

Characteristics of the Arthropod Community in Agroecosystems of Honey Pumpkin Plant (*Cucurbita moschata* Duch)

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ABSTRACT

This research was conducted to analyze the application of the integrated pest management (IPM) model to increase the ecological resilience of the honey pumpkin plant. The research was carried out at the Research and Teaching Farm, Pest Laboratory, Laboratory of Biological Agents, Faculty of Agriculture, Jambi University from June - October 2020. The research was designed with two treatment of pest control, namely: A = conventional pest control (application of synthetic insecticides, synthetic fungicides on a calendar basis and application of synthetic fertilizers; B = planting refugia plants between honey pumpkin plants, application of bio pesticides (*Trichoderma* sp., *Beauveria bassiana* and *Metarhiziumanisoplia*), predatory application (*Oecophyllasmaragdina*) and use of adhesive yellow traps. The observed variables were: species and population abundance of arthropods; Shannon-Wiener index (H'), Evenness index (E), and Berger-Parker dominance index (d). Arthropods samplings were carried out by a pit fall trap, a sweeping net and sticky yellow traps when the plants were 20, 40, and 60 days after planting (DAP). The result shows that the ecology resilience of treated honey pumpkin agro-ecosystem with bio intensive IPM model was better than ecology resilience of treated honey pumpkin agro-ecosystem with conventional pest control; the honey pumpkin agroecosystem that using bio intensive IPM model in pest control was classified as stable (good) until very stable (very good) and the honey pumpkin agroecosystem that using conventional pest control was classified as less stable (dissatisfactory).

Keywords: IPM, ecosystem, quality.

1. INTRODUCTION

Honey pumpkin (*Cucurbita moschata* Duch) belongs to the Cucurbitaceae family, also known as pumpkin butternut. Honey pumpkin attracts attention because of the unique fruit shape, similar to peanuts, reddish-yellow flesh. The taste of the fruit is sweet with a soft texture and gets sweeter after at least two months of storage. Honey squash is increasingly in demand because it tastes good, good for health because it contains carbohydrates, protein, phosphorus, and Fe, vitamins B, C and fiber [1]. Besides, the fruit can be used as raw material for various types of food as well as an alternative to the substitute of rice [2]. Honey pumpkin can be grown and cultivated in the lowlands and highlands, but is more likely in dry areas with moderate rainfall and at an altitude of 1000-3000 meters above sea level [3].

Farmers' interest in honey pumpkin cultivation is currently increasing, which is shown by the fact that the seeds in the market are often used up. On the other hand, pests have become a very serious limiting production factor for the farmers. Various species of pumpkin pests have been reported, namely *Bemisia* spp., *Tetranychus* spp., *Epilachna* [4], *Apomecynasaltator* [5], [6], [7], [8], [9], [10], [11], *Aulacophora* spp., *Bactocera* spp. [5], [12], *Megymenumbrevicorne* [5], *Aspongopusjanus*, *Epilachnavigintioctopunctata*, *Mylabrispustulata*, *Sphenarchescaffer*, *Anadevidiapeponis*, *Diaphaniaindica*, *Melittiaeurytion*, *Liriomyzatrifolii*, *Neolasioptera falcata* [12].

The pest was usually controlled by farmers using synthetic insecticides. It is known that using synthetic insecticides can lead to: pest explosive due to resistance and resurgence of pest, killing of natural enemies; killing

of pollinators, decomposer, toxicity to consumers due to insecticides residues on fruit and environment. Many researchers have explained that the use of pesticides can reduce biodiversity and agro ecosystem ecological resilience [13], [14], [15], [16], [17]. To avoid the various negative impacts of using insecticides, it is necessary to revitalize integrated pest management (IPM) in controlling honey pumpkin plant pests.

IPM is currently believed to be able to provide breakthroughs in pursuing the realization of sustainable agriculture. In principle, IPM is pest management by combining compatibly various control techniques with considerations of pest bioecology and their relationship with plant agronomics in a comprehensive manner so as to obtain optimal and sustainable results. The implementation of IPM is a necessity for agricultural practitioners because it is mandated by Laws of The Republic of Indonesia Number 12 of 1992 about plant cultivation systems. Historically, IPM has developed based on the approach in implementing IPM, namely technological IPM, ecological IPM and bio-intensive IPM.

Bio intensive IPM is an effort to use intensive biological resources in nature to suppress pest population and its attacks. In IPM, the increasing role of biological agents must be understood as an integral part of the overall agri-ecosystem management integrated in plant cultivation techniques. Therefore, the authors tried to develop a honey pumpkin bio-intensive IPM model by combinations of pest control techniques which were compared with conventional pest control techniques.

The research was carried out to analyse the effect of the application of the bio-intensive IPM model on the ecological resilience of the honey pumpkin plant. This research has proven that the developed hypothesis that the application of the bio-intensive IPM model can increase the ecological resistance of honey pumpkin plants.

2. MATERIAL AND METHODS

The research was carried out in the Research and Teaching Farm, Pest Laboratory, Biological Agents Laboratory, Faculty of Agriculture, Jambi University from June — October 2020. The research was designed with two treatment of pest control, namely: A = conventional pest control (application of synthetic insecticides, synthetic fungicides on a calendar basis and application of synthetic fertilizers; B = biointensive IPM model, by planting refugia plants between honey pumpkin plants, application of biopesticides (*Trichoderma* sp., *Beauveria bassiana* and *Metarhiziumanisoplia*), application of predatory (*Oecophyllasmaragdina*) and use of adhesive yellow traps. Every treatment was repeated 5 times that was placed in Randomize Block Design.

Treatment A. Synthetic insecticides and fungicides were applied once a week, starting from 1 week after planting (WAP) to 8 WAP. The insecticides and fungicides used will be adjusted to the type of pest.

Treatment B. The application of *Trichoderma* sp. was carried out at the beginning of planting. A total of 100 grams of *Trichoderma* sp. culture per planting hole. *Beauveria bassiana* application was carried out when the plants were 2 WAP and 6 WAP. The application was carried out by spraying the *B. bassiana* culture suspension with a concentration of 100 gr / 10 liters of water. Application of *M. anisoplia* was carried out when the plants were 4 WAP and 8 WAP. The application was carried out by spraying a culture suspension of *M. anisoplia* with a concentration of 100 gr / 10 liters of water. The spraying doses were adjusted to plant growth. The sunflower seeds 3 weeks after seedlings were planted in the experimental unit at the same time as honey pumpkin planting. Planting was carried out at 4 points in each treatment plot with a distance of 1 x 1m. Kenikir seeds and paper flowers are planted at the beginning of planting the honey gourd on each side of the bed (attached). One colony of *O. smaragdina* which has been prepared in a bottle containing 500 tails was placed at a center point above the tops of the plants when the plants are 35 days old. Yellow sticky trap is a yellow glue trap which was applied to a 1200 ml mineral water bottle, installed when the plant enters the generative phase as many as 4 bottles per treatment unit.

The observed variables were species and population abundance of arthropods; Shannon-Wiener index (H'), Evenness index (E), and Berger-Parker dominance index (d). Arthropods samplings were carried out by a pit fall trap, sweeping net and sticky yellow traps when the plants were 20, 40, and 60 days after planting (DAP). Arthropods samplings were carried out by a pit fall trap, sweeping net and sticky yellow traps when the plants were 20, 40, and 60 days after planting (DAP). Yellow pan trap and pitfall trap were installed one unit in each experimental unit and left for 24 hours (attached). Sampling of insect samples by a sweeping net was carried out by swinging it back and forth 5 times on each experimental plot. Arthropods collected from the field were inserted into 70% alcohol in a collection bottle, and labelled according to the sample unit, and taken to the laboratory for observation. The arthropods collected from the fields were identified by using available keys provided [18], [19], [20], [21], [22].

The data obtained were tabulated and analysed. The characteristics of the arthropod community were analysed by calculating the Shannon-Wiener index (H'), evenness index (E), and dominance index (d) [23], [24]), and discussed based on developed environmental quality weighting criteria as follow.

Table 1. Weighting of ecosystem quality based on the characteristics of arthropod community

Shannon-Wiener Index (H')	Ecosystem Stabilities	Categories
$H' \geq 3$	Very stable	Very good
$2.5 \leq H' < 3$	Stable	Good
$2 < H' < 2.5$	Less stable	Dissatisfactory
$1.5 \leq H' < 2$	Unstable	Poor
$H' < 1.5$	Very unstable	Very poor

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1. Characteristics of Arthropod community based on abundance of species and population,

Characteristics of arthropod community based on abundance of species and population are served in table 2, table 3, and table 4.

Table 2. Characteristics of arthropod community 20 DAP

Community Characteristics	Pest Control	
	A	B
Number of species	20	24
Number of individuals	103	144
Shannon Wiener Index (H')	2.3	2.7
Domination Index (D)	0.2	0.1
Evenness Index (E)	0.8	0.8

Table 2 shows that 20 DAP the diversity of species and populations of arthropods in the honey pumpkin agro-ecosystem with the application of pests control by using biointensive IPM higher than diversity of species and populations of arthropods in the honey pumpkin agro-ecosystem with the application of conventional pests control (by using pesticides).

Shannon Wiener Index (H') in honey pumpkin agro-ecosystem with the implementation of bio intensive IPM was 2.7 higher than H' in honey pumpkin agro-ecosystem with the application of conventional pests control was 2.3.

Domination Index (D) in honey pumpkin agro-ecosystem with the implementation of bio intensive IPM was 0.1 lower than D in honey pumpkin agro-ecosystem with the application of conventional pest control was 0.2.

Evenness Index (E) in honey pumpkin agro-ecosystem with the implementation of IPM bio intensive was equal to E in honey pumpkin agro-ecosystem with the application of conventional pest control was 0.8.

Table 3. Characteristics of arthropod community 40DAP

Community Characteristics	Pest Control	
	A	B
Number of species	21	32
Number of individuals	75	146
Shannon Wiener Indexs (H')	2.4	3.1
Domination Index (D)	0.2	0.1
Evenness Index (E)	0.8	0.9

Table 3 shows that 40 DAP the diversity of species and populations of arthropods in the honey pumpkin agro-ecosystem with the application of pests control by using bio intensive IPM higher than diversity of species and populations of arthropods in the honey pumpkin agro-ecosystem with the application of conventional pests control (by using pesticides).

Shannon Wiener Index (H') in honey pumpkin agro-ecosystem with the implementation of bio intensive IPM was 3.1 higher than H' in honey pumpkin agro-ecosystem with the application of conventional pests control was 2.4.

Domination Index (D) in honey pumpkin agro-ecosystem with the implementation of bio intensive IPM was 0.1 lower than D in honey pumpkin agro-ecosystem with the application of conventional pest control was 0.2.

Evenness Index (E) in honey pumpkin agro-ecosystem with the implementation of bio intensive IPM was 0.9 higher than Ein honey pumpkin agro-ecosystem with the application of conventional pests control was 0.8.

Table 4. Characteristics of arthropod community 60 DAP

Community Characteristics	Pest Control	
	A	B
Number of species	16	26
Number of individuals	57	78
Shannon Wiener Indexs (H')	2.3	3.0
Domination Index (D)	0.5	0.1
Evenness Index (E)	0.8	0.9

Table 4 shows that 60 DAP the diversity of species and populations of arthropods in the honey pumpkin agro-ecosystem with the application of pests control by using bio intensive IPM higher than diversity of species and populations of arthropods in the honey pumpkin agro-ecosystem with the application of conventional pests control (by using pesticides).

Shannon Wiener Index (H') in honey pumpkin agro-ecosystem with the implementation of bio intensive IPM was 3.1 higher than H' in honey pumpkin agro-ecosystem with the application of conventional pest control was 2.4.

Domination Index (D) in honey pumpkin agro-ecosystem with the implementation of bio intensive

IPM was 0.1 lower than D in honey pumpkin agro-ecosystem with the application of conventional pest control was 0.2.

Evenness Index (E) in honey pumpkin agro-ecosystem with the implementation of bio intensive IPM was 0.9 higher than E in honey pumpkin agro-ecosystem with the application of conventional pest control was 0.8.

3.1.2. Characteristics of arthropod community based on its ecological function

Characteristics of arthropod community based on its ecological function are served in table 5, table 6 and table 7.

Table 5. Arthropod community ecology function and its relative population abundance 20 DAP (%)

Ecological Functions	Pest Controls	
	A	B
	Relative Population (%)	
Herbivores	58.25	34.72
Beneficial arthropods	41.75	65.28
➤ Predators	2.91	11.81
➤ Predators/Pollinators	33.01	47.22
➤ Parasitoids/Pollinators	4.85	4.86
➤ Predators/Decomposer	0.97	1.39

Table 5 shows that 20 DAP the relative population of herbivores arthropod in the honey pumpkin agro-ecosystem with the application of pests control by using bio intensive IPM was 34,76 % lower than the relative population of herbivores arthropod in the honey pumpkin agro-ecosystem with the application of conventional pests control (by using pesticides) was 58,25. The relative population of beneficial arthropods (predator, predators/pollinators, parasitoids/pollinators, predators/decomposer) in the honey pumpkin agro-ecosystem with the application of pests control by using bio intensive IPM was 68,28 higher than the relative population of beneficial arthropods in the honey pumpkin agro-ecosystem with the application of conventional pests control (by using pesticides) was 41,74%.

Table 6. Arthropod community ecology function and its relative population abundance 40 DAP (%)

Ecological Functions	Pest Controls	
	A	B
	Relative Population (%)	
Herbivores	58.67	25.34
Beneficial arthropods	41,33	74,65
➤ Predators	20.00	29.45
➤ Pollinator	2.67	8.90
➤ Decomposers	5.33	12.33
➤ Predators/Pollinators	1.33	1.37
➤ Parasitoids/Pollinators	9.33	9.59
➤ Predators/Decomposers	2.67	13.01

Table 6 shows that 40 DAP the relative population of herbivores arthropod in the honey pumpkin agro-ecosystem with the application of pests control by using bio intensive IPM was 25.34 % lower than the relative population of herbivores arthropod in the honey pumpkin agro-ecosystem with the application of conventional pests control (by using pesticides) was 58.67%. The relative population of beneficial arthropods (predator, pollinator, decomposer, predators/pollinators, parasitoids/pollinators, predators/decomposer) in the honey pumpkin agro-ecosystem with the application of pests control by using bio intensive IPM was 74.65% higher than the relative population of beneficial arthropods in the honey pumpkin agro-ecosystem with the application of conventional pests control (by using pesticides) was 41.33%.

Table 7. Arthropod community ecology function and its relative population abundance 60 DAP (%)

Ecological Functions	Pest Controls	
	A	B
	Relative Population (%)	
Herbivores	59.65	29.49
Beneficial arthropods	40.35	70.51
➤ Predators	7.02	17.95
➤ Decomposers		2.56
➤ Predators/Pollinators	8.77	21.80
➤ Parasitoids/Pollinators	15.79	5.13
➤ Predators/Decomposer	8.77	23.08

Table 7 shows that 60 DAP the relative population of herbivores arthropod in the honey pumpkin agro-ecosystem with the application of pests control by using bio intensive IPM was 29.49 % lower than the relative population of herbivores arthropod in the honey pumpkin agro-ecosystem with the application of conventional pests control (by using pesticides) was 59.65%. The relative population of beneficial arthropods (predators, decomposers, predators/pollinators,

parasitoids/pollinators, predators/decomposer) in the honey pumpkin agro-ecosystem with the application of pests control by using IPM was 70.51% higher than the relative population of beneficial arthropods in the honey pumpkin agro-ecosystem with the application of conventional pests control (by using pesticides) was 40.33%.

3.2. Discussion

The results shown that the ecology resilience of treated pumpkin agro-ecosystem with IPM in pest control was better than ecology resilience of treated honey pumpkin agro-ecosystem within pesticides in pest control. Based on weighting of ecosystem quality (table 1), the Shannon Wiener Index (H') in table 2, 3 and 4 indicate that the quality of treated honey pumpkin agro-ecosystem with IPM in pest control in 20 DAP, 40 DAP and 60 DAP were grouped as stable (good), very stable (very good) and very stable (very good) respectively. Different from the quality of treated honey pumpkin agro-ecosystem within pesticides in pest control in 20 DAP, 40 DAP and 60 DAP were grouped as less stable (dissatisfactory).

Table 5, 6 and 7 show that the existing of beneficial arthropods in treated honey pumpkin agro-ecosystem with bio intensive IPM model in pest control in 20 DAP, 40 DAP and 60 DAP were 65,29 %, 74,65% and 70,51% respectively more dominant than the existing of herbivorous arthropods were 34,72%, 25,34% and 29,49% respectively. Otherwise, the existing of beneficial arthropods in treated honey pumpkin agro-ecosystem within pesticides in pest control in 20 DAP, 40 DAP and 60 DAP were 41,75%, 41,33% and 40,35% respectively less dominant than herbivorous arthropods were 58,25%, 58,67% and 59,65% respectively.

The use of refuge and *O. smaragdina* as integrated part IPM was necessary to conduct ecological engineering. Ecological engineering is an approach through manipulation of agroecosystems to optimize biological control. Ecological engineering in managing pests is principally aimed at increasing the role of natural enemies, curbing the development of pests and increasing plant vigor. Natural enemies have the potential to control pests effectively and sustainably. Otherwise the use of synthetic insecticides in honey pumpkin pest suppressed the presence of natural enemies of pests and other useful insects. The use of synthetic insecticides can lead to: pest explosive due to resistance and resurgence of pest, killing of natural

enemies; killing of pollinators, detritivores/decomposers; toxicity to consumers due to insecticides residues on fruit and environment. Many researchers have explained that the use of pesticides can reduce biodiversity and agroecosystem ecological resilience [13], [14], [15], [16], [17].

4. CONCLUSION AND RECOMMENDATION

4.1. Conclusion

- The ecology resilience of treated honey pumpkin agro-ecosystem with bio intensive IPM model was better than ecology resilience of treated honey pumpkin agro-ecosystem with conventional pest control
- The honey pumpkin agroecosystem that using bio intensive IPM model in pest control was classified as stable (good) until very stable (very good).
- The honey pumpkin agroecosystem that using conventional pest control was classified as less stable (dissatisfactory).

4.2. Recommendation

The bio intensive IPM model could be recommended for controlling pest in honey pumpkin cultivation. In implementation of bio intensive IPM model must be adjusted with plant phenology and its relationship with pest.

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