印尼利用性費洛蒙防治大豆田斜紋夜盜蛾之觀察試驗[1]

邱建中[2]　許明禮　許兩順[3]

摘　要

中華民國駐印尼泗水農業技術團由台灣省農業藥物毒物試驗所引進斜紋夜盜蛾性費洛蒙35,000支，於1989~1992年在印尼東爪哇地區進行田間觀察試驗與示範推廣，希望能引進並推薦此一生物防治技術給印尼之大豆農民，也盼能帶動台灣農藥企業進軍印尼市場。1989年旱季第二期作先於Jombang進行性費洛蒙與Dursban混用及僅施用Dursban二種處理方式之比較，發現大豆葉片之受害率都可控制在15~16%之間，但是性費洛蒙與Dursban混用處理較單用Dursban處理，可節省三次Dursban之施藥處理，有降低農藥成本之效果。1991年及1992年分別在Gresik, Lamongan. Ngawi與Jombang等四處進行田間觀察試驗，除Gresik爲旱季第一期作(4~7月份)外，其餘均爲旱季第二期作(6~9月份)，由於Gresik是第一次施用，很可惜未調查誘殺蟲數，其餘三處均詳細記錄誘殺蟲數，全部觀測調查面積270 ha，每公頃用性費洛蒙三支，35天後更新一次，平均誘殺蟲數爲417~615隻/ha，防治效果令人滿意，大豆平均產量在1,544~1,970 kg/ha之間。1992年於Jombang縣五個村進行每公頃設置2、4、6、8、10個誘蟲盒之比較試驗，每一處理2 ha，經計試驗面積50 ha，試驗結果發現，誘蟲盒愈多，誘殺蟲數也愈多，誘殺蟲數從每公頃二盒之289隻直線上升至每公頃十盒之1044隻，效果極爲明顯，而前五週之誘殺蟲數約佔總誘殺蟲數之77%以上，不受設置誘蟲盒數量多寡之影響。經濟效益分析指出，利用性費洛蒙確實可節省農藥費用，經調查54 ha 94個農戶之平均指出，平均農藥費用爲Rp 44,976/ha，較對照區之Rp 65,204/ha爲低，示範區之平均農家淨收益可增加15.7%。

關鍵字：性費洛蒙、斜紋夜盜蛾、大豆。

---

[1] 台中區農農業改良場研究報告第 0314 號，駐印尼泗水農業技術團報告 ATM-ROC Report No. 93~6。

[2] 現任台中區農業改良場副研究員，前任駐印尼泗水農業技術團團長。

[3] 前任駐尼泗水農業技術團農藝專家，植保專家。