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Effects of Integrated Pest Management (IPM) Practice on Insects Population and Yield of Cabbage in Cameron Highlands

Zainudin, Mohd Yusri[1*], Jamil, Saiful Zaimi[1], Nazmi, Mohd Syauqi[2] & Mohd Nor, Mohd Fuad[1]

[1]Agrobiodiversity and Environment Research Center, Malaysian Agricultural Research and Development Institute (MARDI), Ibu Pejabat MARDI, Persiaran MARDI-UPM, 43400 Serdang, Selangor, MALAYSIA

[2]Socio Economic, Market Intelligence and Agribusiness Research Centre, Malaysian Agricultural Research and Development Institute (MARDI), Ibu Pejabat MARDI, Persiaran MARDI-UPM, 43400 Serdang, Selangor, MALAYSIA

*Corresponding author: yus@mardi.gov.my

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Abstract: *Plutella xylostella* is the main pest of cruciferous plants which are widely planted in Cameron Highlands. This pest attack causes losses of up to 90% to farmers. To overcome this problem, most farmers use synthetic chemical pesticides intensively and exceed the prescribed dose. This situation causes pollution to the environment and endangers the health of consumers due to the effects of toxic residues on harvested vegetables. In addition, excessive use of insecticide will increase the insect's immunity to the insecticide, and this will reduce the effectiveness of the insecticide in the future. If this happens, farmers will incur losses because they have to use insecticides at a higher rate or use insecticides that are much more expensive. This study evaluates the effect of using integrated pest management (IPM) methods in MARDI Cameron Highlands cabbage fields in terms of insect population distribution whether pests or natural enemies and cabbage yield for each season. In this study, there were two treatments which were IPM and conventional grown cabbage. Each treatment has 5 replications and was repeated for three seasons. For IPM treatment, pesticide spraying was determined through evaluation of natural pests and enemies found in cabbage on a weekly basis. IPM treatment also uses yellow and blue sticky traps as well as biological control agents to control pests. Monitoring of pest and beneficial insect populations was carried out once every 2 weeks using the direct count and sweeping net method. The name and number of acquired species of insects were recorded in the scoresheet. The harvested cabbage is weighed, and the yield was recorded. The results of the study show that the use of IPM methods in cabbage fields has a positive effect on the interaction between pest populations and natural enemies, and the quality of the harvest also does not show qualitative and quantitative differences compared to conventional cultivation.

Keywords: IPM, Cameron Highlands, cabbage, beneficial insect, biopesticides

1. Introduction

Cabbage, *Brassica oleracea* var. capitata (Brassicaceae), is one of the important vegetable crops grown in Cameron Highlands. Most of the cabbages that are grown in this area is for the overseas market. Among the main export destinations for Malaysian cabbage are Singapore, Brunei, Indonesia, and the Maldives. In 2019, Malaysia's cabbage export production was 15,085 tons or equivalent to RM32.98 million (Anon, 2020). However, this figure is slightly less compared to the records in 2018, which was 15,311 tons and 2017, which was 18,448 tons. Among the factors contributing to the decrease in production is due to the attack of a pest insect, *Plutella xylostella*, which causes damage to cabbage plants. *P. xylostella* is the main pest of cruciferous plants which are widely planted in Cameron Highlands. Attacks by these pests cause losses of up to 90% to farmers. To overcome this problem, most farmers use synthetic chemical pesticides intensively and exceed the prescribed dose. This situation causes pollution to the environment and endangers the health of consumers due to the effects of toxic residues on harvested vegetables (Norida and John, 2005).

*Corresponding author: yus@mardi.gov.my

In addition, excessive use of insecticide will increase the insect's immunity to the insecticide and this will reduce the effectiveness of the pesticide in the future. If this happens, farmers will incur losses because they have to use insecticides at a higher rate or use insecticides that are much more expensive.

Among the strategies used to overcome this problem is, to practice the Integrated Pest Management (IPM) method that emphasizes more environmentally and friendly agricultural practices. Among the components of IPM is the minimal use of chemical pesticide, choosing environmentally friendly or organic pesticide and using natural enemies of pests such as predators or parasitoids. Basically, IPM is carried out in the following framework which is pest identification, field monitoring, control methods, and evaluation after control actions.

Biological control is one of the important components of IPM where this method uses the natural enemies of a pest to control the pest population. These natural enemies are either already present in the farm environment or are intentionally released to the farm for the purpose of controlling the population of a pest. Among the types of natural enemies that are often used are predators and parasitoids. There are several predators or parasitoids that are natural enemies *of P. xylostella such as Diadegma semiclausum, Diadromus collaris, Cotesia vestalis* and so on (Saucke et al., 2000). There are two methods that are often used to maintain the population of biological control agents in the field, which is through the conservation method by providing food sources and shelter to the agent and through the augmentation method, which is by periodically releasing the agent in the field. Through conservation methods, plants that have a high nectar source such as flowering plants will be planted around the farm area. These plants will provide food source in the form of nectar or pollen to biological control agents as well as shelter from predatory attacks.

2. Materials and Methods

2.1 Monitoring of pests and natural enemies of pests

This activity was carried out to obtain an estimate of the population of pests and their natural enemies in the field. Through this process, the numbers were used to identify the economic injury level (EIL), the injury threshold level (ETL), and the equilibrium position value (EP). All of these values were utilized to determine the necessary control actions, such as chemical or bio-pesticide spraying, or to decide against any pesticide spraying. Monitoring was conducted through the direct counting method on randomly selected cabbage plants, and the recorded numbers of insects were entered into a scoresheet. The recorded numbers were then matched with the economic damage threshold level (ETL) in Table 1 for further action.

Table 1: Table of economic damage treshold level (ETL) for cabbage crops.

Crop Age	ETL	Method of controls
1 – 4 weeks	<4 larvae DBM/plant	Zero insecticide application
	>4 <7 larvae DBM/plant; parasitism rate >40%	Zero insecticide application
	>4 <7 larvae DBM/plant; parasitism rate <40%	Bio-insecticide application (Bt, MNPV, dll)
	7 larvae DBM/plant	Chemical insecticide application
5 – 10 weeks	<8 larvae DBM/plant	Zero insecticide application
	>8 <14 larvae DBM/plant; parasitism rate >40%	Zero insecticide application
	>8 <14 larvae DBM/plant; parasitism rate <40%	Bio-insecticide application (Bt, MNPV, dll)
	>14 larvae DBM/plant	Chemical insecticide application

*DBM = *P. xylostella*, Bt = *Bacillus thuringiensis*, MNPV = Multi Nucleuopolyhidrosis Virus

2.2 Pesticide application

In this study, only biological insecticide control was carried out, namely *Bacillus thuringiensis* (Bt) and Multinucleopolyhdyrosis virus (MNPV) types. Applications were run based on ETL values that are monitored weekly. The dosage rate gave to the plant was according to the measure that has been set by the manufacturer.

2.3 Use of biological control agents

In this MARDI Cameron Highlands cabbage farm, conservation and augmentation biological control methods were used. For conservation methods, flowering plants from the species *Asclepias curassavica* and *Chrysanthemum indicum* were planted around cabbage farm as a food source and shelter for natural enemies of cabbage pests (Figure 1).

Fig. 1: Flowering plant from the *A. curassavica* and *C. indicum* was used as a food source and shelter for natural enemies of DBM

For the augmentation method, the natural enemy of DBM from the species of *Diadegma semiclausum* bred in the laboratory was released to the field two (2) times per season, which were in the first week and the fifth week after cabbage was planted in the field. A total of 50 adult *D. semiclausum* were released on the plot for each release session.

Fig. 2: Female adult of *D. semiclausum*

2.4 Uses of sticky trap

Insect stickers such as Yellow sticky trap (YST) and Blue sticky trap (BST) were also used to trap pests in the field (Figure 3). This sticker was set up between the crop bed of the cabbage crops at a height of 0.5 meters from the plant. Stickers are changed biweekly.

Fig. 3: Application of YST and BST in the plot

3. Results and Discussion

3.1 Insect population distribution

The research data showed that the distribution of insect pests and beneficial insects' populations are interact with one another (Figure 4). The presence of natural enemies in the field can help control the pest population from increasing and causing severe damage to crops. From the monitoring activities were carried out throughout the study, a total of 13 species of insect pests and 10 species of beneficial insect have been identified (Table 2 and Table 3).

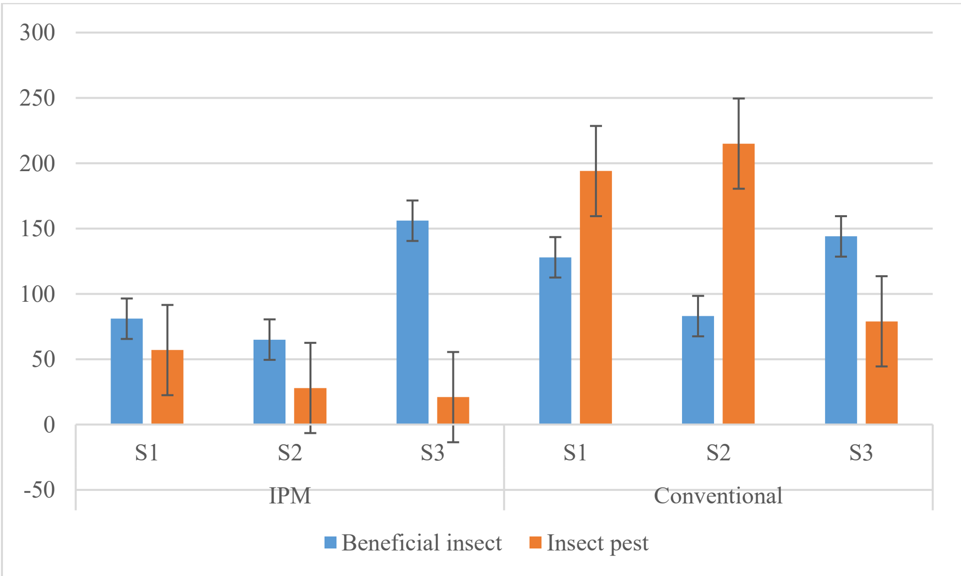

Fig. 4: Population distribution of insect pests and beneficial insects in IPM and conventional MARDI Cameron Highlands cabbage plot for season 1, 2 and 3.

Table 2: List of insect pests were recorded on the plot throughout the study

Scientific name	Common name
Plutella xylostella	Diamondback moth
Spodoptera spp.	Armyworms
Trichoplusia ni	Cabbage looper
Crocidolomia spp.	Cabbage cluster catterpillar
Aleyrodes spp.	Whitefly
Cicadellidae	Leafhopper
Liriomyza brassicae	Cabbage leafminer
Phyllotreta undulata	Flea beetle
Omocestus viridulus	Common green grasshopper
Aphis gossyphii	Aphid
Pseudococccidae	Mealybugs
Graptostethus servus	Grasshopper
Danaus plexippus	Monarch butterfly

Table 3: List of beneficial insects were recorded on the plot throughout the study

Scientific name	Common name
Diadegma semiclausum	Parasitoid wasp
Cotesia vestalis	Parasitoid wasp
Diadromus collaris	Parasitoid wasp
Coccinella magnifica	Ladybug beetle
Oxyopes spp.	Lynx spider
Podiscus maculiventris	Soldier bug
Musca domestica	Housefly
Phoridae	Fruit flies
Chrysomya spp.	Blow fly
Monomorium spp.	Black ant

The study aimed to compare the effectiveness of two treatments, IPM and conventional method, in beneficial insect distribution values. A one-way ANOVA test was conducted to compare the means of the variable beneficial insect between the two treatments. The null hypothesis tested was that there is no significant difference in the mean beneficial values between the two treatments. The results of the ANOVA test revealed that the p-value was 0.626, which was not significant at the 0.05 level. Therefore, the null hypothesis was not rejected, and it was concluded that there was no significant difference in the mean beneficial values between the IPM and conventional treatments.

Further analysis of the mean beneficial values showed that the means for conventional and IPM treatments were 118.3 and 100.7, respectively, and the pooled standard deviation was 40.9919. The Tukey pairwise comparisons also revealed that the mean beneficial values for both treatments were not significantly different from each other.

The ANOVA analysis for insect pest value between IPM and conventional treatments show that the F-value is 8.50 with a p-value of 0.043, which is lower than the significance level of 0.05. This suggests that there is a statistically significant difference between the mean values of insect pest density in the two treatments. The means comparison shows that the mean value of pest density in the conventional treatment is 162.7, while the mean value in the IPM treatment is 35.3. The Tukey pairwise comparison confirms that these means are significantly different.

Results of this analysis suggest that the IPM treatment is significantly more effective in reducing pest density compared to the conventional treatment. A study was conducted between conventional and IPM watermelon cultivation found a population of insect pests, *Acalymma vittatum*, or stripped cucumber beetle, was always below the economic threshold of around 1.18 ± 0.34 per plant for the IPM method (Pecenka et al., 2021). In 3 years study, 77 insecticide sprays were carried out on conventional plots compared to only 1 insecticide spray was conducted in IPM plots (Pecenka et al., 2021). A study by Saikumar et al (2021) on conventional and IPM grown cabbage also recorded lower DBM numbers on IPM plot that was 1.55 ± 0.59 per plant as compared to 5.34 ± 1.18 in conventional plot. This finding could be useful in the development of more effective pest management strategies in agriculture.

3.2 Crop yield

The research data shows that the crop yield between IPM and conventional farms does not have much difference either in terms of quantity or quality of harvested crops. The following is the comparison of crop yield between IPM and conventional farms (Figure 5).

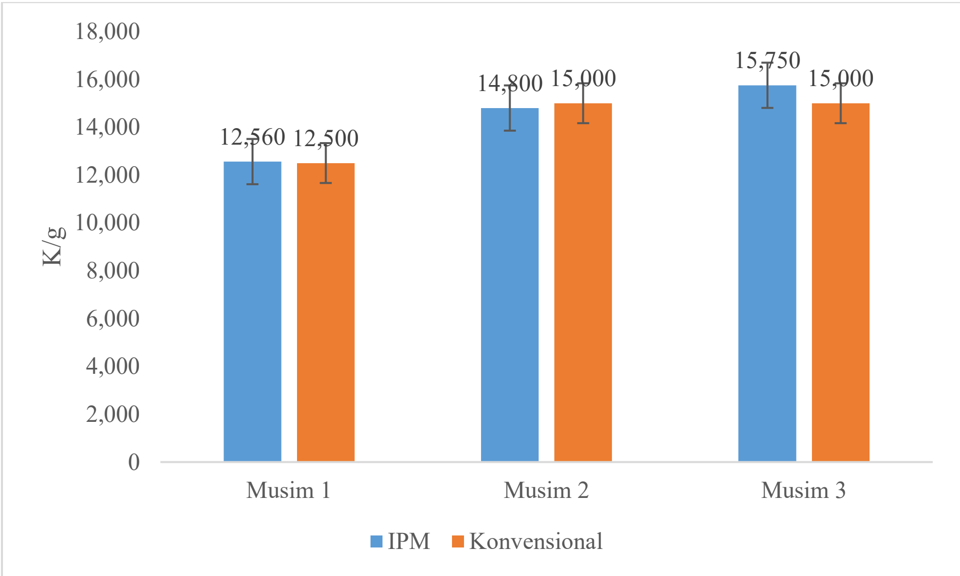

Fig. 5: Comparison between crop yield of IPM and conventional farms (kg/hectare) for seasons 1, 2 and 3.

An ANOVA test was conducted to compare the means of cabbage yield harvested from the plot between the two treatments. The null hypothesis tested was that there is no significant difference in the mean insect distribution between the two treatments. The results of the ANOVA test revealed that the p-value was 0.072, which was not significant at the 0.05 level. Therefore, the null hypothesis was not rejected, and it was concluded that there was no significant difference in the mean insect distribution between the IPM and conventional treatments.

Further analysis of the mean insect distribution showed that the means for conventional and IPM and treatments were 5167 and 14370, respectively, and the pooled standard deviation was 4637.67. The Tukey pairwise comparisons also revealed that the mean insect distribution for both treatments were not significantly different from each other. Findings by Ahuja et al. (2015) on the yield of conventional and IPM grown cauliflower was found that the yield of cauliflower grown by IPM is 10% higher than the conventional method which was around 24 tonnes/hectare. However, for fruit crops such as watermelon, the yield may be higher by up to 25.7% as the IPM method can increase the presence of insect pollinators (Pecenka et al., 2021).

4. Conclusion

In conclusion, the results of this analysis suggest that the IPM treatment is significantly more effective in reducing pest density compared to the conventional treatment. This finding could be useful in the development of more effective pest management strategies in agriculture. The use of IPM methods in cabbage fields can reduce the input cost of farm production by providing results comparable to conventional methods. In addition, this method is safer and gives greater returns in the long term in terms of economics, health and social.

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Conflict of Interest

The authors declare no conflicts of interest.

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