VOLUME 11 Issue 1
JULY 2026

E-ISSN: 2622-3384
P-ISSN: 2527-9939

JURNAL MEdu Mangifera Edu

Species composition of male *Bactrocera spp*. captured by methyl eugenol traps in Karawang Mango Orchards, Indonesia

Hibban Aufaa Istanto, Nurcahyo Widyodaru Saputro*, Siti Latifatus Siriyah, Slamet Abadi
Department of Agrotechnology, Faculty of Agriculture, Universitas Singaperbangsa Karawang, Jalan HS. Ronggo Waluyo, Puseurjaya, Telukjambe Timur, Karawang District, West Java, Indonesia
*Corresponding author: nurcahyo.widyodaru@staff.unsika.ac.id

ABSTRACT

Fruit flies (Diptera: Tephritidae) are major pests reducing mango (Mangifera indica L.) productivity in Indonesia. Information on fruit fly community structure in Karawang Regency remains limited, and the ecological implications of male-biased sampling using methyl eugenol have not been previously evaluated. This study aimed to analyze the species composition, diversity, and dominance structure of fruit flies in a mango orchard in Ciampel District using methyl eugenol traps, providing the first ecological baseline for Bactrocera communities in Karawang. Sampling was conducted from August to December 2025 using five traps during four sampling periods at two-week intervals. Captured specimens were identified morphologically using standard taxonomic keys. A total of 1,469 individuals representing six species were recorded: Bactrocera dorsalis, B. occipitalis, B. zonata, B. kandiensis, B. correcta, and B. umbrosa. Bactrocera dorsalis was the dominant species (57.99%). The Shannon–Wiener diversity index (H′ = 1.28) indicated moderate diversity, whereas the Simpson dominance index (C = 0.38) indicated low dominance. The fruit fly community was relatively stable but strongly dominated by B. dorsalis, reflecting host availability within the semi-polyculture orchard. Nevertheless, because methyl eugenol selectively attracts male individuals, the observed community structure should be interpreted as a male-biased representation of the fruit fly assemblage. This study provides the first ecological baseline of male-attracted Bactrocera communities in Karawang and highlights the importance of considering attractant-induced sampling bias in ecological assessments. The findings support the development of location-specific integrated pest management strategies, including optimizing the Male Annihilation Technique (MAT) and conserving natural enemies.

ARTICLE INFO

Keywords
Bactrocera spp.,
Biodiversity mango,
Ciampel district,
Karawang, Methyl eugenol

Received
February 19, 2026

Revised
July 15, 2026

Accepted
July 18, 2026

Published
July 31, 2026

How to cite
Istanto, H. A., Saputro, N. W., Siriyah, S. L. & Abadi, S. (2026). Species composition of male Bactrocera spp. captured by methyl eugenol traps in Karawang Mango Orchards, Indonesia. *Jurnal Mangifera Edu*, *11*(1), 27-37. https://doi.org/10.31943/mangiferaedu.v11i1.261

INTRODUCTION

Mango (Mangifera indica L.) is an economically important tropical horticultural crop in Indonesia, particularly in West Java, one of the main production regions (Afifah et al., 2024; Tambunan et al., 2024). In Karawang Regency, mango cultivation is primarily carried out by smallholder farmers, who grow superior varieties such as Arumanis and Gedong. However, mango yields are often hindered by pest organisms (OPT), especially fruit flies (Diptera: Tephritidae).

Fruit flies of the genus Bactrocera are considered major pests of tropical fruit crops because they can lay eggs inside the fruit, allowing larvae to develop and damage the mesocarp tissue. This damage leads to internal decay, decreases fruit quality, and causes economic losses (Al-Arsyi et al., 2025). Among these species, Bactrocera dorsalis is frequently identified as the primary pest and belongs to a group of economically significant species (Adnyana et al., 2023; Sshutze et al., 2015). Other species, such as B. correcta, B. zonata, and B. occipitalis, have also been recognized as potential pests of tropical fruits (Delomen et al., 2013; Murtaza et al., 2021; Weems & Fasulo, 2002).

Methyl eugenol is commonly used as an attractant to monitor and control fruit fly populations, especially the B. dorsalis complex. This compound effectively attracts male flies and is often used in the Male Annihilation Technique (MAT) and in ecological studies of species composition and relative abundance (Patty, 2018; Susanto et al., 2019).

Several studies have documented fruit fly composition in mango agroecosystems in Indonesia. However, most of these studies mainly reported species presence or assessed the effectiveness of attractant traps rather than quantitatively analyzing community structure through ecological diversity and dominance indices. Additionally, previous research rarely addressed sampling bias related to methyl eugenol, which preferentially attracts male individuals and could affect estimates of species composition and community diversity. Furthermore, ecological data on fruit fly communities in Karawang Regency are still lacking. To our knowledge, no published research has thoroughly described the species composition, diversity, dominance patterns, and potential sampling bias of male-attracted *Bactrocera* communities in mango orchards in Karawang using methyl eugenol traps. Therefore, this study addresses these gaps by providing the first ecological evaluation of species composition, community diversity, dominance structures, and the influence of male-biased sampling with methyl eugenol in a semi-polytropic mango orchard in Karawang Regency.

Understanding community structure is essential for predicting pest outbreak risks and developing ecologically based management strategies. Therefore, this study aims to analyze the species composition and community structure of fruit flies in a mango orchard in Ciampel District, Karawang, using methyl eugenol traps.

It is suggested that Bactrocera dorsalis will dominate the fruit fly community due to its polyphagous habits and high ecological adaptability.

METHOD

Study Site

The research was conducted from August to December 2025 at the Sumur Kopo mango orchard in Ciampel District, Karawang Regency, West Java, Indonesia. The entire research period included site preparation, trap installation trials, and environmental observations, all conducted between August and September 2025. This was followed by the main sampling phase, which occurred from October to November 2025.

Fruit fly sampling was conducted in four rounds at two-week intervals, specifically on October 5, October 19, November 2, and November 16, 2025. Each sampling session involved placing traps for 24 hours, after which the captured specimens were collected for identification and analysis. This sampling design aimed to capture short-term temporal variation in fruit fly abundance within the orchard.

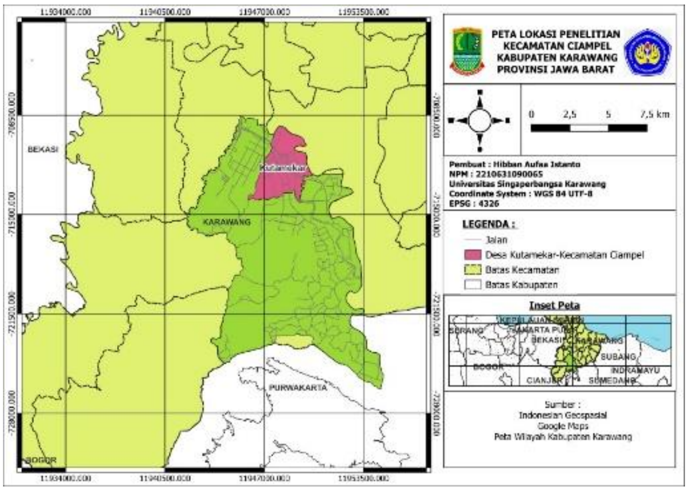

Figure 1. Map of the fruit fly sampling location at the Sumur Kopo mango orchard, Ciampel District, Karawang Regency, West Java, Indonesia.

The study area has a tropical monsoon climate, with average temperatures between 26°C and 32°C and relative humidity levels from 70% to 85%.

The orchard contains about 80 mango trees (*Mangifera indica* L.), mainly of the Arumanis and Gedong varieties, spaced approximately 10 meters apart in a semi-polyculture system. Additionally, other fruit crops such as bananas, starfruit, and coffee are intercropped within the orchard, which may affect fruit fly diversity by offering more host options.

Trap Description

Modified Steiner traps were used to capture fruit flies. Each trap contained 2 mL of methyl eugenol on a cotton wick as an attractant. The traps were hung about 1.5 to 2 meters above ground. All traps were placed in the central part of the orchard to target the main fruit fly population around mango trees, where host availability is more concentrated. Centralized trap placement has been used in previous studies to represent the dominant pest population in managed orchards, especially when the goal is to assess species composition related to the main crop.

However, this placement may introduce spatial bias because it does not consider potential differences in fruit fly populations at orchard edges, which could act as movement corridors or interface zones with surrounding vegetation. Therefore, the results of this study should be viewed as representing the central orchard community rather than the entire spatial distribution of fruit flies across the whole plantation.

Five traps were chosen to provide representative sampling across the roughly 80-tree orchard while minimizing interference among traps. This number of traps was deemed sufficient to characterize the main fruit fly community associated with the mango orchard while maintaining proper spacing to reduce overlap among methyl eugenol attraction plumes. Consequently, the captures were viewed as estimates of relative species abundance rather than exact population counts.

Each trap was set for 24 hours during each sampling period to ensure consistent sampling effort and allow enough time for male fruit flies to respond to the methyl eugenol lure under different daily environmental conditions. A 24-hour trapping period also helps prevent excessive lure degradation and reduces the chance of trap disturbance while providing accurate estimates of fruit fly populations. Sampling was carried out four times at two-week intervals.

Experimental Design

This study employed a descriptive ecological survey with purposive sampling. Trap placement was focused on the orchard center to identify the primary fruit fly community associated with mango cultivation. Repeated sampling every two weeks aimed to detect short-term fluctuations in fruit fly numbers while preventing excessive reduction of male populations caused by continuous trapping.

Specimen Identification

Captured specimens were collected and brought to the University of Singaperbangsa Karawang Laboratory for identification. They were identified based on morphological features, including coloration and patterns on the head, thorax, abdomen, wings, and legs.

Species identification was conducted using standard taxonomic keys and authoritative references, including Clarke et al. (2005) for the *Bactrocera dorsalis* species complex and Drew & Romig (2013) for tropical fruit flies of Southeast Asia. Taxonomic updates and species status were confirmed following Sshutze (2015), particularly for species within the *B. dorsalis* complex. Species identification was further confirmed using regional identification guides to ensure accuracy. When necessary, diagnostic morphological features were re-examined under a stereomicroscope to minimize the risk of misidentification.

Data Analysis

Data on the number of individuals of each species were analyzed to calculate the Shannon–Wiener diversity index (H′) and the Simpson dominance index (C).

The Shannon–Wiener diversity index (H′) was used to evaluate species diversity within the fruit fly community. In contrast, the Simpson dominance index (C) was used to assess the level of species dominance.

Shannon-Wiener Diversity Index (H')

$$H' = -\sum(p_i \ln p_i) \qquad (1)$$

The Shannon–Wiener diversity index (H') was used to evaluate the level of species diversity within the fruit fly community. In this index, H' represents the Shannon–Wiener diversity index, n_i denotes the number of individuals belonging to the *i*th species, N represents the total number of individuals of all recorded species, and *ln* refers to the natural logarithm. Higher values of H' indicate greater species diversity within the community, reflecting both higher species richness and a more even distribution of individuals among species.

Simpson Dominance Index (C)

$$C = \sum(p_i)^2 \qquad (2)$$

The Simpson dominance index (C) was used to assess the degree of species dominance within the fruit fly community. In this index, C represents the Simpson dominance index, n_i denotes the number of individuals belonging to the *i*th species, and N represents the total number of individuals of all recorded species. Higher values of C indicate that the community is dominated by one or a few species, whereas lower values reflect a more even distribution of individuals among species, suggesting lower species dominance within the community.

Which:

$$p_i = \frac{n_i}{N} \qquad (3)$$

The notation used in this study includes $\boldsymbol{n_i}$, which represents the number of individuals belonging to species i; N, which denotes the total number of individuals across all species observed; and P, which refers to the proportion of individuals of species i relative to the total number of individuals in the community. These parameters are commonly used in ecological diversity calculations to quantify species composition and abundance within a given ecosystem.

It is important to recognize that methyl eugenol specifically attracts male individuals, especially from the Bactrocera dorsalis complex. As a result, the data collected reflect a male-biased portion of the fruit fly community and may underestimate species that do not respond to this attractant.

Since methyl eugenol specifically attracts sexually mature males, particularly those within the Bactrocera dorsalis species complex, the community described here represents a subset of male-attracted fruit flies rather than the entire fruit fly community. Therefore, estimates of species richness and community composition may underestimate species that are weakly attracted to or do not respond to methyl eugenol, including those more attracted to cue lures or food-based attractants. These methodological limitations should be considered when analyzing the ecological patterns observed in this study.

RESULTS AND DISCUSSION

Sampling activities took place in a mango orchard managed with a traditional cultivation system. Farmers mainly used inorganic fertilizers to promote plant growth, without adopting organic farming techniques. The orchard had about 80 mango trees (Arumanis and Gedong varieties) spaced approximately 10 meters apart in a semi-polyculture setup. Intercropped species like banana, starfruit, and coffee were also present, possibly influencing fruit fly populations by providing additional hosts (Pangngan et al., 2025; Saputra & Afriyansyah, 2021).

Methyl eugenol was used as an attractant in modified Steiner traps because of its effectiveness in attracting male *Bactrocera* species, especially those within the *Bactrocera dorsalis* complex (Susanto et al., 2018; 2021). Five traps were set during each sampling period and left in the field for 24 hours before collecting specimens, followi The total number of individuals captured across four sampling periods is shown in Figure 2, while detailed species composition and abundance data are summarized in Table 1. The relatively consistent number of individuals captured during these periods suggests that fruit fly populations remained stable throughout the observation period. This stability may reflect the ongoing availability of host resources within the semi-polyculture orchard, where mango trees coexisted with other fruit-producing plants such as banana, starfruit, and coffee. Continuous host availability is known to reduce seasonal fluctuations in fruit fly abundance by providing alternative breeding resources when the primary host is less suitable.

ng standard fruit fly monitoring procedures (Maesyaroh et al., 2020). Sampling was conducted every two weeks over four periods to monitor short-term population changes while preventing excessive population suppression caused by ongoing trapping.

Table 1. Species composition, abundance, and proportional values (pi) of fruit flies captured during four sampling periods in the study site.

Species	1st Period	2nd Period	3rd Period	4th Period	Total (ni)	Relative Abundance (%)	pi
Bactrocera dorsalis	210	220	215	207	852	57.99	0.5799
Bactrocera occipitalis	50	52	51	50	203	13.82	0.1382
Bactrocera zonata	43	44	43	42	172	11.71	0.1171
Bactrocera kandiensis	40	40	39	40	159	10.82	0.1082
Bactrocera correcta	14	14	13	14	55	3.75	0.0375
Bactrocera umbrosa	7	7	7	7	28	1.91	0.0191
Total	**364**	**377**	**368**	**360**	**1469**	**100**	–

Sex pheromone traps were placed in the center of the orchard to represent the fruit fly community across the planting area. Methyl eugenol is commonly used as an attractant in studies of species composition and diversity of the genus *Bactrocera*, especially the *Bactrocera dorsalis* complex, because of its effectiveness in attracting male fruit flies (Susanto et al., 2018; 2021). Five hanging traps were set up, each containing 2 mL of Methyl eugenol. The traps were left in the field for 24 hours, and the insects caught were collected the following day, in accordance with standard procedures for monitoring fruit fly populations using methyl eugenol attractants (Maesyaroh et al., 2020). Sampling was conducted every two weeks for four periods over two months to monitor population dynamics while reducing excessive population decline caused by continuous male trapping (Pangngan et al., 2025).

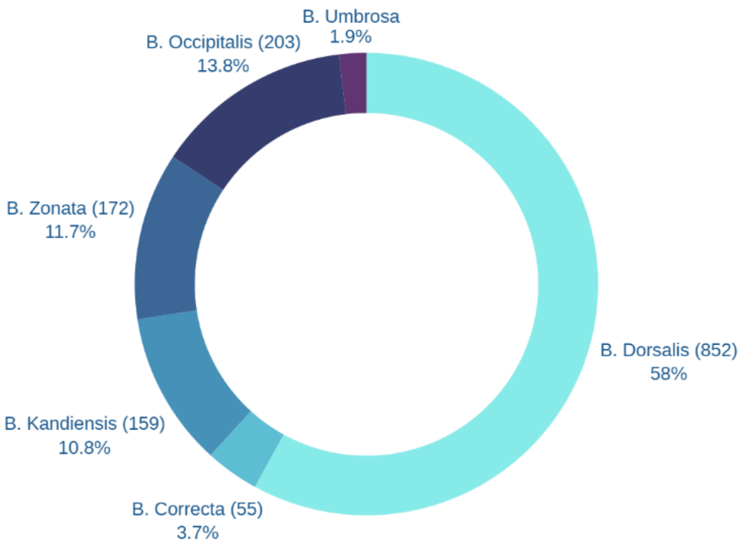

Figure 2. Total number of fruit fly individuals captured during four sampling periods at the Sumur Kopo mango orchard, Ciampel District, Karawang Regency.

Species Composition

Based on identification results from four sampling periods in Ciampel District, Karawang Regency, a total of six fruit fly species were documented: *Bactrocera dorsalis* (852 individuals), *Bactrocera occipitalis* (203 individuals), *Bactrocera zonata* (172 individuals), *Bactrocera kandiensis* (159 individuals), *Bactrocera correcta* (55 individuals), and *Bactrocera umbrosa* (28 individuals). Variations in species abundance were evident, with *Bactrocera dorsalis* showing the highest number of individuals among the observed species during the study period (Figure 2). The dominance of *B. dorsalis* is likely due to the combination of continuous host availability within the semi-polyculture orchard and the high responsiveness of sexually mature males to methyl eugenol. Additionally, B. dorsalis exhibits broad host preferences, high dispersal capacity, and a rapid reproductive rate, which collectively enable it to colonize fruiting habitats more efficiently than sympatric Bactrocera species. These ecological traits have consistently contributed to its dominance in tropical fruit production systems. The presence of banana, coffee, and starfruit surrounding the mango orchard may also have helped sustain fruit fly populations throughout the sampling period. These alternative host plants can provide additional food resources and breeding sites outside the main mango fruiting season, thus facilitating population persistence across the agricultural landscape. This landscape complementation has been widely recognized as an important ecological factor influencing fruit fly abundance and species composition in tropical agroecosystems.

Diversity and Dominance Indices

The Shannon–Wiener diversity index (H’) was 1.28, indicating moderate diversity in the Sumur Kopo plantation, Ciampel District, Karawang Regency. The Simpson dominance index (C) was 0.38, showing low dominance.

The moderate diversity value (H’ = 1.28) shows that the orchard ecosystem supports multiple fruit fly species but does not have high heterogeneity. According to ecological theory, agroecosystems dominated by monoculture or semi-polyculture often exhibit moderate diversity. This indicates that although B. dorsalis is numerically dominant in the orchard, other Bactrocera species can coexist within the same agroecosystem. This pattern suggests that ecological interactions among host plants, differences in host preference, and variations in resource use may prevent complete competitive exclusion. As a result, the semi-polyculture system likely promotes coexistence among several fruit fly species despite the dominance of one, due to resource concentration effects.

Although the Simpson index indicates low dominance (C = 0.38), the numerical predominance of B. dorsalis suggests ecological superiority rather than complete monopolization of available resources. Other species remained consistently present throughout the sampling period, indicating that niche differentiation and host resource partitioning may help them persist within the orchard ecosystem. This could be due to its high reproductive rate and strong attraction to methyl eugenol.

Therefore, the observed community structure should be seen as representing the male-attracted component of the fruit fly assemblage rather than the entire community. Species that respond mainly to cue lures or food-based attractants may have been underrepresented, meaning that the diversity indices reported here likely reflect the relative diversity among methyl eugenol-responsive species rather than the full fruit fly fauna in the orchard.

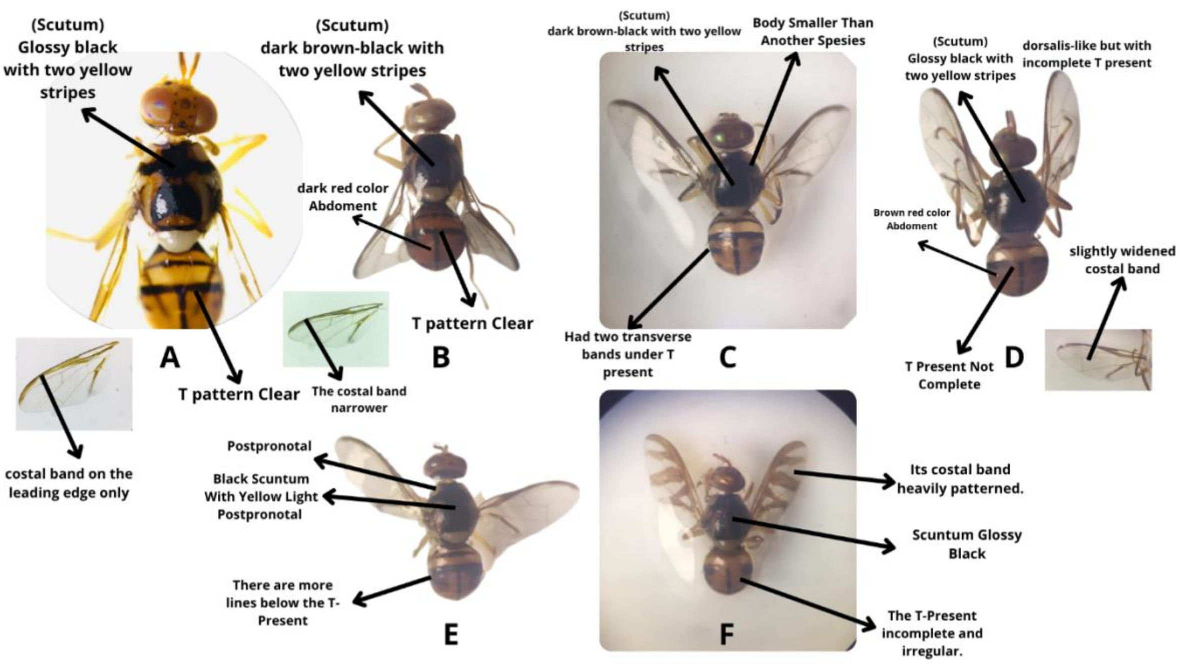

Figure 3. Dorsal morphological characteristics of six *Bactrocera* species identified at the study site: (a) *Bactrocera dorsalis*; (b) *Bactrocera correcta*; (c) *Bactrocera kandiensis*; (d) *Bactrocera zonata*; (e) *Bactrocera occipitalis*; (f) *Bactrocera umbrosa*.

From an agroecological perspective, the semi-polyculture system observed in this orchard can help maintain ecological complexity by increasing plant diversity. Although such systems may support higher biodiversity than monoculture plantations, they can also offer continuous host availability that favors polyphagous pests such as B. dorsalis. Consequently, boosting biodiversity alone may not always decrease pest pressure unless paired with effective ecological regulation through natural enemies and proper orchard sanitation.

Methyl eugenol selectively attracts male individuals of certain Bactrocera species, especially those in the B. dorsalis complex. Therefore, the community structure described in this study only represents the male-attracted part of the fruit fly population and may underestimate species that respond weakly or not at all to methyl eugenol. As a result, the diversity indices reported here should be seen as reflecting the community structure of methyl eugenol-responsive species rather than the entire fruit fly community found in the orchard.

Ecological Interpretation of the Recorded Species

Although species identification was verified using diagnostic morphological characters (Figure 3), the following discussion emphasizes the ecological importance of each recorded species rather than detailed taxonomic descriptions. The focus is on their relative abundance, ecological traits, and potential influence on community structure within the semi-polyculture mango orchard.

- ***Bactrocera dorsalis*** was the dominant species, accounting for 57.99% of the total captures. Its prevalence is likely due to the combination of continuous host availability within the semi-polyculture orchard and the strong response of sexually mature males to methyl eugenol. Additionally, this species has a broad host range, high dispersal ability, and rapid reproductive potential, allowing it to colonize fruiting habitats more effectively than sympatric Bactrocera species (Clarke et al., 2005; Susila & Supratha, 2020). The dominance seen in this study aligns with previous reports from other tropical fruit production systems in Indonesia.

- ***Bactrocera correcta***: Although B. correcta constituted only a small proportion of the captured individuals, its presence indicates the availability of alternative host plants within the orchard landscape. This polyphagous species is commonly associated with guava and citrus but may utilize mango as an alternative host when fruit is available (Clarke et al., 2005).
- ***Bactrocera kandiensis***: The presence of B. kandiensis indicates that the orchard supports several members of the B. dorsalis complex. Although it is generally less common than B. dorsalis, this species has been reported to infest mango during fruit ripening and may survive where alternative host plants are available (Saputra et al., 2024).
- ***Bactrocera zonata***: The presence of B. zonata indicates the availability of multiple suitable fruit hosts within the semi-polyculture system. Although commonly linked to peach and guava, this species also targets mango and has been reported from various tropical fruit production systems, showing notable ecological adaptability (Rasool, 2025).
- ***Bactrocera occipitalis***: The relatively consistent presence of B. occipitalis suggests that this species can coexist with the dominant B. dorsalis population. This coexistence might be supported by differences in host preference, oviposition behavior, or timing of resource use, thereby diminishing direct competition between species.
- ***Bactrocera umbrosa***: Although B. umbrosa was the least common species, its presence adds to the overall diversity of the orchard ecosystem. Since this species is usually associated with hosts in the Moraceae family, its occasional capture might indicate movement from nearby vegetation rather than an exclusive relationship with mango trees.

Overall, the presence of six Bactrocera species shows that the mango orchard hosts a moderately diverse fruit fly community despite B. dorsalis being the most common. The coexistence of multiple species is probably helped by the semi-polyculture planting system, which offers a steady supply of alternative host plants. However, this same landscape complexity might also support pest populations year-round, highlighting the need for integrated pest management strategies that include orchard sanitation, attractant-based monitoring, and the preservation of natural enemies.

CONCLUSION

This study showed that Bactrocera dorsalis was the main fruit fly species in the mango agroecosystem of Ciampel District, Karawang, making up 57.99% of all captures. Although six Bactrocera species were recorded, the community displayed moderate diversity (H′ = 1.28) and low overall dominance (C = 0.38), suggesting that the semi-polyculture orchard supports species coexistence while remaining heavily influenced by the ecological competitiveness of B. dorsalis. Since methyl eugenol selectively attracts male individuals, the observed community structure should be interpreted as representing the male-attracted part of the fruit fly population rather than the entire community.

These findings establish the first ecological baseline for fruit fly community structure in mango orchards in Karawang and support the development of location-specific integrated pest management strategies. Future studies should combine multiple attractants, extend sampling across different fruiting seasons, and include broader spatial coverage to gain a more comprehensive understanding of fruit fly biodiversity and population dynamics.

ACKNOWLEDGMENT

The authors sincerely thank the owner of the mango orchard in Ciampel District for granting permission and providing support during the research. They also appreciate all individuals who helped with sampling and specimen identification.

REFERENCES

Adnyana, I. M. M., Susila, I. W., & Elysabet, L. I. D. Y. A. (2023). Komposisi populasi lalat buah (Diptera: Tephritidae) dan parasitoid yang berasosiasi dengan tanaman mangga (Mangifera indica L.) di beberapa Kabupaten Provinsi Bali. *Agrotrop: J. Agric. Sci*, *13*(1), 137-149. https://doi.org/10.24843/AJoAS.2023.v13.i01.p12

Afifah, A. A. N., Fajar, R., & Trisnawan, A. (2024). Application of climate smart agriculture in the implementation of the primadona program (Sustainable innovative independent mango farming). *Progress In Social Development*, *5*(2), 128-139. https://doi.org/10.30872/psd.v5i2.89

Al-Arsyi, M., Artayasa, I. P., & Ilhamdi, M. L. (2025). Kelimpahan lalat buah Bactrocera pada buah-buahan yang dijual di Kota Mataram sebagai media pembelajaran biologi SMA. *Journal of Authentic Research*, *4*(2), 2274-2282. https://doi.org/10.36312/z8ybgx04

Aluja, M., & Mangan, R. L. (2008). Fruit fly (Diptera: Tephritidae) host status determination: Critical conceptual, methodological, and regulatory considerations. *Annu. Rev. Entomol.*, *53*(1), 473-502. https://doi.org/10.1146/annurev.ento.53.103106.093350

Clarke, A. R., Armstrong, K. F., Carmichael, A. E., Milne, J. R., Raghu, S., Roderick, G. K., & Yeates, D. K. (2005). Invasive phytophagous pests arising through a recent tropical evolutionary radiation: The Bactrocera dorsalis complex of fruit flies. *Annu. Rev. Entomol.*, *50*(1), 293-319. https://doi.org/10.1146/annurev.ento.50.071803.130428

Delomen, M. L. C., Mendioro, M. S., & Diaz, M. G. Q. (2013). Morphometric analysis and DNA barcoding of fruit flies Bactrocera occipitalis (Bezzi) and B. philippinensis Drew and Hancock (Diptera: Tephritidae) from Cavite and Davao del Norte. *Philippine Journal of Science*, *142*(1), 69-76. http://philjournalsci.dost.gov.ph/

Drew, R. A. I., & Romig, M. C. (2013). *Tropical fruit flies of South-east Asia*. CABI. https://www.cabidigitallibrary.org/doi/book/10.1079/9781780640358.0000

Lengkong, M., & Rante, C. S. (2019). Identifikasi morfologi lalat buah Bactrocera spp.(Diptera: Tephritidae) di Kabupaten Minahasa. *Jurnal Entomologi dan Fitopatologi*, *1*(1), 29. https://ejournal.unsrat.ac.id/v3/index.php/enfit/article/view/27169

Maesyaroh, S. S., Mutakin, J., & Fathurrohman, B. I. (2022). Pengaruh warna perangkap dan dosis metil eugenol terhadap lalat buah (Bactrocera spp.) yang terperangkap pada pertanaman tomat. *Creative Research Journal*, *8*(02), 121-126. https://doi.org/10.34147/crj.v8i2.313

Murtaza, G., Fazlullah, T. A., Ramzan, M., Daud, M., Iqbal, S., Ali, A., & Ramzan, M. (2021). Biology and morphology of bactrocera dorsalis and bactrocera zonata on guava under laboratory conditions. *India journal of Pure and Applied Biosciences*, *9*, 180-185. http://dx.doi.org/10.18782/2582-2845.8701

Oktavia, R. D., Wijayanti, T., Arifin, A. A. S., & Hindun, N. (2025). The diversity of macroinvertebrates as a bioindicator of water quality in the Amprong River, Kedungkandang District. *Edubiotik: Jurnal Pendidikan, Biologi dan Terapan*, *10*(02), 386-397. https://doi.org/10.33503/ebio.v10i02.2013

Pangngan, S. B. S., Andini M, S. ., Nurannisa, N., Masriany, M., & Amrullah, S. H. . (2025). Identifikasi dan pola distribusi lalat buah (Bactrocera spp.) di green house biologi Universitas

Islam Negeri Alauddin Makassar. *Filogeni: Jurnal Mahasiswa Biologi*, *5*(1), 1–8. https://doi.org/10.24252/filogeni.v5i1.54718

Patty, J. A. (2012). Efektivitas metil eugenol terhadap penangkapan lalat buah (Bactrocera dorsalis) pada pertanaman cabai. *Agrologia*, *1*(1), 288705. https://doi.org/10.30598/a.v1i1.300

Rasool, B. (2025). Diversity of host preference of peach fruit fly Bactrocera zonata (Saunders, 1842)(Diptera: Tephritidae). *Journal of the Entomological Research Society*, *27*(1), 15-30. https://doi.org/10.51963/jers.v27i1.2654

Saputra, H. M., & Afriyansyah, B. (2021). Distribution and identification of fruit flies (Diptera : Tephritidae) attracted on methyl euganol and cue lure in Central Bangka Regency,. *HPT Tropika*, *21*(1), 72–81. https://doi.org/10.23960/jhptt.12172-81

Saputra, H. M., Rahmawati, V., Apriyadi, R., Henri, H., & Setiawan, F. (2024). Keanekaragaman dan Kunci Identifikasi Lalat Buah Berdasarkan Inang Tanaman Buah di Kabupaten Bangka, Bangka Belitung. AGROSAINSTEK: Jurnal Ilmu Dan Teknologi Pertanian, 8(1), 33–40. https://doi.org/10.33019/agrosainstek.v8i1.429

Septiyani, T., Supeno, B., & Haryanto, H. (2026). Keragaman hama lalat buah (Diptera: Tephritidae) pada tanaman cabai rawit (Capsicum frutescens l.) yang ditumpangsarikan dengan tanaman kacang tanah. *Agroteksos*, *36*(1), 146-157. https://doi.org/10.29303/agroteksos.v36i1.1596

Sharashy, O. (2022). Application of Shannon and Simpson diversity index to study plant biodiversity on coastal rocky ridges habitats with reference to census data in the Ras El-Hekma and Omayed Area on the Western Coastal Region of Egypt. *Journal of Pure & Applied Sciences*, *21*(1), 41-45. https://doi.org/10.51984/JOPAS.V21I1.1578

Sshutze, M. K., Chinvinijkul, S., Yesmin, F., Tan, K. H., Reyes, J., Cameron, S. L., ... & Mavragani-Tsipidou, P. (2015). Synonymization of key pest species within the bactrocera dorsalis species complex (Diptera: Tephritidae). *Systematic Entomology*, *40*(IKEEXREF-267238), 456-471. https://doi.org/10.1111/syen.12113

Susanto, A., Nasahi, C., Rumaisha, Y. K., Murdita, W., & Lestari, T. M. P. (2019). Penambahan essens buah terhadap keefektifan metil eugenol dalam menarik Bactrocera spp. Drew & Hancock. *Agrikultura*, *30*(2), 53-62. https://doi.org/10.24198/agrikultura.v30i2.23315

Susanto, A., Natawigena, W. D., Puspasari, L. T., & Atami, N. I. N. (2018). Pengaruh penambahan beberapa esens buah pada perangkap metil eugenol terhadap ketertarikan lalat buah Bactrocera dorsalis kompleks pada pertanaman mangga di Desa Pasirmuncang, Majalengka. *Jurnal Perlindungan Tanaman Indonesia*, *22*(2), 150-159. https://doi.org/10.22146/jpti.27001

Susanto, A., Permana, A. D., Hartati, S., & Saragih, D. N. B. (2021). Pengaruh metil eugenol block plus terhadap tangkapan lalat buah Bactrocera spp. pada tanaman cabai di Desa Lembang, Kecamatan Lembang, Kabupaten Bandung Barat. *Jurnal Entomologi Indonesia*, *18*(2), 93-93. https://doi.org/10.5994/jei.18.2.93

Susila, I. W., & Supartha, I. W. (2020). Jenis dan peranan parasitoid dalam mengendalikan populasi lalat buah (Bactrocera dorsalis Complex.)(Diptera: Tephritidae) yang menyerang buah mangga (Mangifera indica L) di Kabupaten Buleleng. *Agrotrop: Journal on Agriculture Science*, *10*(1), 29-38. https://doi.org/10.24843/AJoAS.2020.v10.i01.p04

Tambunan, G. G., & Tanjung, D. (2024). Analisis daya saing ekspor komoditas mangga terhadap pertumbuhan ekonomi Indonesia. *Jurnal Ilmiah Ekonomi dan Manajemen*, *2*(7), 38-46. https://doi.org/10.61722/jiem.v2i7.1804

Weems, Jr., H. V., & Fasulo, T. R. (2004). Guava fruit fly, Bactrocera correcta (Bezzi) (Insecta: Diptera: Tephritidae): EENY200/IN357, rev. 10/2002. *EDIS*, *2004*(15). https://doi.org/10.32473/edis-in357-2002