



## Identification and Infestation Levels of Fruit Flies (*Bactrocera* spp.) Using Petrogenol Traps in Tomato (*Solanum lycopersicum*) Fields in Waiheru Village, Baguala District, Ambon City

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**Abstract:** This study aimed to identify fruit fly species associated with tomato plants and to determine the infestation level of *Bactrocera* spp. in tomato crops cultivated in farmers' fields in Waiheru Village, Baguala District, Ambon City. The study was conducted from August to October 2025 using an exploratory survey approach. Adult fruit flies were collected using five Petrogenol-baited traps positioned diagonally at five observation points within the tomato field, with each trap installed approximately 2 m above the ground between tomato rows. Captured fruit flies were identified based on morphological characteristics of the head, thorax, wings, and abdomen using Tephritidae identification keys with the aid of a hand lens or microscope. Fruit fly infestation was assessed on 20 tomato plants, with four plants selected at each trapping point, by recording symptoms of fruit fly attack on the fruits. Two fruit fly species were identified, namely *Bactrocera carambolae* and *Bactrocera umbrosa*, both belonging to the family Tephritidae and order Diptera. A total of 45 adult fruit flies were captured, consisting of 40 individuals of *B. carambolae* (88.89%) and 5 individuals of *B. umbrosa* (11.11%). The percentage of fruit infestation ranged from 2.86% to 6.43% and was classified as low. These results indicate that *B. carambolae* was the dominant species captured in the tomato field, while the overall fruit fly infestation level remained low. The findings provide baseline information for fruit fly monitoring and may support the development of integrated and environmentally sustainable management strategies in tomato cultivation.

**Keywords:** Fruit fly identification; infestation level; *Bactrocera* spp.; Petrogenol; *Solanum lycopersicum*

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## INTRODUCTION

Pest infestation remains a major constraint on food and horticultural crop production because it can reduce yield quantity and quality, increase production costs, and ultimately decrease farmers' profitability. In the context of sustainable agriculture, pest management has increasingly shifted from a primary reliance on chemical pesticides toward approaches that maintain crop productivity while preserving ecosystem health. The Food and Agriculture Organization (FAO) emphasizes that Integrated Pest Management (IPM) is an ecosystem-based approach that combines multiple control strategies, prioritizes pest monitoring, conservation of natural enemies, and low-risk control methods, while synthetic pesticides are used only when economically justified (FAO, 2022).

This approach is consistent with current developments in pest management, which emphasize the integration of cultural, mechanical, biological, and behavioral methods with the selective use of pesticides to suppress pest populations while minimizing environmental impacts. Zhou et al. (2024) reported that recent advances in IPM increasingly focus on reducing dependence on chemical pesticides through strengthened biological control, more targeted control technologies, and ecosystem-based management strategies. For *Bactrocera* fruit flies, sustainable management has

also increasingly incorporated semiochemical-based approaches, including attractants, to improve pest detection, monitoring, and population management (Jaffar et al., 2024). Therefore, attractant-baited traps represent a relevant tool for fruit fly monitoring and may contribute to integrated pest management programs.

Fruit flies of the genus *Bactrocera* are among the major pests of horticultural crops and are considered important plant pests in Indonesia and many other regions worldwide. These insects have a broad host range and can infest more than one hundred horticultural plant species, including mango, guava, star fruit, melon, jackfruit, water apple, tomato, red chili, and bitter melon (Sari et al., 2020). Fruit damage generally begins when female flies oviposit eggs into fruit tissue. The eggs subsequently hatch into larvae that develop and feed within the fruit, causing direct tissue damage and potentially facilitating secondary infection by microorganisms that accelerate fruit decay. Consequently, infested fruits may deteriorate before reaching optimal maturity and may drop prematurely from the plant (Sahetapy et al., 2019). Fruit fly infestation therefore has both production and market implications, as it can reduce yield and fruit quality and may also restrict horticultural trade because importing countries impose sanitary and phytosanitary requirements to prevent the introduction and spread of plant pests (Direktorat Jenderal Hortikultura, 2023).

Fruit fly infestation has also been observed in tomato production areas, including Waiheru Village, Baguala District, Ambon City, where it may contribute to deterioration in fruit quality. Sembel (2021) reported that fruit flies are among the pests commonly associated with horticultural production areas. Chemical control using insecticides may adversely affect environmental and human health, while excessive and repeated insecticide use may promote the development of pest resistance. These limitations highlight the need for selective, environmentally compatible, and sustainable approaches for fruit fly monitoring and management. One potential approach is the use of attractant-baited traps, including Petrogenol, a commercial attractant containing methyl eugenol.

Petrogenol is used to attract fruit flies, particularly male individuals. Its methyl eugenol component is a volatile compound capable of attracting responsive male fruit flies (Yumaizah et al., 2022). Because of this behavioral response, methyl eugenol-baited traps can facilitate the detection and collection of adult males, thereby supporting fruit fly monitoring and species identification. Information obtained from trap captures can also provide an indication of the occurrence and distribution of responsive fruit fly species within cultivated areas (Patty, 2024). However, because methyl eugenol primarily attracts males of particular fruit fly species, trap catches should be interpreted as an indicator of species occurrence rather than as a direct measure of the entire fruit fly population or fruit infestation.

Previous studies have shown that fruit fly species composition varies among host plants and geographic locations. Astriyani (2016) identified two fruit fly species associated with mango in Bali, namely *Bactrocera papayae* and *Bactrocera carambolae*. Similarly, Syahfari & Mujiyanto (2013) reported four fruit fly species in Balikpapan City, namely *B. carambolae*, *B. albistrigata*, *B. cucurbitae*, and *B. papayae*, associated with several host plants, including mango, papaya, star fruit, guava, and water apple. These findings indicate that fruit fly assemblages may differ according to host availability and geographic conditions, emphasizing the importance of location-specific monitoring as a basis for effective pest management.

However, information on fruit fly species occurring in tomato fields and the level of fruit infestation in farmer-managed tomato production systems in Waiheru Village remains limited. Such information is needed as baseline data for developing locally

appropriate monitoring and integrated management strategies. Therefore, this study aimed to identify fruit fly species captured in tomato fields using Petrogenol-baited traps and to determine the percentage of fruit fly infestation in tomato crops in Waiheru Village, Baguala District, Ambon City.

## METHOD

### Study Site and Research Design

This study employed an exploratory survey with a quantitative descriptive approach to identify fruit fly species captured in tomato fields and to assess the infestation level of *Bactrocera* spp. on tomato (*Solanum lycopersicum*) fruits. The study was conducted from August to October 2025 in a farmer-managed tomato field in Waiheru Village, Baguala District, Ambon City. The study area covered approximately 500 m<sup>2</sup> (20 m × 25 m) and consisted of 12 planting beds, each containing 50 tomato plants. The study population comprised all tomato plants and adult fruit flies present within the study area during the observation period.

### Fruit Fly Sampling and Identification

Adult fruit flies were sampled using five Petrogenol-baited traps positioned diagonally at five observation points within the tomato field. Each trap was installed approximately 2 m above the ground between tomato rows. Adult fruit flies captured in each trap were collected, counted, and stored in specimen bottles for subsequent identification. Species identification was conducted based on diagnostic morphological characteristics of the head, thorax, wings, and abdomen using a fruit fly identification guide (Suputa, 2020), with the aid of a hand lens or microscope. The number of individuals belonging to each identified species was recorded to determine the composition and relative abundance of fruit flies captured during the study.

### Assessment of Fruit Fly Infestation

Tomato plants were sampled by selecting four plants at each trapping point, resulting in a total of 20 sample plants across the five observation points. The selected plants were monitored periodically from the fruiting stage until harvest. Five observation periods were conducted during the study. All fruits on the sampled plants were examined for symptoms associated with fruit fly infestation, including oviposition punctures, discoloration, tissue softening, and decay. Whenever possible, infestation was further confirmed by the presence of larvae within the fruit. At each observation period, the number of infested fruits and the total number of fruits examined were recorded for each observation point.

### Data Analysis

The data were analyzed descriptively. Fruit fly species composition was determined from the number of individuals of each species relative to the total number of adult fruit flies captured. Fruit infestation was expressed as the percentage of infested fruits relative to the total number of fruits observed at each sampling point and observation period. The resulting percentages were summarized across the five observation points to describe variation in infestation levels over the five observation periods.

The severity of fruit fly infestation was interpreted according to the classification reported by Rahim et al. (2023), as presented in Table 1.

**Table 1.** Classification of fruit fly infestation levels based on the percentage of infested fruits

| Infestation percentage (%) | Infestation level |
|----------------------------|-------------------|
| 0–25                       | Low               |
| >25–50                     | Moderate          |
| >50–90                     | High              |
| >90                        | Very high         |

(Rahim et al., 2023)

## RESULTS AND DISCUSSION

This study aimed to identify fruit fly species associated with tomato cultivation and to evaluate the percentage of *Bactrocera* spp. infestation in tomato plants grown in farmers' fields in Waiheru Village, Baguala District, Ambon City.

### Identification and Composition of Fruit Flies

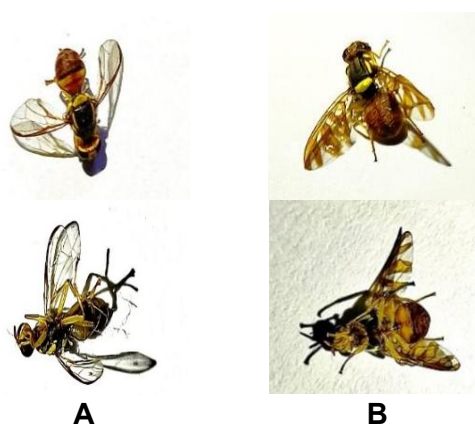
The identification and composition of adult fruit flies captured in the tomato field are presented in Table 2.

**Table 2.** Identification and composition of captured adult fruit flies

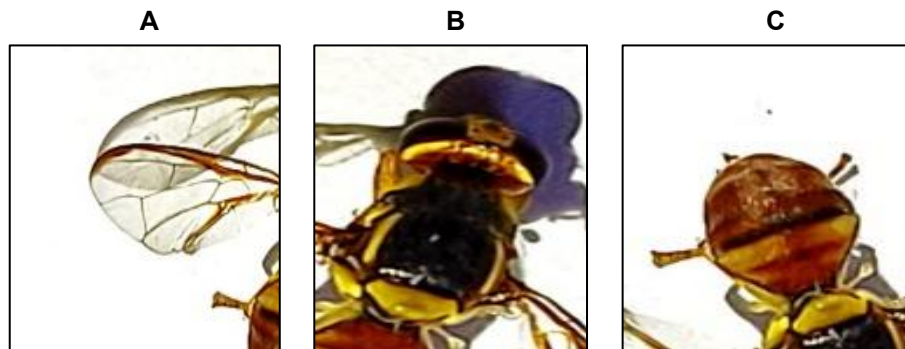
| No.   | Species                      | Number of Individuals | Percentage (%) | Category     |
|-------|------------------------------|-----------------------|----------------|--------------|
| 1     | <i>Bactrocera carambolae</i> | 40                    | 88.89          | Dominant     |
| 2     | <i>Bactrocera umbrosa</i>    | 5                     | 11.11          | Non-dominant |
| Total |                              | 45                    | 100            |              |

A total of 45 adult fruit flies were captured using Petrogenol-baited traps. Morphological identification based on the fruit fly identification guide of Suputa (2020) revealed two species, *Bactrocera carambolae* and *Bactrocera umbrosa*, both belonging to the family Tephritidae and order Diptera. *B. carambolae* was the most abundant species, with 40 individuals representing 88.89% of the total catch, whereas *B. umbrosa* accounted for only 5 individuals or 11.11%. Thus, *B. carambolae* was the dominant species captured at the study site, with a proportion approximately nine times higher than that of *B. umbrosa*. This difference indicates that *B. carambolae* was more frequently detected in the tomato-growing area during the observation period. Its greater abundance may be associated with the suitability of available host plants and environmental conditions at the study site.

The two identified species differed in several morphological characteristics, particularly those of the wings, thorax, and abdomen, as shown in Figure 1.

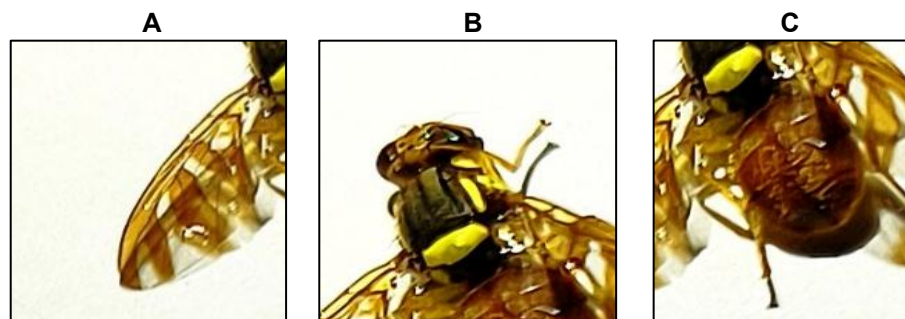
**Figure 1.** Fruit fly species captured in the tomato field (A. *Bactrocera carambolae* and B. *Bactrocera umbrosa*)

Based on morphological examination, *B. carambolae* was characterized by transparent wings with a distinctive dark pattern, particularly along the wing margin (Figure 2A). The scutum was predominantly dull black with yellow lateral bands (Figure 2B), while the abdomen was orange-brown with a characteristic dark pattern.



**Figure 2.** Morphological characteristics of *Bactrocera carambolae*

*Bactrocera umbrosa* exhibited a distinctive wing pattern consisting of three transverse bands extending from the costal region toward the posterior margin of the wing (Figure 3A). The thorax was predominantly black with yellow lateral bands (Figure 3B), whereas the abdomen was yellow-orange and lacked a distinct black T-shaped pattern (Figure 3C).



**Figure 3.** Morphological characteristics of *Bactrocera umbrosa*

The wing pattern of *B. umbrosa* is an important diagnostic feature. Hasanah et al. (2018) reported that this species is distinguished by its characteristic wing variation, with a wingspan of approximately 5.5–8.1 mm and three transverse bands extending from the costal band to the posterior wing margin. The abdomen is generally brownish with variable patterning. Wing morphology is therefore an important taxonomic character for distinguishing among fruit fly species (Sari et al., 2020).

*Bactrocera carambolae* has a broad host range that includes star fruit, papaya, water apple, guava, chili, jackfruit, mango, and tomato (Sahetappy et al., 2019). Its occurrence in tomato fields in Waiheru Village may therefore be associated with the availability of suitable host plants. Tomato fruits can provide resources for feeding, oviposition, and larval development, while surrounding horticultural vegetation may offer alternative host plants that support fruit fly persistence when crop composition changes. The presence of fruits at different stages of development and ripeness may also increase opportunities for oviposition. After hatching, larvae develop within the fruit tissues and feed on the pulp, which may result in tissue discoloration, softening, decay, and, under more severe infestation, premature fruit drop (Habibi, 2021).

The occurrence of *B. carambolae* in Waiheru Village may also be related to vegetation surrounding the tomato field. Agricultural landscapes containing alternative

host plants and continuously available fruit can support fruit fly populations across cropping periods. Therefore, the presence of *B. carambolae* at the study site highlights the potential importance of field sanitation and management of alternative host plants as components of integrated fruit fly management (Koswanudin et al., 2018).

### Symptoms of Fruit Fly Infestation on Tomato Fruits

Field observations showed that fruit fly infestation was associated with visible changes in tomato fruits, particularly on the fruit surface where oviposition may occur. Typical symptoms included puncture-like marks, discoloration, tissue softening, and decay. These symptoms are presented in Figure 4.



**Figure 4.** Symptoms associated with *Bactrocera* spp. infestation on tomato fruits: (a) external symptoms and (b) internal fruit damage

Figure 4a shows several small dark spots on the tomato fruit surface. These marks visually resemble oviposition punctures produced by female fruit flies. Such punctures may represent an early symptom of fruit fly infestation, although at the initial stage they can be difficult to distinguish from mechanical injury or other types of damage. After eggs are deposited within the fruit tissue, the larvae may hatch and begin feeding internally. Figure 4b shows the internal condition of a dissected fruit, with damaged tissues, browning, softening, and localized decay. These symptoms are consistent with damage that may result from larval feeding within the fruit. Such damage can reduce fruit quality and, under more severe infestation, render the fruit unsuitable for marketing. Roohigohar (2022) demonstrated that fruit fly larvae can survive and develop within tomato fruits, using fruit tissues as a food source.

### Percentage of Fruit Fly Infestation

The percentage of *Bactrocera* spp. infestation varied among observation periods, as shown in Table 3.

**Table 3.** Percentage of *Bactrocera* spp. infestation on tomato plants at each observation point

| Observation | A    | B    | C    | D    | E    | Total | Mean (%) |
|-------------|------|------|------|------|------|-------|----------|
| 1           | 3.12 | 5.90 | 0.00 | 2.50 | 2.78 | 14.30 | 2.86     |
| 2           | 6.82 | 4.57 | 3.94 | 4.77 | 3.37 | 23.47 | 4.69     |
| 3           | 6.66 | 4.86 | 3.45 | 4.34 | 9.30 | 28.61 | 5.72     |
| 4           | 6.84 | 8.57 | 7.78 | 4.69 | 4.26 | 32.14 | 6.43     |
| 5           | 4.05 | 7.29 | 7.15 | 5.27 | 5.41 | 29.17 | 5.83     |

The mean infestation percentage increased from 2.86% during the first observation to 4.69% in the second, 5.72% in the third, and 6.43% in the fourth observation. It then decreased slightly to 5.83% during the fifth observation. This pattern indicates temporal variation in fruit fly infestation during the study period. The increase observed up to the fourth observation may have coincided with increasing

fruit availability as the tomato plants matured, whereas the subsequent decline may have corresponded with reduced fruit production. Kallie (2021) reported that changes in crop age and fruit availability may influence pest infestation because greater fruit production can increase the availability of suitable resources for infestation.

Across all observation periods, the mean infestation level ranged from 2.86% to 6.43%. According to the infestation categories reported by Rahim et al. (2023), values of 0–25% are classified as low, >25–50% as moderate, >50–90% as high, and >90% as very high. Therefore, the infestation observed in this study was categorized as low.

The relatively low infestation level may have been influenced by several ecological factors, including temperature, humidity, light, wind, host availability, and the presence of natural enemies. Because these variables were not directly measured in this study, their possible effects should be interpreted as ecological explanations supported by previous literature rather than as experimentally demonstrated causes. Temperature is known to influence adult activity, mating, oviposition, and the development of immature fruit fly stages. Conditions outside the optimal thermal range may slow development or increase mortality, potentially reducing population growth and fruit infestation (Michel et al., 2021).

Humidity may also affect fruit fly survival, activity, and the development of immature stages. Similarly, light and wind can influence adult movement, dispersal, mate searching, food-seeking behavior, and host location. Variation in these environmental conditions may therefore contribute to changes in fruit fly activity and spatial distribution within agricultural landscapes (Sahetapy et al., 2019).

In addition to abiotic conditions, host availability is an important factor affecting fruit fly occurrence and infestation. Tomato fruits provide suitable tissues for oviposition and larval development, but host attractiveness and larval success may vary depending on fruit condition and maturity. A greater availability of fruits suitable for oviposition may increase the probability of infestation, whereas limited availability may reduce infestation levels. Natural enemies, including parasitoids, predators, and pathogens, may also contribute to fruit fly population regulation by increasing mortality at different life stages. Such ecological interactions may ultimately reduce the proportion of fruits exposed to infestation (Rahim et al., 2023).

## CONCLUSION

The study identified two fruit fly species captured in the tomato field in Waiheru Village, Baguala District, Ambon City, namely *Bactrocera carambolae* and *Bactrocera umbrosa*, both belonging to the family Tephritidae and order Diptera. A total of 45 adult fruit flies were captured during the study, with the highest catch recorded during the fourth observation (14 individuals) and the lowest during the first observation (5 individuals). The summed infestation percentages across the five observation points ranged from 14.30 to 32.14, while the mean infestation percentage ranged from 2.86% to 6.43%. The lowest mean infestation was recorded during the first observation (2.86%), whereas the highest occurred during the fourth observation (6.43%). The increase in infestation coincided with greater tomato fruit production during crop development, whereas infestation declined as fruit production decreased. Based on the infestation severity criteria applied in this study, the observed infestation levels were classified as low.

## RECOMMENDATION

Based on the findings of this study, Petrogenol-baited traps may be used as part of fruit fly monitoring and management in tomato cultivation. Further studies are

recommended to investigate factors that may influence the occurrence and infestation levels of *Bactrocera* spp., particularly abiotic factors such as climatic conditions and biotic factors such as the presence and activity of natural enemies.

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