Insect management on mungbean pests in rice based cropping system

การจัดการแมลงศัตรูของถั่วเหลืองในระบบที่ปลูกข้าวเป็นหลัก

S. Jamornmarn[1/], S. Kemma[1/] and K. Suwan[1/]

Abstract

Studies on insect pests and their damage were undertaken in Ratchaburi province to determine the best possible cropping pattern among Rice-Rice, Rice-Sweet Corn-Rice and Rice-Mungbean-Rice. The result from two years (1987-1988) shows that the pattern of Rice-Mungbean-Rice is the most suitable cropping pattern to be grown in this area. Added costs, added returns and "marginal benefit cost ratio (MBCR)" on the additional costs for three levels of insecticides (Economic threshold, Next Higher, and Maximum Protection) were evaluated on both sweet corn and mungbean in rice based cropping system. The result revealed that economic threshold treatment is the only one that would be economically attractive in the three levels of insecticide for both crops. Insect pests, insecticide use, expense, yields and profit were monitored in insect management plots and farmers' fields in Ratchaburi province. Insect populations were slightly higher than economic thresholds. In the management plots insecticide averaging about 3.0 times of the recommended dosage was applied, but farmers in the profect area treated their field more frequently. About 40 percent less insecticide was applied in the insect management plots compared to farmers' fields. Yield and profit were slightly higher in insect management plots than in the farmers' field.

บทคัดย่อ

ได้มีการศึกษาเรื่องแมลงศัตรูพืชและความเสียหายที่เกิดจากการทำลายที่จังหวัดราชบุรี เพื่อหาระบบการปลูกพืชที่เหมาะสม โดยศึกษาระบบข้าว-ข้าว ข้าว-ข้าวโพดหวาน ข้าว-ถั่วเขียว-ข้าว ผลจากการทดลองในปี 1987-1988 พบว่าระบบการปลูกข้าว-ถั่วเขียว-ข้าว เป็นระบบที่เหมาะสมที่สุดในเขตนี้ จากการศึกษาด้านค่าใช้จ่าย ผลตอบแทน และสัดส่วนของผลตอบแทนต่อค่าใช้จ่าย (marginal benefit cost ratio – MBCR) สำหรับการใช้ยาฆ่าแมลงสามระดับ (ที่ระดับให้ผลตอบแทนคุ้มค่าระดับสูงขึ้น และระดับที่ให้กำจัดแมลงได้สูงสุด) พบว่า การใช้ยาในระดับที่ให้ผลตอบแทนคุ้มค่านั้นเป็นระดับที่ดีที่สุดสำหรับข้าวโพดและถั่วเขียวที่ปลูกในระบบสลับกับข้าว ได้มีการติดตามดูประชากรแมลงศัตรูพืช การใช้ยาฆ่าแมลง ค่าใช้จ่าย ผลผลิต และผลตอบแทนหรือกำไร จากแปลงเกษตรกรในเขตจังหวัดราชบุรี และเปรียบเทียบกับแปลงที่มีการทดลองกำจัดแมลงศัตรูพืช พบว่าในแปลงทดลองมีการใช้ยาฆ่าแมลงในอัตราที่สูงกว่าในแปลงเกษตรกร กล่าวคือมีการใช้ยาในอัตราที่สูงกว่าที่ทางการแนะนำถึงสามเท่า อย่างไรก็ตามพบว่า เกษตรกรใช้ยาฆ่าแมลงบ่อยครั้งกว่า จึงทำให้โดยส่วนรวมแล้วในแปลงทดลองมีการใช้ยาฆ่าแมลงน้อยกว่าในแปลงเกษตรกรถึง 40 เปอร์เซ็นต์ และผลผลิตรวมทั้งกำไรผลตอบแทนในแปลงทดลองจึงสูงกว่าในแปลงเกษตรกร

Department of Entomology, Kasetsart University

INTRODUCTION

In 1984, Kasetsart University (KU) and Australian Cooperation National Agricultural Research Project (ACNARP) began testing improved cropping pattern in farmers' fields in Ban Pong district, Ratchaburi province. The thrust of cropping pattern testing was to evaluate the pest incidence of double crop rice (R-R) by the farmers over the alternative patterns Rice-Sweet Corn-Rice (R-S-R) and Rice-Mungbean-Rice (R-M-R). It was realized that each site was not a homogeneous landscape in term of water supply and retention. Therefore, at least over two to three years-testing period (1984-1986) cropping patterns were designed for the prevalen rice environmental subunits.

Each plot included not only tested and evaluated cropping patterns but also developed management practices-land preparation, seedling rate/method, variety, fertilizer and pest control. Insect control which is highly complex, site specific, and demanding on scarce resources, was a major component in cropping research and development.

An integrated pest management approach could help Thai rice farmers apply insecticides more effectively. Insecticides are often applied at the wrong time or when insect populations are low, and rates applied are usually considerably below those recommended levels. Improper use of insecticides also causes secondary problems such as the resurgence of brown planthoppers and poisoning to human, livestock, and fish, although rice insects resistant to insecticide are presently uncommon in Thailand, the recent increase in continuous rice cropping and more frequent use of insecticides pest management practices should be adopted to prevent development of insecticide resistance in the future.

Our research has been conducted on component of insect pest management in rice based cropping system, such as the use of resistant varieties, the development of appropriate sampling methods, economic thresholds, crop loss assessment, and more effective use of insecticides.

During 1985-1987, in Ban Pong district, research on key pests and their damage between R-R pattern and R-S (M)-R pattern were conducted. The conclusion from both years were evaluated in this report. This information would be helpful in designing appropriate insect control technology which would be within the means of the farmers to adopt. We also hope to learn new practices from farmers as a result of their many years of experience at each site, which we could test them site by site by site with Kamphaeng Saen experiment station derived technology.

An economic analysis on net return and benefit cost ratio of sweet corn and mungbean in the rice based cropping system was also evaluated in this report.

The result from three years research indicated that insect control technology on mungbean in rice based cropping system was more camplicated than other crops. Insect management research plots were established in KU-ANCARP project field are at Kamphaeng Saen campus and in farmers' fields so that available technology could be evaluated and insect populations, damage, insecticide use, yields and profits in these plots could be compared with farmers' plots in the project areas. Reported here are the results of monitoring the insect pest control practiced by farmers in the project area and research trials to measure crop loss from insects and to test available pest management technology.

MATERIALS AND METHODS

Comparisons of Insect Pest and Their Damage on KU-ACNARP Project and Farmers' Cropping System

The project were conducted for two years (1985-1987) in the farmers' fields in Ban Pong district, Ratchaburi province. R-S-R, R-M-R and R-R pattern were grown in August 1985-July 1987.

The detailed description was explained in our previous report (Jamornman et al., 1987).

Estimating Yield Loss From Insects on Sweetcorn and Mungbean in Rice Based Cropping System

Quantifying yield losses in each growth stage proved to be highly useful in evaluating potential practices in term of the timing of insecticide applications. Research plots were set up to estimate damage and crop loss at different growth stages in the sweet corn (supersweet DMR) and mungbean (Kamphaeng Saen 1 and Uthong 1). The treatments explanation were indicated in Jamornman et al. (1987), page 53-57. Insect populations in the yield loss insecticide treatments were sampled as a check to verify if the degree of control obtained was sufficiently below economic injury levels. If significant yield losses were recorded at low insect pest population one should look for 1) other pest species or 2) interactions from multiple pest attack. The ecomomic analysis was computed to evaluated this experiment.

Insect Management Research Plots

Insect management research plots were conducted on mungbean at Kamphaeng Saen campus and farmers' fields in January 1988 so that available technology could be evaluated more throughly in the tested fields. Also, insect populations, damage, insecticide use, yields and profits in these plots could be compared. Ten of approximately 10×10 m research plots were set up at separate locations throughout the project area. Agronomic practices were identified to those of farmers in related area and research plots. All of the project and farmers' plots were planted with a mungbean resistant variety, Kamphaeng Saen 1 (KPS 1). This variety is slightly resistant to pod borer, Maruca testulalis and Etiella zinckenella, and pod sucking pug, Nezara viridula and Cletus sp.

Fermers were interviewed during crop growth and immediately after harvest to determine: (1) pesticide use, rates, and costs; (2) expenses for and preparation, planting, pesticide application and harvesting; and (3) yield.

Twice each week during crop growth two technicians sampled pest incidence at each plot throughout project area. Whenever insect levels reached the economic threshold at any plot, the technician issues "action orders" suggesting control measures for the insect pest to farmers. Researcher then assisted and supervised the farmers in the application of contral measures. Sampling techniques and economic thresholds used in the insect management research plots were similar to the technique previously used (Jamornmarn et al., 1987). Farmers in the area were directed not to apply insect control measure unless advised to do so by technician or researcher. Dimethoate and monocrotophos at 0.5 kg ai./ha were applied when the insect pests reach economic threshold. No insecticides were applied beforehand. Records of fertilizer use, pesticide treatments, and research plots were kept. Yield was estimated in the research plots and farmers' field by harvesting and threshing a 5×5 m area, adjusting the moisture content of the grain to 14 percent and converting the weight to ton per hectare.

RESULTS AND DISCUSSION

Comparisons of Insect Pests and Their Damage on KU-ACNARP Project and Farmers' Cropping System

Insect pests and their damage without insecticide protection on Rice-Rice (R-R), Rice-Sweet

Corn-Rice (R-S-R), and Rice-Mungbean-Rice (R-M-R) patterns were evaluted for two years (1986-1987). The result from both years indicated that number of hopper (green leaf hopper and brown plant hopper) were greatly higher on R-R than on R-S-R and R-M-R pattern (Table 1). Highest number of hoppers were found on rice in the wet season (12.7 and 18.3 hoppers per 10 sweeps in 1986 and 1987 respectively) in R-R pattern. On the second year number of hopper per 10 sweeps were slightly decreased in the pattern of R-S-R and R-M-R. Again, rice stem borer not only destroyed the stem of rice Table 1. but also the stem of sweet corn (8.6 and 10.7% dead heart on stem of corn in 1986 and 1987 respectively). The damages of RSB on rice and sweet corn were high on R-R and low on R-S-R and R-M-R. On sweet corn, CSB damage was lower in the second year (18.2%) than the first year (28.3%). Only the number of GLH/plant was higher in the mungbean of R-M-R pattern for the second year (21.1) than for the first year (13.4). The remaining pests, pod borer and pod sucking bug per 10 sweeps were lower in the second year than in the first year. From the result of this experiment we concluded that the pattern of R-M-R is the most suitable cropping pattern to be grown in Ban Pong district, Ratchaburi province. The farmers' pattern (R-R) was more preferred to the pest on both years. When farmers used the R-R pattern longer, more difficult control problems was encountered.

Estimating Yield loss from Insects on Sweet Corn and Mungbean in Rice Based Cropping System

On sweet corn, the first data set was from yield loss experiments conducted at Kamphaeng Saen campus during 1986. The result showed that corn stem borer played an important role for the yield loss during the seedling and pretasseling stage. However the yield at post-tasseling stage did not respond to corn stem borer. The second data set was from the experiments on economic analysis. Table 2 shows the yield, value of the yield, fixed cost, and insecticide cost in each treatment. Highest yield was found on maximum protection (6.1 t/ha). Nevertheless, there were some profits involved in applying the economic threshold and next higher over no protection on sweet corn.

Table 1 Comparison number of pests or insect damage on Rice-Sweet Corn-Rice; Rice-Mungbean-Rice and Rice-Rice cropping system over two years period (1985-1986 and 1986-1987) in Ratchaburi Province.[1/]

Cropping[2/] System	Hoppers[3/] /10 sweep		RSB (%)[4/] DH		RSB (%)[4/] WH		CSB[5/] Damage		GLH[6/] /plant		Pod borer[7/] /10 sweep		Pod[8/] sucking bug /10 sweep	
	1986	1987	1986	1987	1986	1987	1986	1987	1986	1987	1986	1987	1986	1987
Rice (WS)	7.7b	6.8c	4.4b	5.1c	3.6c	4.8c	–	–	–	–	–	–	–	–
Sweet corn	–	–	8.6a	10.7b	–	–	28.3	18.2	–	–	–	–	–	–
Rice (DS)	5.1c	4.8c	2.7b	4.8c	4.1c	5.7b	–	–	–	–	–	–	–	–
Rice (WS)	8.6b	5.8c	3.8b	4.4c	5.3bc	4.1c	–	–	–	–	–	–	–	–
Mungbean	–	–	–	–	–	–	–	–	13.4	21.1	2.7	1.9	7.9	6.3
Rice (DS)	7.0b	6.3c	2.9b	2.1b	3.4c	2.9d	–	–	–	–	–	–	–	–
Rice (WS)	12.7a	18.3a	9.4a	12.4a	14.7a	13.5a	–	–	–	–	–	–	–	–
Rice (DS)	6.3b	11.5b	3.2b	6.7c	7.1b	6.9b	–	–	–	–	–	–	–	–

1/ Pests or damage levels within the column followed by the same letter are not significantly different (DMRT, $P<0.05$)
2/ WS = Wet season; DS = Dry Season
3/ means of 6-7 weekly exposures nymph and adult of Nilaparvata lugens and Nephotettix virescens (>5 leafhoppers/1 sweep is Economic Threshold)
4/ RSB = Rice Stem Borer, Chilo polychrysus and Scirpophaga incertulas; DH = Dead Heart; WH = white Head (15% DH an 5% WH are Economic Threshold).
5/ CSB = Corn Stem Borer, Ostrinia furnacalis:
6/ GLH = Green Leaf Hopper, Amrasca sp.
7/ Pod borer adult, Maruca testulalis and Etiella zinckenella:
8/ Nezara viridula and Cletus sp.

Table 2 Yield, the value of yield, other costs and cost of insecticide in each treatment of sweet corn at Kamphaeng Saen campus 1986-1987.

Treatment	Yield (t/ha)	Value of[1/] yield (US$/ha)	Other cost[2/] (US$/ha)	Cost of[3/] insecticide (US$/ha)
Maximum protection	6.1	683.2	189.3	152.7
Economic threshold	5.9	660.8	189.3	26.5
Next higher	5.4	604.8	189.3	46.5
No protection	3.2	358.4	189.3	0.0

1/ Value of the yield at price of 0.112 US$/kg of harvested sweet corn.
2/ Includes costs of land preparation, seed, herbicide, fertilizer and harvesting.
3/ 1 kg of carbofuran 3G = 0.8 US$ 1 liter of monocrotophos 56% WSC = 9.6 US$.

Table 3 presents the added cost, added returns and "marginal benefit cost ratio" (MBCR) on the additional costs for three levels of insecticides at Kamphaeng Saen campus. Note that in this case the value was computed with respect to the next lower treatment : economic threshold compared to no protection, next higher compared to economic threshold, and maximum protection compared to next higher. If the MBCR is 2.0 there is a return of 2 US$ for every 1 US$ spent, if the MBCR is below 1.0, then the expenditure results in a loss.

Using a criterion of a 2:1 rate of return, Table 3 shows that the economic threshold treatment (MBCR=4.3) is the only that be economically attractive in the three levels of insecticide. MBCR's for the maximum protection treatment is less than 1.0, and is in fact negative in next higher treatment.

Table 3 Economic analysis of average performance of three levels of insecticide application in sweet corn experiments at Kamphaeng Saen campus, 1986-1987.[1/]

Treatment	Added cost	Added return	MBCR[2/]
Economic Threshold (ET)	26.5	113.1	4.3
Next Higher (NH)	20.0	-56.0	neg.
Maximum Protection (MP)	106.2	78.4	0.7

1/ Shows added cost and added return compared to the lower treatment, ET compared to control, NH compared to ET and MP compared to NH.
2/ MBCR = Marginal Benefit Cost Ratio

The same analysis is presented in Tables 4 and 5 for mungbean at Kamphaeng Saem campus. The results for mungbean indicated that the economic threshold treatement (MBCR = 5.4) was uniformly best, but it was noticed that maximum protection also gave a higher return (MBCR = 4.8) than that of the next higher (MBCR = negative).

The economic analysis on both sweet corn and mungbean showed that only the lowest level of application, the economic threshold treatment was economically profitable, on the average. This meant that even though the total yield loss in sweet corn was 2.9 t/ha and 0.29 t/ha in mungbean, the ET treatment, which saves 2.7 t/ha in sweet corn and 0.14 t/ha in mungbean, was most econmically attractive. This illustrates one of the important advantages of lower use of insecticide at ET, the lower economic imcentive to high rates of insecticides save farmer's money, conserves natural enemies, reduces the potential for environmental problems and reduces the likelihood of the development of insect that are resistant to pesticides.

Table 4 Yield, the value of yield and cost of insecticide in each treatment of mungbean at Kamphaeng Saen campus, 1986-1987.

Treatment	Yield (t/ha)	Value of[1/] yield (US$/ha)	Other cost[2/] (US$/ha)	Cost of[3/] insecticide (US$/ha)
Maximum Protection	0.98	509.6	176.6	40.6
Economic Threshold	0.83	431.6	176.6	13.5
Next Higher	0.78	405.6	176.6	18.8
No Protection	0.69	358.8	176.6	0.0

1/ Value of the yield at price of 0.52 US$/kg of harvested mungbean.
2/ Includes costs of land preparation, seed, herbicide, fertilizer, and harvesting.
3/ 1 litre of dimethoate 40% BC = 4.43 US$
1 litre of monocrotophos 56% WSC = 9.6 US$
1 litre of cabaryl 85% = 7.2 US$

Table 5 Economic analysis of average performance of three levels of insecticide application in mungbean experiments at Kamphaeng Saen campus 1986-1987.[1/]

Treatment	Added cost	Added return	MBCR[2/]
Economic Threshold (ET)	13.5	72.8	5.4
Next Higher (NH)	5.3	-26.8	neg.
Maximum Protection (MP)	21.8	104.0	4.8

1/ Shows added cost and added return compared to the lower treatment ET compared to control, NH compared to ET and MP compared to NH.
2/ MBCR = Marginal Benefit Cost Ratio

Insect Management Research Plots

Insect population and damage on mungbean were slightly higher than economic threshold levels and were similar in both the insect management plots and farmers' fields. Farmers in our project applied insecticides more frequently and those fields received a large dosage of insecticide during the season than insect management plots (Table 6). The insect management plots (Table 6). The insect management plot had higher gross margins (462.8 US$/ha) than farmers' fields (369.2 US$/ha). The Management plots were slightly more profitable than the farmers' fields, because of lower insecticide costs.

This study illustrates the difficulty in implementing practical insect pest management program for our farmers. Research trials in the project area indicated that most of these treatments were unnecessary because insect populations and damage sometimes were generally low and insecticide applications did not increase yields. The farmer in our project area consistently applied more insecticide than those in research plots. This suggests that farmers in the project were more aware and concerned about insect pest than the farmers in other areas, but they needed additional experience to learn to monitor insect accurately and wait unitil populations reached economic thresholds before applying insecticide.

Improved varieties resistant to insect and disease are the most important part of pest management in the tropics. Currently, this is the only component of available management technology. In Thailand, green leaf hopper and pod borers, are probably the most potentially serious insect pests on mungbean. This study suggests that when mungbean varieties with an effective level of resistance to those two key pests are planted over a large area, crop loss from low populations of other insects is minimal, and protective insecticide application does not increase yields.

Table 6 Comparison of insect management research plots and farmers' field planted with mungbean.

Insect population or damage[1/]	Insect management plots	Farmers' field
GLH/plant	9.8	10.7
Pod borer adult/10 sweeps	2.8	3.3
Pod sucking bug/10 sweeps	1.3	1.9
Insecticide use		
Average insecticide applications/field Yield	3	5
Average yield (t/ha)	0.89	0.71
Costs and Gross Margin		
Cost of insecticide (US$/ha)	13.5	18.8
Other costs (US$/ha)[2/]	176.6	176.6
Av. total expenses/ha	190.1	195.4
Av. gross margin (US$/ha)[3/]	462.8	369.2

1/ GLH = Green Leaf Hopper. Amrasca sp. : pod borer. Maruca testulalis and Etiella zinckenella: Pod sucking bug, Nezara viridula and Cletus sp.

2/ Data in table from sampling when maximum pests occurred.

3/ Includes costs of land preparation, seed, herbicides, pesticide application, fertilizer and harvesting.

4/ Value of the yield at a price of 0.52 US$/kg of mungbean seed.

However this study showed that farmers in our project area, where some areas were planted to resistant mungbean variety (KPS 1), could reduce their insecticide application further by adapting insect management program using frequent sampling and economic thresholds. In the future, practical insect management programs and research trial designed to measure yield loss at different growth stages, and to test sampling techniques, economic threshold and insecticide efficiency should be undertaken in farmers' fields at various locations with different insect pest complexes, Then, continuous interaction and feedback between the practical programs and research tests will result in the development of the most effective programme adapted to local conditions. The existing insect management technology must be simplified if it proves too complex to be used by farmers. One way in which this might be done is to train farmers to manage only those few insect pests in an area which may cause economic losses because of inadequate varietal resistance.

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