Research Journal of Life Science
DECEMBER 2021 Volume 8 No. 3 (173-180)
journal homepage: www.rjls.ub.ac.id

Abundance and Diversity of Fruit Flies Species (Diptera: Tephritidae) in Bogor and Depok District

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KEYWORDS

Bactrocera spp.**;**
Dacus spp.;
Zeugodacus spp.;
Steiner trap;
Cue lure.

Abstract Fruit flies (Diptera: Tephritidae) are important pests of horticultural crops. This study investigates the abundance and species richness of Bogor and Depok District as a center area horticulture commodity based on Cue Lure Trap. Each Cue Lure Trap was observed to record the abundance and species richness of fruit flies at seven days intervals from June until August 2021 in Bogor District (Babakan, Mekarsari and Parigi Mekar) and Depok District (Bedahan and Pancoran Mas), West Java, Indonesia. A total of 1,025 individuals were collected and consist of nine species of fruit fly i.e., *Bactrocera albistrigata, B. carambolae, B. neocognata, B. verbascifoliae, Dacus conopsoides, D. longicornis, Zeugodacus calumniata, Z. caudatus, and Z. cucurbitae.* The number of individuals of fruit flies was highest in the Bedahan, Depok District (F = 5.454, P = 0.002). *Zeugodacus cucurbitae* was the most abundant species (792 individuals), representing 77.27% of the specimens collected during the sampling period. The highest Shannon–Wiener diversity index of all fruit flies captured in this study was in Bedahan, Depok (1.11) and the lowest in Parigi Mekar, Bogor (0.23). A Bray–Curtis analysis showed that the species compositions of fruit flies on Bedahan and Parigi Mekar had a similarity of 70.1%.

Introduction

Fruit flies (Diptera: Tephritidae) are important pests of horticultural crops (Akhila & Jiji, 2015). The fruit flies may attack more than a hundred types of horticultural crops worldwide *(Sultana et al*., 2020). In high populations, this pest can cause yield losses reach to 100% (Mulyadi *et al*., 2021). In Indonesia, the important Tephritid species was reported from 35 host plant species in 18 families i.e., *Bactrocera* spp., *Atherigona orientalis*, and *Dacus longicornis* (Trisyono *et al*., 2010). *Bactrocera* spp. is one of the most common fruit fly species that attack fruits and vegetables (Trisyono *et al*., 2010). Mass trapping is a viable alternative to insecticides for fruit flies management (Stupp *et al*., 2021).

The selection of effective and efficient trap attractant for monitoring and control remains challenging (Broughton & Rahman, 2017). There are types of chemical compounds used for the monitoring and management of Tephritid genera in Indonesia: cue lure (CL; 4-(p-acetoxyphenyl)-2-butanone) (Vargas *et al*., 2010). This chemical compound is a product containing phenylpropanoid and related compounds of plant origin (Tan & Nishida, 2012). CL is known as a natural product, except as hydrolyzed derivatives, and also attracts male fruit flies of the species *Bactrocera cucurbitae* (Coquillett) (Vargas *et al*., 2015).

Indonesia is a tropical country that has a fairly high diversity of fruit flies (Hudiwaku *et al*., 2021). AQIS (2008) reported that in Indonesia including West Java were found 63

How to cite this article : Octavia, E., Tarno, H., Himawan, T., and Setiawan, Y. (2021). Abundance and Diversity of Fruit Flies Species (Diptera: Tephritidae) in Bogor and Depok District. Research Journal of Life Science, 8(3), 173-180.
https://doi.org/10.21776/ub.rjls.2021.008.03.7

species of fruit flies. In Bogor and Depok Districts, those were reported to have various fruit fly species (AQIS, 2008). Bogor and Depok District is a center area for agricultural development especially horticulture such as guava, carambola, lemon, papaya, avocado, and banana. In this study, we collected fruit fly by using Cue Lure (CL) on five different locations in Bogor and Depok District, West Java, Indonesia. This study aimed to investigate the abundance and species richness of Bogor and Depok District as a center area horticulture commodity in West Java.

Materials and Methods

Study site and sampling method

This study was conducted in five sites in Bogor District (Babakan, Parigi Mekar and Mekarsari) and Depok District (Bedahan and Pancoran Mas), West Java, Indonesia. Fruit flies were collected at seven days intervals from June to August 2021. Fruit flies were collected by using Steiner traps baited with Cue Lure (CL) (4-(p-acetoxyphenyl)-2-butanone). A total of 25 Steiner traps were placed in the selected sites. The traps were placed in tree branches 1.5 m above the ground. The Steiner traps were made from transparent cylindrical plastic jars, 15 cm high and 10 cm in diameter, with the bottom of the funnel protected with wire gauze.

At the top of the trap, an iron hook was used to hang the trap from a tree branch, while the inside was wired to hang cotton. They contained cotton wicks impregnated with 0.25 mL of a mixture of 4 mL of attractant CL and 1 mL of insecticide (Deltamethrin 2.8 EC 0.0028%). The traps were serviced every seven days and the bait replaced. The fruit flies were collected and kept in small paper boxes lined with tissue paper and labeled for further identification. In Babakan, we set a trap in the Jamaica guava orchard (*Syzygium malaccense* L) with the chili plant surrounding (*Capsicum annuum* L.), Parigi Mekar in lemon orchard and chili (*Citrus limon* L. and *Capsicum frutescens*), Mekarsari in lemon orchard (*Carica papaya* L.), Bedahan in guava and carambola orchards (*Psidium guajava* L. and *Averrhoa carambola* L.), and Pancoran Mas in carambola orchard (*Averrhoa carambola* L.).

Fruit fly identification

The fruit flies' specimens were separated and identified to morphospecies level using an Olympus SZ61 stereo microscope (Olympus Optical Co. LTD, China). The fruit flies were identified to species level based on their morphological characters, using identification keys for the tropical fruit flies of South-East Asia. The references used were Indomalaya to North-West Australasia by Drew & Romig (2013) and The Australian Handbook for The Identification of Fruit Flies by (Schutze *et al.*, 2018).

Data analysis

The abundance of fruit flies in each site was analyzed by using analysis of variance (ANOVA) and if the results were significantly different among the treatments, a post-hoc test was conducted with the Tukey test with an error level of 5%. The fruit fly diversity was analyzed using the Shannon–Wiener diversity index (H'), the Evenness index (E), and the Simpson Dominance Index (C). The value and category of Shannon-Wiener Indices (H') were based on Tarno *et al*. (2016). All data were analyzed using the statistical software R Studio, with the Agricolae and Vegan packages (Team, 2019; Oksanen *et al.*, 2020).

Results and Discussion

Abundance of fruit fly

During sampling, a total of nine species of fruit fly were collected i.e., *Bactrocera albistrigata*, *B. carambolae, B. neocognata, B.*

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verbascifoliae, Dacus conopsoides, D. longicornis, Zeugodacus calumniata, Z. caudatus, and *Z. cucurbitae* (Table 1). Our study indicated that all fruit fly species collected were attracted to Cue lure. Our findings are in agreement with studies that reported that *Dacus* spp. from Indonesia and *Z. caudatus* in India responded only to CL (Trisyono *et al*. 2010; Nair *et al*., 2021). Hudiwaku *et al*. (2021) also reported that *D. conopsoides* were collected in Cue lure-treated traps in Lombok Island, West Nusa Tenggara, Indonesia. *Dacus longicornis* also collected in this study. Schutze *et al*. (2018) reported that *D. longicornis* was attracted to cue lure attractants.

In this study, a total of 1,025 of fruit fly were collected. *Zeugodacus cucurbitae* was the most abundant species (792 individuals), representing 77.27% of the specimens collected during the sampling period (Table 1). It was followed by *Z. caudatus*, represented by 78 individuals (7.16%) and *B. albistrigata*, which comprised 66 of the individuals (6.44 %). The other fruit fly species were collected at proportions below 5%. In several study, reported that CL is more effective at attracting *Z. cucurbitae* (Vargas *et al*., 2010b; Apriyadi *et al*., 2021). Besides that, this study also collected the *Bactrocera* genus but few numbers of individuals, this is indicated that this genus was less attracted to Cue Lure. In several study, *Bactrocera* spp. are generally attracted to ME attractant trap (Tan *et al.*, 2011; Trisyono *et al.*, 2010; Bajaj & Singh, 2020; Shah *et al*., 2020; Suwinda *et al*., 2020;).

In all sites, the number of individuals of fruit flies was highest in the Bedahan, Depok District (F = 5.454, P = 0.002) (Figure 1). In Bedahan, traps were set in carambola and guava orchards and causing this site had the highest number of individual of fruit flies. Almeida *et al.* (2016) reported that *A. carambola* (Oxalidaceae) and *P. guajava* (Myrtaceae) are the host plants responsible for sustaining the population of *Bactrocera* spp. Bellis *et al*. (2017) also reported that monitoring of fruit flies in several hosts, such as *A. carambola* and *P. guajava*, in Timor-Leste revealed the presence of 16 species of *Bactrocera* and one species of *Dacus*.

Diversity of fruit fly

The Shannon's diversity index was varied in each study site. The highest Shannon–Wiener diversity index was found in the Bedahan (1.11) and the lowest in Parigi Mekar (0.23) (Table 2). Shannon's evenness index showed a variation between sites with the highest value in Bedahan (0.53) and the lowest in Parigi Mekar (0.14) (Table 2). The Simpson's dominant index value was the highest in Bedahan (0.52), and the lowest in Parigi Mekar (0.08) (Table 2). The diversity of fruit flies was highest in Bedahan. According to Tarno *et al*. (2016), an index value between 1 and 3 is categorized as intermediate diversity, and the distribution of each species was also moderate. The species evenness index indicated the highest species evenness for Bedahan. According to Tarno *et al.* (2016), an index value between 0.50 and 0.75 is categorized as a medium level of species evenness and indicates an unstable community of species. The Simpson's dominant index value of Bedahan indicated middle-level species dominance. According to Tarno *et al*. (2016), when the index value is between 0.5 and 0.75, there are middle dominant species in the community. Several things that affect the differences in diversity, including: host diversity, seasons, environmental balance, spatial distribution, competition and other complex factors (Gizachew, 2022). Higher species diversity of fruits fly is found in a habitat with a higher number of suitable host species (Linda *et al.*, 2018). The species compositions of fruit flies

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on Bedahan (Depok*)* and Parigi Mekar (Bogor) were 70.1% similar. In this study, the species of fruit flies collected in Bedahan (Depok) and Parigi Mekar (Bogor) were similar because dominated by *Z. cucurbitae* and suitable host for this species i.e., lemon and carambola. In several study, *Z. cucurbitae* was reported had several plant host species in Anacardiaceae, Oxalidaceae, Solanaceae, and Rutaceae including carambola and *Citrus* spp. (De Meyer *et al*., 2015; Follett *et al*., 2022).

Table 1. Abundance of fruits flies collected in Bogor and Depok Districts, West Java

Species	BBK		PGM		MKS		PCM		BDH		Total	
	Σ	%	Σ	%	Σ	%	Σ	%	Σ	%	Σ	%
B. albistrigata	7	3.89	3	0.82	1	1.35	45	83.33	10	2.85	66	6.44
B. carambolae	1	0.56	0	0.00	0	0.00	3	5.56	0	0.00	4	0.39
B. neocognata	0	0.00	0	0.00	1	1.35	0	0.00	27	7.69	28	2.73
B. verbascifoliae	0	0.00	0	0.00	0	0.00	0	0.00	2	0.57	2	0.20
D. conopsoides	1	0.56	0	0.00	0	0.00	0	0.00	1	0.28	2	0.20
D. longicornis	3	1.67	1	0.27	0	0.00	0	0.00	2	0.57	6	0.59
Z. calumniata	8	4.44	2	0.55	10	13.51	1	1.85	26	7.41	47	4.59
Z. caudatus	10	5.56	11	3.01	6	8.11	2	3.70	49	13.96	78	7.61
Z. cucurbitae	150	83.33	349	95.36	56	75.68	3	5.56	234	66.67	792	77.27
Total	**180**	**100**	**366**	**100**	**74**	**100**	**54**	**100**	**351**	**100**	**1,025**	**100**

Note: BBK: Babakan, PGM: Parigi Mekar, MKS: Mekarsari, BDH: Bedahan and PCM: Pancoran Mas.

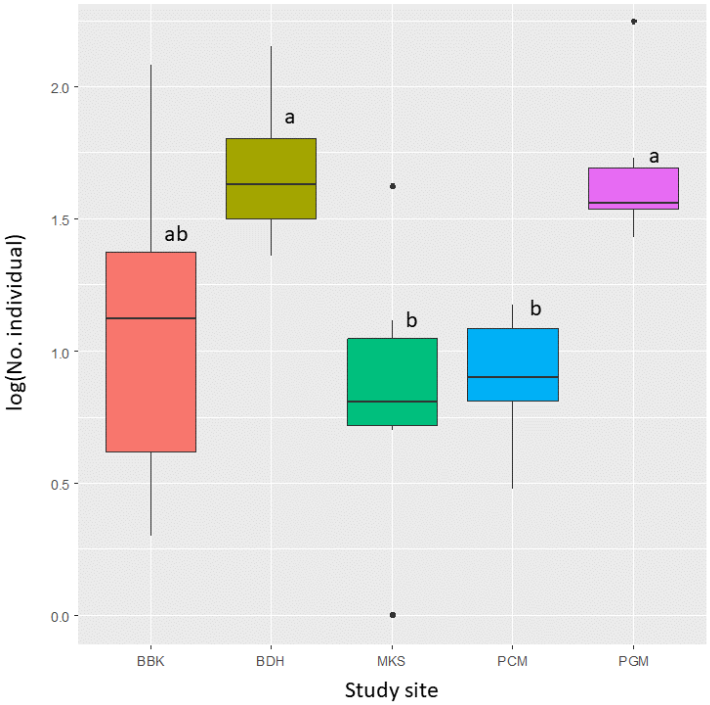

Figure 1. The number of individuals of fruits fly in Bogor and Depok District. BBK: Babakan, PGM: Parigi Mekar, MKS: Mekarsari, BDH: Bedahan and PCM: Pancoran Mas. Different lowercase letters denote significant differences at P < 0.05 (ANOVA; TukeyHSD).

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Table 2. Diversity indices of fruit flies in Bogor and Depok Districts, West Java

Study Site	Indices		
	Shannon-Wiener Diversity	**Evenness**	**Simpsons**
Babakan	0.70 (Low)	0.36 (Low)	0.29 (Low)
Bedahan	1.11 (Middle)	0.53 (Middle)	0.52 (Middle)
Mekarsari	0.80 (Low)	0.49 (Low)	0.40 (Low)
Pancoran Mas	0.66 (Low)	0.41 (Low)	0.29 (Low)
Parigi Mekar	0.23 (Low)	0.14 (Low)	0.08 (Low)

Note: Shannon-Wiener diversity index (H') value: <1: Low, 1-3: moderate, >3: High. Evenness index (E) value: 0.00<E<0.50: Low, 0.50<E<0.75: Medium, 0.75<E<1.00: High. Simpson's Dominance index (D) value: 0.00<C<0.50: Low, 0.50<C<0.75: Medium, 0.75<C<1.00: High (Tarno et al., 2016).

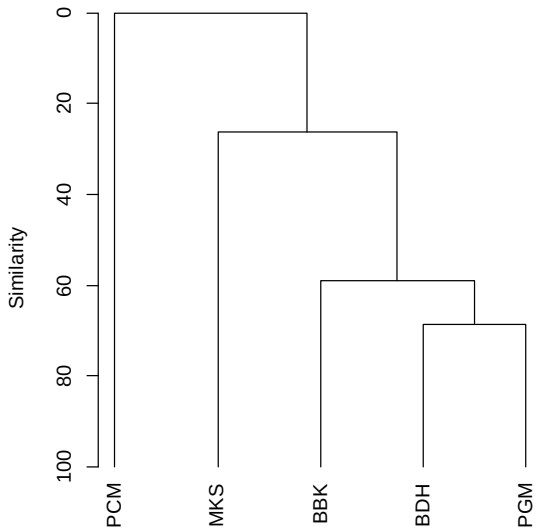

Figure 2. Bray-Curtis similarity of fruit fly communities in Bogor and Depok District. PCM: Pancoran Mas, MKS: Mekarsari, BBK: Babakan, BDH: Bedahan, PGM: Parigi Mekar.

Conclusions and Suggestion

In this study, nine fruit fly species were collected. *Zeugodacus cucurbitae* was the most abundant species (792 individuals), representing 77.27% of the specimens collected during the sampling period. The highest Shannon–Wiener diversity index was found in the Bedahan (1.11) and the lowest in Parigi Mekar (0.23). According to Bray–Curtis analysis, The species compositions of fruit flies in Bedahan (Depok) and Parigi Mekar (Bogor) were 70.1% similar.

Acknowledgements

The authors would like to thank the Agricultural Extension and Human Resources Development Agency, the Ministry of Agriculture, the Republic of Indonesia for the scholarship given to the study assignment program in 2019. We also thank the Directorate General of Horticulture for invaluable support and encouragement and the Pest and Disease Forecasting Institute for laboratory support.

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