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FEEDING BEHAVIOR OF BANANA AND TARO APHIDS (*Pentalonia* spp.) (HEMIPTERA: APHIDIDAE) ON MUSACEAE AND ARACEAE PLANTS: AN ELECTRICAL PENETRATION GRAPH (DC-EPG) STUDY

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ABSTRACT

The feeding behavior of the banana aphid, *Pentalonia nigronervosa* Coquerel, and the taro aphid, *P. caladii* van der Goot (Hemiptera: Aphididae), was evaluated on plants from the Musaceae family (bananas cv. Kepok [*Musa* x *paradisiaca*], and cv. Mas [*M. acuminata*]) and the Araceae family (taro [*Colocasia esculenta*], and dumb cane [*Dieffenbachia* sp.]) using the electrical penetration graph (DC-EPG) technique. These two aphids are reported as vectors of *Banana bunchy top virus* (BBTV), which causes banana bunchy top disease (BBTD). In the laboratory, the EPG equipment setup involved attaching the aphids to the host plants using a fine gold wire connected to an EPG box for signal amplification. This setup was linked to a PC for waveform recording using EPG Stylet 3.0 software for 10 hours. Specific EPG recording parameters were selected for data analysis. The results suggest that the banana aphid grows better on banana plants (Musaceae) and less on plants from the Araceae family, whereas the taro aphid prefers taro and similar plants (Araceae) over banana plants (Musaceae). This also indicates that the taro aphid is less likely to spread BBTV on bananas than the banana aphid.

Keywords: *Pentalonia caladii*, *Pentalonia nigronervosa*, bunchy top, banana virus, banana disease

ABSTRAK

Tingkah laku pemakanan afid pisang, *Pentalonia nigronervosa* Coquerel, dan afid keladi, *P. caladii* van der Goot (Hemiptera: Aphididae), telah dinilai pada tumbuhan daripada famili Musaceae (pisang cv. Kepok [*Musa* x *paradisiaca*], dan cv. Mas [*M. acuminata*]) dan famili

Araceae (keladi [*Colocasia esculenta*], dan tebu [*Dieffenbachia* sp.]) menggunakan teknik graf penembusan elektrik (DC-EPG). Dua afid ini dilaporkan sebagai vektor virus atas tandan pisang (BBTV), yang menyebabkan penyakit atas tandan pisang (BBTD). Dalam makmal, penyediaan peralatan EPG melibatkan penyambungan afid pada tumbuhan perumah menggunakan wayar emas halus yang disambungkan kepada kotak EPG untuk menguatkan isyarat. Tetapan ini disambungkan kepada PC untuk rakaman gelombang menggunakan perisian EPG Stylet 3.0 selama 10 jam. Parameter rakaman EPG tertentu telah dipilih untuk analisis data. Hasil menunjukkan bahawa afid pisang berkembang lebih baik pada tumbuhan pisang (Musaceae) dan kurang pada tumbuhan dari famili Araceae, manakala afid keladi lebih menyukai keladi dan tumbuhan serupa (Araceae) berbanding tumbuhan pisang (Musaceae). Ini juga menunjukkan bahawa afid keladi kurang berkemungkinan untuk menyebarkan BBTV pada pisang berbanding afid pisang.

Kata kunci: *Pentalonia caladii*, *Pentalonia nigronervosa*, atas tandan, virus pisang, penyakit pisang

INTRODUCTION

Banana bunchy top disease (BBTD) is recognized as the most significant disease affecting bananas worldwide, capable of causing yield losses of up to 90% (Kumar et al. 2015). BBTD has spread extensively in Indonesia and has been reported in several banana-producing regions in Java, Sumatra, Bali, and Nusa Tenggara (Latifah et al. 2021; Rahayuniati et al. 2021). Typical symptoms of bunchy top include erect and narrow leaves, yellowing leaf margins that can become necrotic, stunted plant growth, and rare fruit production. The disease is caused by the *Banana bunchy top virus* (BBTV), which is transmitted by aphids (Hemiptera: Aphididae) and can also spread through vegetative propagation materials such as suckers and corms (Latifah et al. 2021; Ngatat et al. 2017).

The banana aphid, *Pentalonia nigronervosa* Coquerel, is known to transmit BBTV very efficiently in a circulative non-propagative manner (Anhalt & Almeida 2008; Watanabe et al. 2013). Recently, it was reported that the taro aphid, *Pentalonia caladii* van der Goot, which originates from ginger (*Zingiber officinale*), heliconia (*Heliconia* spp.), and taro (*Colocasia esculenta*) plants, can also transmit BBTV, although at a lower rate than the banana aphid (Pertiwi et al. 2022; Watanabe et al. 2013). Due to the polyphagous nature of these aphids, both the banana aphid and the taro aphid have the potential to share common hosts. However, their natural host ranges differ significantly. Colonies of the banana aphid are primarily found on bananas (*Musa* spp.) and taro (*C. esculenta*), while the taro aphid is more commonly found on plants belonging to the Araceae family such as *Colocasia* sp., *Dieffenbachia* sp., *Caladium* sp., and the *Zingiberales* such as *Zingiber* sp., *Costus* sp., and *Canna* sp. (Foottit & Maw 2019). Bagariang et al. (2019) reported that the banana aphid is more commonly found on banana plants than on non-Musa plants, whereas the taro aphid is rarely found on banana plants but is more commonly found on *C. esculenta*, *Curcuma longa*, *Costus* sp., and *Dieffenbachia* sp. BBTV transmission by aphid vectors occurs in a persistent manner. The virus circulates but does not replicate in the vector's body, and there is no transovarial transmission. The virus is detected in viruliferous aphids in the digestive tract (anterior midgut) and the salivary glands. BBTV persists in the insect vector even after molting (Hafner et al. 1995; Hu et al. 1993; Watanabe et al. 2013). The efficiency of aphids in transmitting viruses highly depends on their feeding behavior and the suitability of the plant as a host. Stylets play a crucial role in an insect's feeding behavior, especially in their interactions with plants. In general, the stylet

activities can be broken down into several phases: stylet penetration, anchoring and explorations, salivation, ingestion, and stylet removal.

Rahmah et al. (2021) reported that the population growth of the banana aphid is higher on banana plants (Musa sp.), especially on the local cultivars 'Kepok', 'Raja', and 'Mas', and the introduced cultivar 'Cavendish', compared to non-Musa plants. In contrast, the population growth of the taro aphid is higher in C. esculenta than in Musa spp. Although there are differences in the host range between the banana aphid and the taro aphid, their impact on the transmission and spread of BBTD is not yet well understood. Therefore, research was conducted to study the feeding behavior of these two aphid species on various Musaceae and Araceae plants using the Electrical Penetration Graph (EPG) technique. EPG is a common tool to study the feeding behavior of many kinds of fluid-sucking insects, mostly from the order Hemiptera. Some insects from other orders, such as the synchronized fireflies, *Pteroptyx tener* (Coleoptera: Lampyridae), also feed on plant fluids by piercing (Othman 2018). However, because they do not have stylets, they cannot be fitted with EPG to study their feeding behavior. The use of EPG in monitoring aphid feeding behavior can determine the host plant most preferred by each aphid species (Prado & Tjallingii 2007).

MATERIALS AND METHODS

Plant Materials

Four host plants were used for the study, consisting of two from the Musaceae family (bananas cv. Kepok [*Musa* x *paradisiaca*], and cv. Mas [*M. acuminata*]) and two from the Araceae family (taro [*Colocasia esculenta*], and dumb cane [*Dieffenbachia* sp.]) All plants were grown in polybags (20 cm in diameter and 20 cm in height) containing a mixture of soil, husk charcoal, and manure in a 2:1:1 ratio as the growing medium. Each plant used in the experiment was covered with a gauzed mica cage to prevent insect infestation.

Banana and Taro Aphids

Aphids were collected from banana and taro plants around the campus in Dramaga, Bogor, West Java, Indonesia. These aphids are commonly found on the inner part of the leaf sheaths of both banana and taro plants. The leaf sheaths containing aphids were carefully cut and placed inside cylindrical plastic tubes (7 cm in diameter and 20 cm in height) and brought to the laboratory for identification. Morphological identification was performed by first preparing slide preparations (Hidayat et al. 2023). Based on morphometric characters as described by Foottit et al. (2010), the aphids from banana and taro plants were identified as the banana aphid and the taro aphid, respectively (Rahmah et al. 2021).

Furthermore, a single apterous adult female from each species was placed on host plants to initiate aphid cultures. The aphids were maintained and reared on host plants grown in polybags: the banana aphid on banana and the taro aphid on taro (Figure 1). Each host plant was covered in a mesh cage and placed in a greenhouse with sufficient sunlight exposure.

Figure 1. Aphid colonies in host plants: A) banana aphid on banana; B) taro aphid on taro

Aphid Feeding Behavior

The experiment was conducted in the Laboratory of Applied Entomology, Department of Plant Protection, Faculty of Agriculture, Gadjah Mada University, Indonesia. Aphid feeding behavior on four host plants was monitored using the electrical penetration graph (DC-EPG). Each aphid was mounted to a thin gold wire (2-3 cm in length, 20 µm in diameter) using silver glue on the dorsal side immobilized by a suction device (Recatala & Tjallingii 2015). The other end of the gold wire was attached to a copper wire (3 cm in length, 0.2 mm in diameter) and connected to an amplifier input with a resistance of 1 giga ohm and a gain of 50x. Copper electrodes (10 cm long, 2 mm thick) were inserted into the soil of the potted plant and connected to the power supply of the EPG device (Tjallingii 2006). Test plants were watered in advance because moist soil provides better conductivity (Walker 2000). Plants were placed in a Faraday cage (24 cm x 30 cm x 30 cm) to eliminate electrical noise. Three plants, each containing a single aphid, were monitored simultaneously.

Recording of The Feeding Behavior

Real-time recording of aphid feeding behavior was conducted using the EPG Stylet 3.0 application system (https://www.epgsystems.eu/) for 10 hours (Montana 2023; Salsabillah 2018) (Figure 2). The recorded data included six EPG waveforms: (1) Np waves, No probing activity into plant tissue; (2) C pathway phase, The aphid's stylet puncturing into the epidermal and mesophyll tissues; (3) Potential drop (Pd), The aphid's stylet entering the epidermal and mesophyll tissues and searching for phloem; (4) G phase, The aphid's stylet sucking water from the xylem; (5) E1 phase, Representing salivation activity; and (6) E2 phase, Representing phloem sap ingestion. Variable parameters included the number of probes, the total probing duration, and the feeding duration (from either the phloem or xylem tissues).

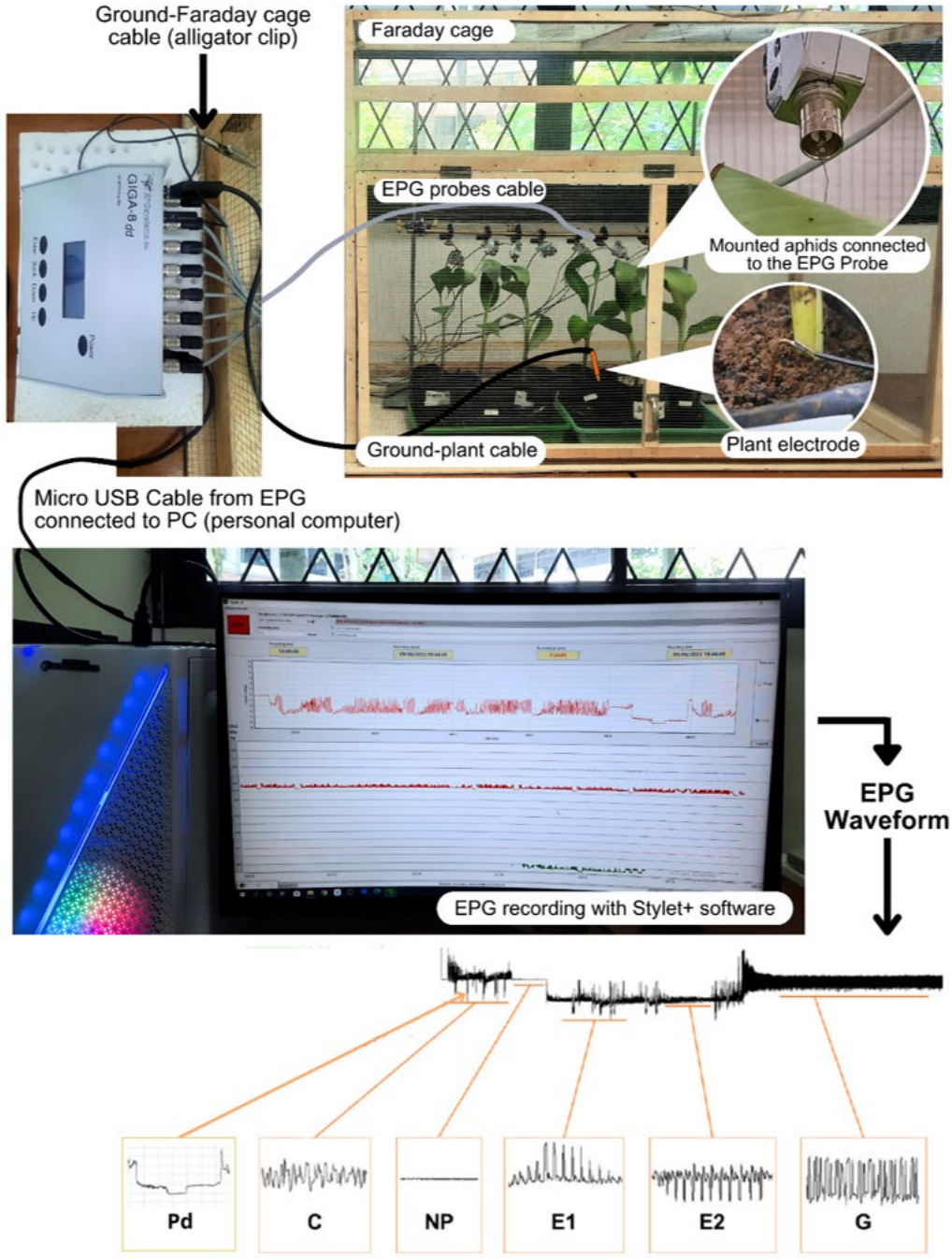

Figure 2. Schematic mechanism of EPG recording (courtesy of Montana 2023)

Experimental design and statistical analysis

The experiment was conducted separately for the banana aphid and the taro aphid using a completely randomized design with host plants as treatments. The aphid species, the banana aphid and the taro aphid, were subjected to different treatments, including feeding on bananas cv. Mas and cv. Kepok, taro, and dumb cane plants. Each treatment combination was replicated five times, with each replication consisting of three plants.

Data were analyzed using Analysis of Variance (ANOVA) followed by LSD-Fisher at a 95% significance level using Minitab 17 and the Paleontological Statistics Software Package

(PAST) statistical program. Abnormal data were analyzed using the non-parametric ANOVA Kruskal-Wallis test. Data analysis was conducted using Minitab 17 programs, and Principal Component Analysis (PCA) was performed using the PAST statistical program. Several parameters were considered for the PCA, including the total duration of probing, number of punctures in xylem (G waveform) and phloem (E waveform), total duration of E waveform, and percentage of time probing.

RESULTS

The feeding behavior of a total of 40 individual adult banana aphids and taro aphids was successfully recorded for 10 consecutive hours. In general, the stylet activities of aphids during feeding in plant tissue can be divided into two parts: stylet activity in non-phloem tissue and in phloem tissue. Aphids carry out probing activities in a few cells in non-phloem tissue, which are not related to nutrient uptake; whereas in phloem tissue, the main activity is taking plant nutrients. The waveforms observed in the EPG during the feeding period consist of non-probing (Np), stylet pathway (C), potential drop (Pd), xylem (G), and phloem (E) waveforms.

Non-probing (Np) Activity

The initial feeding behavior phase monitored using EPG was the non-probing activity, also identified as stylet withdrawal activity. Non-probing activity may indicate aphids' preferences for a host plant, with a high frequency and duration of non-probing activities often associated with unfavorable feeding conditions. The taro aphids exhibited a host preference for cv. Kepok, indicated by the shortest duration of non-probing activity, while the banana aphid did not exhibit a distinct host preference (Table 1). Generally, the frequency and duration of non-probing activity on *C. esculenta* tended to be higher than on other plants. However, there were no significant differences in Np activity between the two aphid species on different host plants based on ANOVA (P>0.05).

Table 1. Non-probing feeding behavior (Np waveform) of *P. nigronervosa* and *P. caladii* on Musaceae (bananas cv. Kepok and cv. Mas) and Araceae (*C. esculenta* and *Dieffenbachia* sp.) plants

No	Parameter	Species/ *P*-value	Host Plant (Mean±SE)			
			cv. Kepok	cv.Mas	*C. esculenta*	*Dieffenbachia* sp.
1	Frequency of non-probing	*Pn*	13±4.7a	10±3.8a	14.4±5.4a	6.8±1.5a
		Pc	5.2±0.5a	14.4±4.0a	16.6±5.2a	8.0±1.4a
2	Total duration of non-probing (min)	*Pn*	60.6±28.2a	77.9±28.4a	207±46.8a	180±80.9a
		Pc	30.6±10b	121.2±17a	133±40.2a	121±45.4a

SE: Standard error; *Pn*: *P. nigronervosa*; *Pc*: *P. caladii*

The mean numbers in the same row for each aphid species, indicated by the same letter, are not significantly different between host plants based on an LSD test with a 95% confidence level. Mean numbers in the same column between *P. nigronervosa* and *P. caladii* on the same host plant are not significantly different (P>0.05) based on a t-test.

Potential drop (Pd) and Pathway Phase (C) Punctures

Aphid feeding activity begins when the aphid inserts its stylet intercellularly into plant tissue, recorded by the EPG as a C waveform. Potential drop (Pd) indicates the total and average number of punctures per probing activity.

The highest total probing time for the banana aphid occurred on cv. Kepok and the lowest on taro. Similarly, for the taro aphid, the highest total probing time was also on cv. Kepok, but the lowest was on cv. Mas and taro (Table 2). Despite differences in total probing time, there were no significant differences in the total number (frequency) or total duration of probing for both the banana aphid and the taro aphid.

Table 2. Non-phloem feeding behavior (C and Pd waveforms) of *P. nigronervosa* and *P. caladii* on Musaceae (bananas cv. Kepok and cv. Mas) and Araceae (*C. esculenta* and *Dieffenbachia* sp.) plants

No	Parameter	Species/ *P*-value	Host Plant (Mean±SE)			
			cv.Kepok	cv. Mas	*C. esculenta*	*Dieffenbachia* sp.
1	Total probing time (min)	*Pn*	539.4±28.2a	522±28.4ab	393±46.8b	420±80.9ab
		Pc	569±10.2 a	479±17.2b	467±40.2b	479±45.4ab
2	Number of C (frequency)	*Pn*	14.8±4.9 a	12.6±4.1a	15.6±6.0a	7.2±1.5a
		Pc	7±0.9 a	19.6±4.9a	17.6±5.3a	8.6±1.1a
3	Number of short probes (C<3 min)	*Pn*	6.6±3.3a	4.8±2.6a	7.2±3.8a	1.8±0.7a
		Pc	0.6±0.4ab	5.6±2.2b	11±3.6a	2±0.9b
4	Total duration of C (min)	*Pn*	358.4±38.8a	300.3±83a	357.4±49a	416.4±81.5a
		Pc	460.6±47.7a	355.7±35a	372.8±69a	411.9±9.3a
5	Probing time in C (%)	*Pn*	67.2±7.8bc	59.9±16.5c	91.1±5.8ab	99±0.8a
		Pc	80.6±7.4a	73.7±5.4a	79.6±11.5a	87±8.5a
6	Number of Pd (frequency)	*Pn*	57.4±27.8a	94.2±32.2a	21.2±12b	3.0±2.3b
		Pc	73.0±17.0b	81.6±27.5a	30.6±6.9b	6.4±3.6c
7	Average number of Pd	*Pn*	7.6±4.8ab	17.1±7.3a	2.1±1bc	0.5±0.4c
		Pc	14.6±3.5a	6.6±2ab	3.2±1.4b	0.8±0.4c

SE: Standard error; *Pn*: *P. nigronervosa*; *Pc*: *P. caladii*

The mean numbers in the same row for each aphid species, indicated by the same letter, are not significantly different between host plants based on an LSD test with a 95% confidence level.Mean numbers in the same column between *P. nigronervosa* and *P. caladii* on the same host plant are not significantly different (P>0.05) based on a t-test.

The taro aphid showed the fewest short probings in *Dieffenbachia* sp. and the most in taro. For both the banana aphid and the taro aphid, the highest Pd frequencies occurred in cv. Mas, while the lowest occurred in *Dieffenbachia* sp.

This analysis indicates that while the duration of probing varies among different host plants, the frequency of probing activities does not significantly differ between the banana aphid and the taro aphid. This suggests that certain host plants may be more or less conducive to prolonged feeding, which could influence the efficiency of virus transmission by these aphids.

Xylem Phase (G) Activity

Stylet activity in the xylem indicates the aphid's feeding activity to obtain water from plant cells. For the banana aphid, there was no significant difference in the number of stylet punctures on various host plants based on ANOVA (P>0.05), although the longest duration was observed on cv.

Table 3. Xylem feeding behavior (G waveform) of *P. nigronervosa* and *P. caladii* on Musaceae (banana cv. Kepok and cv. Mas) and Araceae (*C. esculenta* and *Dieffenbachia* sp.) plants

No	Parameter	Species/ *P*-value	Host Plant (Mean±SE)			
			cv. Kepok	cv. Mas	*C. esculenta*	*Dieffenbachia* sp.
1	Number of G (frequency)	*Pn*	1.2±0.6a	1.6±0.7a	0.4±0.4a	0.2±0.2a
		Pc	1.0±0.5b	2.6±0.6a	0.4±0.2b	0.4±0.2b
2	Total duration of G (min)	*Pn*	113.7±56.4a	61±18ab	11±11b	2.8±2.8b
		Pc	64.5±37.8a	62±27a	31±19a	67±44a
3	Probing time in G (%)	*Pn*	21.1±9.9a	12±4ab	3.1±3.1b	0.9±0.9b
		Pc	11.3±6.5a	13±5.4a	7.5±4.7a	13±8.5a

SE: Standard error; *Pn*: *P. nigronervosa*; *Pc*: *P. caladii*

The mean numbers in the same row for each aphid species, indicated by the same letter, are not significantly different between host plants based on an LSD test with a 95% confidence level. Mean numbers in the same column between *P. nigronervosa* and *P. caladii* on the same host plant are not significantly different (P>0.05) based on a t-test.

Kepok and the shortest on *Dieffenbachia* sp. For the taro aphid, xylem activity occurred more frequently on cv. Mas, but the duration did not significantly differ among the host plants (Table 3). This suggests that while the frequency of xylem feeding might vary, the overall time spent in xylem feeding remains consistent across different plants.

Phloem Feeding Activity (E1, E2)

The amount and duration of feeding activity in the phloem phase are crucial as the phloem provides essential nutrients for aphids. Both the banana aphid and the taro aphid showed the lowest number and duration of phloem activity on *Dieffenbachia* plants. Generally, the feeding activity in the phloem is higher on Musaceae plants (cv. Kepok and cv. Mas) compared to Araceae plants (taro and *Dieffenbachia* sp.).

Phloem feeding activity is divided into two phases: active salivation (E1) and passive ingestion of phloem sap (E2) (Tjallingii 2006). The frequency and duration of the banana aphid's feeding activity in the E1 phase did not significantly differ between host plants, though there was a tendency for higher activity on cv. Mas. Similar results were observed for the taro aphid, with a higher frequency of E1 activity occurring on cv. Mas (Table 4). The lowest frequency and total duration of E2 activity were recorded on *Dieffenbachia* sp. for both the banana aphid and the taro aphid (Table 4). This indicates that *Dieffenbachia* sp. is not suitable as a host plant for aphids.

There is a clear difference in feeding behavior preferences between the two species of aphids based on ANOVA (P>0.05): the banana aphid is more active on cv. Mas, while the taro aphid is more active on taro.

Table 4. Phloem feeding behavior (E waveforms) of *P. nigronervosa* and *P. caladii* on Musaceae (banana cv. Kepok and cv. Mas) and Araceae (*C. esculenta* and *Dieffenbachia* sp.) plants

No	Parameter	Species/ *P*-value	Host Plant (Mean±SE)			
			cv. Kepok	cv. Mas	*C. esculenta*	*Dieffenbachia* sp.
1	Number of E1 (frequency)	*Pn*	3.0±2.1a	3.0±1.3a	1.6±0.9a	0.4±0.4a
		Pc	1.6±0.9b	4.8±1.1a	1.6±0.7b	1.2±0.9b
2	Total duration of E1 (min)	*Pn*	1110.6 a	12.8±7.1a	9.9±7.9a	5.7±5.5a
		Pc	1.9±1.4a	7.4±2.2a	2.5±1.0a	0.7±0.7a
3	Number of E2 (frequency)	*Pn*	1.6±0.9ab	2.4±0.9a	1.0±0.5ab	0.0±0.0b
		Pc	1.4±0.7ab	2.6±0.5a	1.4±0.6ab	0.6±0.6b
4	Total duration of E2 (min)	*Pn*	66±34.6a	152±111.4a	14±12.1a	0.0±0.0a
		Pc	45±31.1ab	59±16.6ab	141±72.3a	5.4±5.4b
5	Total duration of E (min)	*Pn*	78±38.2a	165±111.1a	24.2±14.1a	0.7±0.7a
		Pc	47±31.1ab	67±18.35ab	144±73.0a	11±10b
6	Probing time in E1 (%)	*Pn*	12±5.8a	27.9±18.8a	5.8±3.4a	0.1±0.1a
		Pc	8.1±5.8a	13.1±4.9a	12.9±12.5a	0.1±0.1a

SE: Standard error; *Pn*: *P. nigronervosa*; *Pc*: *P. caladii*

The mean numbers in the same row for each aphid species, indicated by the same letter, are not significantly different between host plants based on an LSD test with a 95% confidence level. Mean numbers in the same column between *P. nigronervosa* and *P. caladii* on the same host plant are not significantly different ($P>0.05$) based on a t-test.

Multivariate Analysis of Aphid Feeding Behavior

Multivariate analysis effectively differentiates aphid feeding behavior on various host plants. Principal Component Analysis (PCA) results indicate that 98% of the variation in the five parameters tested is captured. Overlap between the banana and taro aphid plots (Figure 3A) suggests that both species share similar host plants. The taro aphid plot being within the banana aphid plot further implies that the taro aphid's host preferences and suitability are more specific or sensitive compared to the banana aphid.

Separate analyses were conducted for the banana aphid and the taro aphid individually (Figures 3B & 3C). For the taro aphid, Dieffenbachia plots were distinct from other host plant plots, confirming that Dieffenbachia is not a suitable host plant. Conversely, the banana aphid plot shows overlapping patterns among host plants, indicating that its feeding behavior does not significantly differ among the host plants tested. This suggests that the host range of the banana aphid is broader than that of the taro aphid. The PCA confirms that Dieffenbachia is unsuitable for the taro aphid, and the banana aphid exhibits a broader host range. These findings align with the observed feeding behaviors and support the conclusion that the banana aphid is more adaptable to different host plants compared to the taro aphid.

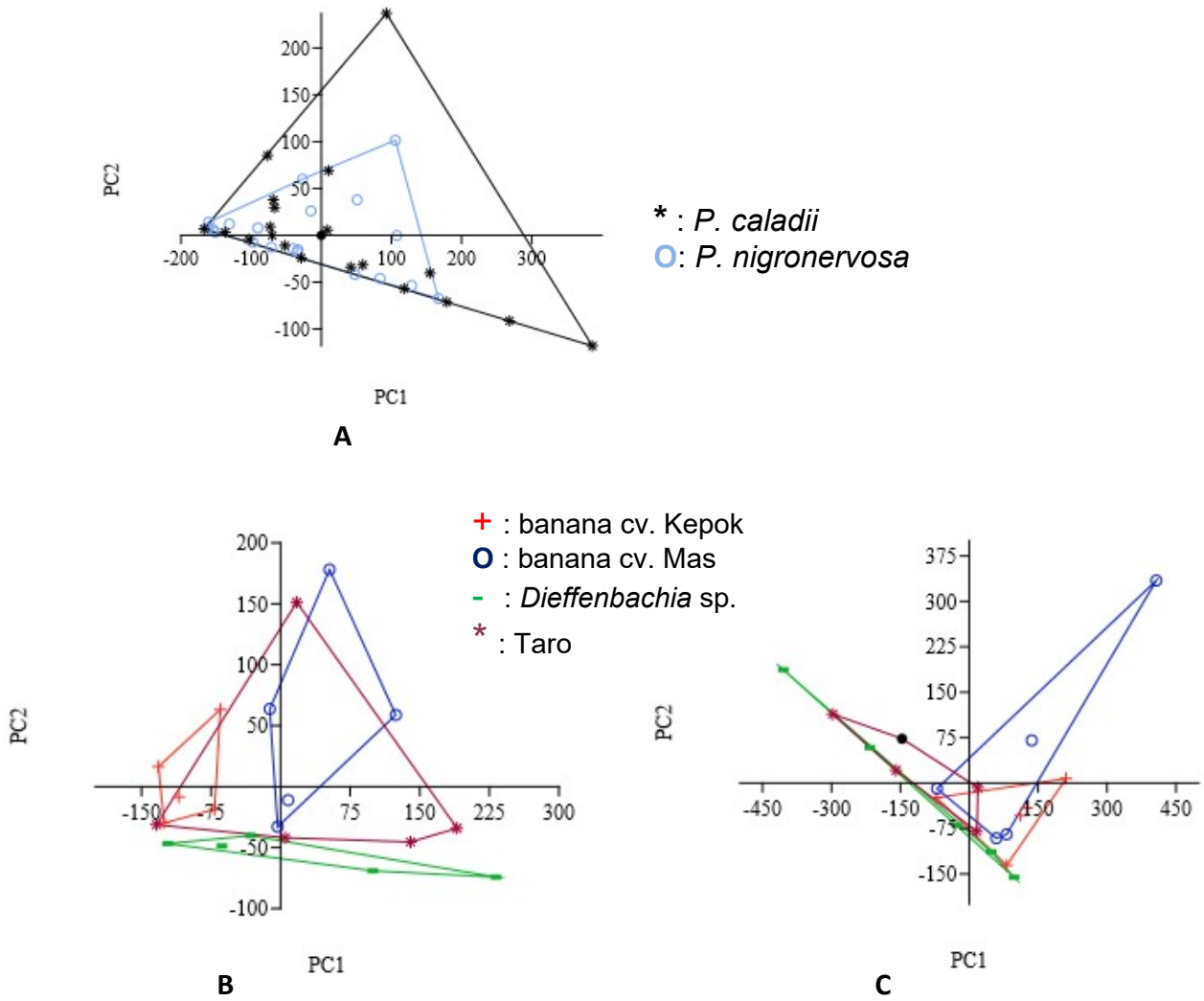

Figure 3. PCA Results of Aphid Feeding Behavior on Different Host Plant: (A) Combined PCA of the banana aphid and taro aphid on various host plants showing plot overlap, (B) PCA of the taro aphid indicating distinct separation of Dieffenbachia plots, (C) PCA of the banana aphid showing overlapping plots among host plants

DISCUSSION

There are some findings of this research: (1) Both aphid species showed the highest number and duration of non-probing activity on taro plants, with the least non-probing activity on banana cv. Kepok. This suggests taro plants are less favorable for feeding compared to banana plants; (2) Both banana and taro aphids exhibited the lowest frequency and duration of feeding activity in the phloem phase on Dieffenbachia plants. Phloem feeding activity was higher on banana plants (cv. Kepok and cv. Mas) compared to taro and Dieffenbachia plants, indicating banana plants are more favorable as host plants; (3) EPG results confirmed that taro aphids, while preferring taro plants, also showed a significant preference for banana plants. This suggests that taro aphids can potentially be vectors of BBTV, albeit less efficiently than banana aphids; (4) Taro aphids have a higher growth rate and population on taro plants compared to banana aphids on banana plants. This was supported by Bhadra & Agarwala (2010) who reported an average growth of 2.73 aphids per day for taro aphids on taro, and 0.87 aphids per

day for banana aphids on banana plants; (5) Banana aphids have a broader host range compared to taro aphids, colonizing various plants across multiple families, including Musaceae, Araceae, Zingiberaceae, Marantaceae, Asteraceae, Solanaceae, Cactaceae, Commelinaceae, Orchidaceae, Strelitziaceae, and Heliconiaceae. The host range and feeding behavior of banana and taro aphids are critical for understanding their role in BBTV transmission. Both aphids showed higher feeding activity on banana plants, indicating their suitability as primary hosts. The broader host range of banana aphids suggests they can exploit a wider variety of plants, potentially increasing their capacity to spread BBTV.

The higher non-probing activity on taro plants suggests these plants are less suitable for feeding, despite being preferred hosts in previous reports. This discrepancy might be due to environmental or physiological factors affecting aphid behavior in different plants. Dieffenbachia plants were the least suitable hosts for both aphid species, as indicated by the lowest frequency and duration of phloem-feeding activity. This information is crucial for developing pest management strategies, as it suggests that controlling alternative host plants can reduce BBTV inoculum sources.

The growth rates and population data highlight that taro aphids thrive better on taro plants, while banana aphids have a broader host range but a slower growth rate on banana plants. This could influence the spread dynamics of BBTV, with taro aphids playing a significant role in specific environments.

Overall, the study's findings provide insights into the feeding behavior and host preferences of banana and taro aphids, which can inform integrated pest management strategies aimed at controlling BBTV spread by targeting both aphid populations and their preferred host plants. Understanding these dynamics is essential for mitigating the impact of BBTV on banana production.

The identification of banana plants as the preferred hosts for both aphid species suggests that focusing control efforts on these plants could be highly effective. This includes regular monitoring and the use of resistant banana cultivars. Since banana aphids have a broader host range, including many alternative plants, managing these alternative hosts in and around banana plantations is crucial. By understanding the feeding behavior and host preferences of these aphids, growers can develop more effective strategies to manage BBTV, ultimately safeguarding banana crops and improving agricultural sustainability.

CONCLUSION

This research elucidates the feeding behavior and host preferences of banana and taro aphids, emphasizing their roles in transmitting the *Banana bunchy top virus* (BBTV). The study found that both banana and taro aphids prefer banana plants (cv. Kepok and cv. Mas) over taro and Dieffenbachia plants, as demonstrated by increased phloem-feeding activity on bananas. Taro aphids exhibited longer phloem-feeding activity on Araceae family plants, such as taro, compared to Musaceae family plants such as banana, suggesting a lower likelihood of spreading BBTV to bananas.

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Conflict of Interest
The authors declare that they have no conflict of interest.

Ethics Declarations
No ethical issue is required for this research

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My manuscript has no associated data

Authors' Contributions
Purnama Hidayat (PH), Sri Hendrastuti Hidayat (SHH), Siti Rahmah (SR), and Alan Soffan (AS) conceptualized and designed the experiments, analyzed the data, and wrote the manuscript. SR, AS, and Yuni Apriliana (YA) performed data acquisition, analysis, and interpretation. All authors participated in revising the manuscript and approved the final version.

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