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Aphid species found on citrus in Ogan Komering Ilir District, South Sumatra, Indonesia

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Abstract. Citrus is an economically valuable plantation crop and has high market opportunities. In Southeast Asia, Indonesia is the second largest citrus importer after Malaysia, with an import volume of 160,254 tons; however, various obstacles limiting the cultivation of citrus plants cannot be separated from pests that can affect citrus quality and reduce citrus production. One of the obstacles is insect attacks such as aphids. Therefore, this study aims to determine the species of aphids in citrus. This research was conducted from May to June 2023 in Ogan Komering Ilir Regency using a direct observation method in the field. Observations were made on the parts attacked by aphids and symptoms of attack. The results showed that three species from 1 family of aphids were found. The species found were *Toxoptera aurantii*, *Toxoptera citricidus*, and *Toxoptera citricola* from the Aphididae family. The highest species found in the study was *T. aurantii*, with 861 individuals, and the lowest species found was *T. citricola*, with 29 individuals. Aphid species were found mainly on *Citrus microcarpa* and least on *Citrus grandis*.

Keywords: Aphididae, *Citrus microcarpa*, *Citrus grandis*, symptoms, Toxoptera

1. Introduction

Citrus (*Citrus* sp.) is a fruit commodity horticultural crop from the Rutaceae family with economic value and market opportunities [1]. Citrus, which is currently widely developed by the community, consists of several types, including sweet orange, lime, kaffir lime, grapefruit, and lemon originating from Southeast Asia [2]. Various obstacles limiting the cultivation of citrus plants cannot be separated from the problem of plant pest organisms (OPT), which can affect citrus quality and reduce citrus production [3]. Aphids (Ordo Hemiptera) are one of the plant pest organisms that can be detrimental to citrus farmers [4]. This insect can be a significant pest in citrus plants [5]. Aphids attack stems, young leaves, old leaves, flowers, and fruit [6]. This insect attacks by stabbing its stylet and then sucking plant cells so that it can damage the



plant [7]. Aphids suck liquid from the leaves so that it can cause plant growth to be inhibited [8]. Aphids can also cause plant growth to stunt because leaves attacked by aphids will wrinkle and curl [9]. Aphids can also secrete a sweet, honey-like liquid [10]. The liquid will attract ants and cause sooty mold on the fruit and leaves, which can cause a decrease in the quality of citrus fruit [11].

Aphids can also be vectors of viruses in citrus. According to research by [12], Citrus plants can be attacked by diseases that can be caused by viruses such as *Citrus Tristeza Virus* (CTV), spread by aphids (*Toxoptera citricida*). It is necessary to control aphids to get maximum results, and control can be done by spraying synthetic and botanical pesticides. The presence of predatory insects can also control aphids. Cocci beetles act as predatory insects that can control scale lice, mites, mealybugs, aphids, and flour beetles [13]. Aphids commonly found on citrus plants are from Aphididae, Aleyrodidae, Coccinellidae, Diaspididae, and Pseudococcidae [14].

2. Methods

2.1. Preparation

The research was conducted in the sub-districts of Kayu Agung Asli, Pedamaran, and Teluk Gelam, Ogan Komering Ilir Regency, South Sumatra in June 2023. The land used as the object of research was the yard of a smallholding citrus farmer in Ogan Komering Ilir Regency, which includes: District 1: Kayu Agung Asli, District 2: Pedamaran, District 3: Teluk Gelam.

2.2. Sample collection and Identification

This study used a purposive sampling method. The sampling methods were direct observation and hand-picking. Direct observation was done by observing aphids on citrus plants' leaves, fruit, and stems. Observations were made from morning to evening, from 08.00 am to 4.00 pm. The presence of aphids was taken directly (hand picking) using a small brush and then put into a vial bottle containing 80% alcohol and labeled in the form of location, date, and color of aphids obtained. The aphids were observed under a light microscope to investigate the species.

2.3. Data Analysis

The total number of individuals from each species was used to analyze evenness diversity. The calculation of the diversity index used Shannon-Wiener. The formulae was explained below:

$$H' = - \sum P_i \ln P_i \text{ with } P_i = n_i / N \quad (1)$$

H is the diversity index; n_i is the number of individuals in species i , and N is the total number of individuals. The criteria for the Shannon-Wiener diversity index value H' : $H' < 1$ is categorized as low diversity, $1 < H' < 3$ is categorized as moderate diversity, $H' > 3$ is categorized as high diversity.

The dominance of an organism was determined using a dominance index. The Dominance Index value was calculated using the Simpson dominance formula [4].

$$D = \sum (P_i)^2 \quad (2)$$

An explanation of the formula: D is the dominance index, P_i is n_i/N , and N is the total individual. The Criteria for the dominance index are 0-0.50 for low dominance, 0.5-0.75 for moderate dominance, and 0.75-1 for high dominance.

The evenness index can be calculated by following the formula:

$$E = H' / \ln S \tag{3}$$

H' is diversity values, and S is the total individuals observed. The value from the calculation based on the formula matched with the value at the index explained below. $0 < E < 0.4$ is categorized as small evenness or depressed community. $0.4 < E < 0.6$ is categorized as moderate evenness, unstable community. $0.6 < E < 1.0$ is categorized as high evenness or stable community.

3. Result

The results of research that has been done observation of aphids on citrus plants in Ogan Komering Ilir Regency found three aphid species, namely *Toxoptera aurantii*, *Toxoptera citricidus*, *Aphis spiraecola* derived from the Aphididae family. The most common species found was *T. aurantii*, with as many as 861 individuals; the lowest was *A. spiraecola*, with 29 individuals. *T. aurantii* species were found in every observation location, while *A. spiraecola* species were only found in the Teluk Gelam sub-district (Table 1).

Table 1. Species of aphids on citrus plants in Ogan Komering Ilir Regency.

Location	Species discovered		
	<i>Toxoptera aurantii</i>	<i>Toxoptera citricidus</i>	<i>Aphis spiraecola</i>
Kayu Agung	378	115	-
Pedamaran	265	78	-
Teluk Gelam	218	70	29

The species *T. aurantii* has a very high number of individuals (861 individuals) compared to *A. spiraecola*, with only 29 individuals, and *T. citricidus*, 263 individuals (Table 2). The most common species of aphids found on citrus in Ogan Komering Ilir Regency was *T. aurantii*. *T. aurantii* was found presumably because the host range of *T. aurantii* is broader and more diverse. *T. aurantii* has more than 80 host plant families [15]. In addition, *T. aurantii* is commonly found because it can attack young leaves, old leaves, flowers, and fruit. *T. aurantii* can attack citrus on fruit, flowers, and young and old leaves [16]. The lowest aphid species found in Ogan Komering Ilir Regency is *A. spiraecola*. *A. spiraecola* is suspected because citrus is not the primary host of *A. spiraecola*. The main host of *A. spiraecola* is the plant species *Spiraea* sp. [17]. The optimal temperature for developing *A. spiraecola* is 25°C [18].

Table 2. The total number of aphids observed in Ogan Komering Ilir District.

Species	Individual number (n)
<i>Toxoptera aurantii</i>	861
<i>Toxoptera citricidus</i>	263
<i>Aphis spiraecola</i>	29
Total (N)	2609

The study results found that the diversity of aphid species in Ogan Komering Ilir Regency was classified as low because the diversity index value $H' < 1$. The diversity of aphid species is low because only three species of aphids were found. The dominance index of aphids in Ogan

Komering Ilir Regency is classified as moderate ($0.5 < D < 0.75$) with an index value of $D = 0.610$. The dominance index is moderate because the number of individuals of *T. aurantii* was higher than that of *A. spiraecola* and *T. citricidus*. The aphid community in Ogan Komering Ilir Regency is considered stable ($0.75 < E < 1.00$) with an evenness index value of $E = 0.935$ (Table 3).

Table 3. Shannon-Weiner Diversity Index, Dominance Index, and Evenness Index of aphids found in Ogan Komering Ilir District.

Index	value
Diversity (H')	0.648
Dominance (D)	0.610
Evenness (E)	0.935

The morphological characteristics of the three aphids are different. The species *T. aurantii* and *T. citricidus* have almost the same morphological characteristics; in the species *T. aurantii*, the body is slender and oval with a brown color, while in *T. citricidus*, the body is round and black. *T. aurantii* has a more petite body than *T. citricidus*, namely *T. aurantii* 2-6 mm, while *T. citricidus* 2-8 mm. *T. aurantii* has shorter cauda than *T. citricidus* (Figure 1 A and B). The species *A. spiraecola* is characterized by a slender oval-shaped body and a green to brass color. The limbs are green, while the tarsus is darker brown. The cauda has a longer distance than the *Toxoptera* species; at the end, it is black (Figure 1 C).

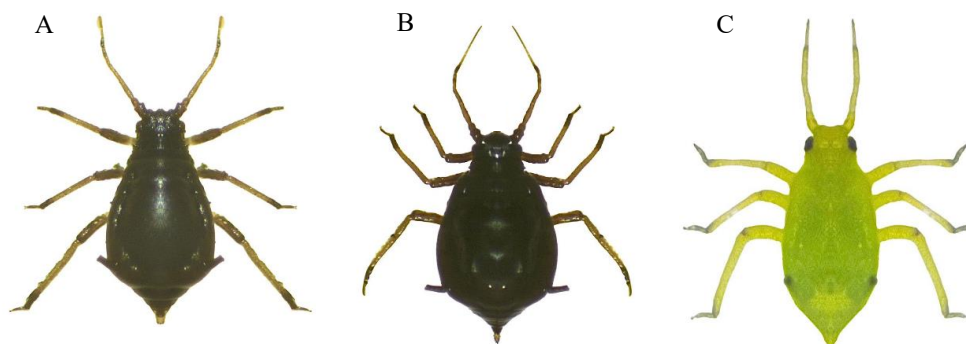


Figure 1. Species of aphids on citrus. (A) *Toxoptera aurantii*, (B) *Toxoptera citricidus*, (C) *Aphis spiraecola*.

4. Discussion

The morphological characteristics of the three species are different. The *T. aurantii* species has a characteristic brown, slender, oval-shaped body [19]. The morphological characteristics of *T. aurantii* are characterized by a body length of no more than 2 mm, a cauda shaped like a tongue, and 10-21 hairs [20]. Imago *T. aurantii* is oval-shaped and blackish brown, with black and white antennae interspersed, caudal, and black cornicles. In the species *T. citricidus*, the body is oval with a blackish color, more significant than the species *T. aurantii*, and has a longer cauda than *T. aurantii*. The body shape is oval and black, and the femur has fine hairs that are very long and many compared to *T. aurantii* [21]. Cauda size is longer than *T. aurantii* species. The species *A. spiraecola* is characterized by a slender, oval-shaped body and green in color.

The tarsus is brownish. The aphids measuring 0.07-0.13 mm in length have a yellow or green color, adult aphids without wings, and dark-colored cauda [22].

Aphids are an important pest of citrus crops that can result in reduced citrus production [5]. These insects attack and damage the fruit, leaves, and stems [23]. Aphids are found to attack young leaves, old leaves, and flowers [24]. The symptoms found are on young leaves and old leaves that are stiff and curled, then the flowers will wither and die. The presence of aphids is significant because they can attack various types of citrus [25]. The abundance of aphids population can be influenced by biotic and abiotic factors [26]. Climate is one of the essential factors that can affect the population of aphids [27].

5. Conclusion

The aphid species found on *Citrus* sp. in the Ogan Komering Ilir district consisted of 3 aphid species, namely *T. aurantii*, *T. citricidus*, and *A. spiraecola*. The species *T. aurantii* and *T. citricidus* have almost the same characteristics; *T. aurantii* has a slender oval body shape and is blackish brown, while *T. citricidus* has an oval, round body shape and is solid black. In contrast, the species *A. spiraecola* has an oval body shape and is green in color. The *T. auranti* species was mainly found in the Ogan Komering Ilir district, South Sumatera, Indonesia.

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