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Behavior of *Heterotrigona itama* in Hydroponic Melon (*Cucumis melo* L.) Planting in Greenhouse with Insecticide Spraying

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Abstract

Sustaining and improving melon production is essential to fulfill the increasing demand for melon fruit in Indonesia. In order to maintain this level of production, it is necessary to utilize insecticides to manage the pests that pose a threat to melon crops. This research aims to assess the impact of insecticide application on the pollination activity of Heterotrigona itama, a vital pollinating insect for melon plants. This research aimed to investigate the effect of Heterotrigona itama activity on melon plants in a greenhouse treated with insecticides. The study was carried out utilizing a survey-based methodology. Data was collected on several aspects of Heterotrigona items' behavior before and after applying insecticides. The research findings demonstrated that using insecticides on melon crops within a controlled environment decreased the frequency of visits from Heterotrigona itama to the melon flowers. Additionally, it was observed that the application of insecticides resulted in the mortality of Heterotrigona itama within the initial six days following the insecticide spraying. On the second day, the maximum number of individuals present was 14. The analysis of Heterotrigona itama honey revealed that the detected levels of pesticide residues were lower than the benchmark dose response (BMR) threshold.

Keywords: Behavior, Greenhouse, *Heterotrigona itama*, Insecticide, Melon, Pollinator

1. Introduction

Melon cultivation is of significant importance to the Indonesian population. This fruit, rich in various beneficial nutrients, is widely consumed fresh and enjoys popularity across all societal levels. According to reports, national melon production reached only 138,177 tons in 2020, which declined to 129,147 tons in 2021, further decreasing to 118,699 tons in 2022 and finally to 117,730 tons in 2023 (Anonymous, 2024).

The observed decline in melon production may be attributed to inadequate pollination of melon plants. As a monoecious flowering species, melons necessitate a pollination process for successful fruit development. A key pollinator that effectively facilitates this process is *Heterotrigona itama*. This eusocial insect is crucial for pollinating numerous plant species (Budianto & Sukendah, 2022). However, *Heterotrigona itama* is highly sensitive to insecticide compounds, and farmers typically use insecticides for pest management in melon cultivation.

Numerous investigations have demonstrated the impact of insecticides on the behavior and emergence of insects across various plant species. In the case of oil palm plants, the application of insecticides has been shown to influence the visitation rates of beetles to flowering blooms, resulting in a decrease in the frequency of beetle visits to individual spikelets (Prasetyo & Susanto, 2019). Pesticide application can occur through direct contact, ingestion, and accumulation, which poses risks to pollinator populations (Chreil & Maggi, 2023). There is a significant knowledge gap regarding the interactions between pesticides and pollinators, encompassing theoretical and data-related aspects and practical implications (Sponsler et al., 2019). This research is particularly significant as it addresses the lack of studies examining the effects of insecticide application on the behavioral patterns of pollinator insects, specifically *Heterotrigona itama*, as well as the presence of insecticide residues in honey produced in conjunction with melon cultivation within a controlled environment.

Nevertheless, the impact of applying insecticides to melon plants on the behavior of pollinating insects in

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Closed Greenhouse cultivation remains inconclusive.

2. Material and Methods

This research was conducted in the Dhabit Farm Greenhouse in Pulau Godang Kari Village at 0 0 32'47"S 101 0 32'56"E with an altitude of 59.83 meters above sea level. This research used a drip hydroponic system for 200 melon plants cultivated in a Closed Greenhouse. At the age of the melon, 2 weeks after planting, 1 colony of *Heterotrigona itama* brought from the Dhabit Farm in healthy condition was acclimatized to the melon plantation.

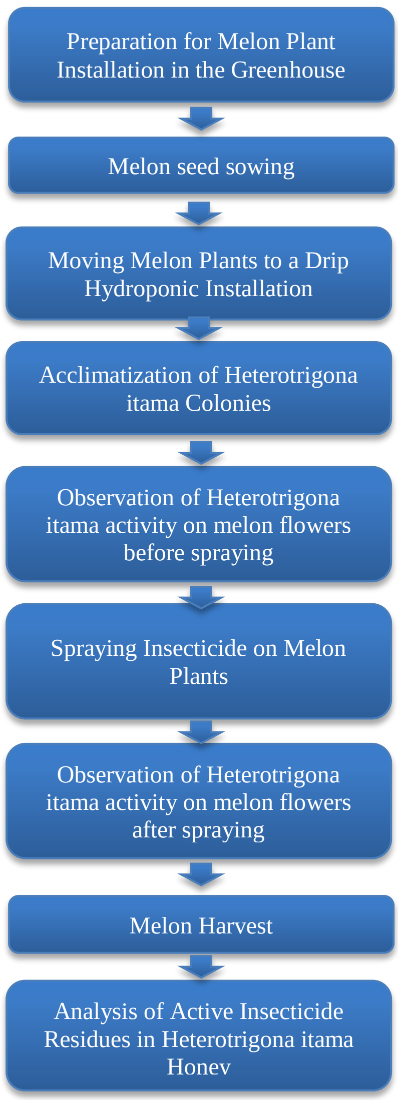

Figure 1. Research flow diagram

Insecticide application to melon plants was carried out once in one melon cultivation period 9 weeks after planting. Observations were made on the number of visits and the number of *Heterotrigona itama* before and after insecticide spraying. The parameter is the number of *Heterotrigona itama* individuals active on melon flowers. This data was collected by direct observation 11 days before spraying and 11 days after. In addition, data on pesticide residue content in *Heterotrigona itama* honey was also taken at the end of the study. Pesticide residue analysis was carried out using the HPLC method. The research data were analyzed statistically using Microsoft Excel and presented in table form.

3. Results and Discussion

3.1. Number of visits by Heterotrigona itama before and after insecticide spraying

The greatest number of visits occurred on the day preceding the spraying event, with an observed frequency of 120 trips. The fewest visits occurred on day -10 before spraying, totaling 22 visits. Applying insecticide to melon plants resulted in a significant decrease in the frequency of visits by *Heterotrigona itama*. There were no visits to melon flowers from the first day to the sixth day after spraying.

Observations revealed that *Heterotrigona itama* commenced visiting melon flowers seven days after insecticide application, with two total visits documented. The frequency of visits demonstrated a positive correlation with the number of days elapsed post-application of insecticides.

Table 1. Average comparison of the number of visits by *Heterotrigona itama* to melon flowers before and after insecticide spraying.

	Number of Visits		
Day	Before Spraying	Day	After Spraying
-10	22	1	0
-9	32	2	0
-8	47	3	0
-7	69	4	0
-6	81	5	0
-2	100	6	0
-5	105	7	2
-4	117	8	2
-3	119	9	3
-2	116	10	5
-1	120	11	3

Spraying pesticides can affect organisms in the plants where the pesticide is applied. It can even directly reduce the population of herbivorous insects. Pesticide application during the day has a negative impact on insect foraging behavior.

3.2. Number of individuals of Heterotigona itama visiting melon flowers.

The peak average count of *Heterotrigona itama* individuals recorded was on melon flowers before applying pesticide. Specifically, the maximum observation occurred on the fourth day before spraying, with an average of 11.4 individuals per plant. In contrast, the minimum count was noted on the eighth day before spraying, averaging 5.9 individuals per plant.

Following the spraying, the average number of *Heterotrigona itama* individuals visiting melon flowers was highest on the tenth and eleventh days, with a count of 6 individuals. Conversely, the lowest observation was recorded from the first to the sixth day post-spraying, during which no individuals were noted. Pesticide application during the day has a negative impact on insect foraging behavior.

Table 2. Mean comparison of the number of *Heterotrigona itama* individuals on melon flowers before and after insecticide spraying.

Number of individuals			
Day	Before Spraying	Day	After Spraying
-10	6.3	1	0
-9	7.9	2	0
-8	5.9	3	0
-7	7.0	4	0
-6	6.8	5	0
-2	9.8	6	0
-5	8.2	7	2
-4	11.4	8	2
-3	9.2	9	4
-2	9.4	10	6
-1	10	11	6

3.3. Number of Individual Deaths of Heterotrigona itama at the Research Site

Before insecticide spraying, no deaths were found in *Heterotrigona itama* individuals at the research location. After spraying insecticide, the second day after spraying resulted in the highest number of *Heterotrigona itama* individuals dying, namely 14 individuals. On the following day, the number of individuals dying decreased until, on the 6th day, no more individuals died.

Some pesticide applications can cause death in pollinator insects. This insecticide can also cause poisoning and death in pollinator insects (Biddinger & Rajotte, 2015); even this insecticide can also cause death in pollinator bee colonies. The application of pesticides with the active ingredient profenofos was also found to cause death in Eocanthecona furcellata up to 63.33% (Rustam et al., 2019)

Table 3. Number of *Heterotrigona itama* mortalities in melon plantations before and after insecticide spraying.

Number of individuals			
Day	Before Spraying	Day	After Spraying
-10	0	1	9
-9	0	2	14
-8	0	3	7
-7	0	4	5
-6	0	5	2
-2	0	6	0
-5	0	7	0
-4	0	8	0
-3	0	9	0
-2	0	10	0
-1	0	11	0

3.4. Pesticide Residues in Honey

According to the HPLC method analysis findings for pesticide residue, the data shown in Table 4 were acquired. This study found that the amount of insecticide residue present in the honey samples was determined to be below the government-mandated minimum residue standard (MRL) of 2.00 ppm, as reported by Sinambela in 2024.

During the cultivation of melons in the greenhouse, the highest levels of the active ingredients Mancozeb and profenopos in pesticide residues were found to be 0.004 mg/L and 0.007 mg/L, respectively, following a single application.

Figure 2. *Heterotrigona itama* individuals died after insecticide spraying on melon plants.

Table 4. Pesticide residues in *Heterotrigona itama* honey

No	Analysis	SD-1	SD-2	ST-1	ST-2	Jlh	Average
1	Mancozeb (mg/L)	0.004	0.001	0.002	0.001	0.008	0.002
2	Profenopos (mg/L)	0.007	0.006	0.003	0.001	0.0017	0.00425

4. Conclusion

Applying pesticides in greenhouse melon plantations for pest and disease management can diminish the frequency of melon flower visitations by *Heterotrigona itama* and may even lead to their mortality. The application of pesticides containing Mankozeb and Prenofos was observed to result in pesticide residues that were found to be lower than the Benchmark Level.

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