The role of insect vector Pentalonia nigronervosa in spreading banana bunchy top disease in South Sumatera

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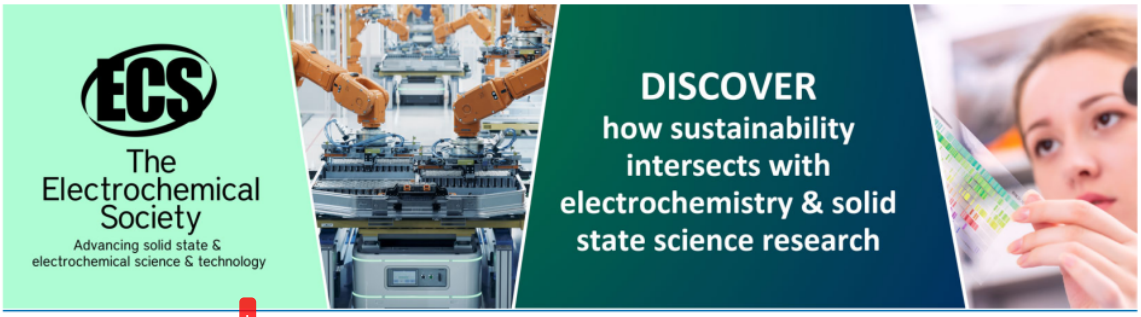

The role of insect vector *Pentalonia nigronervosa* in spreading banana bunchy top disease in South Sumatera

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Abstract. Banana (*Musa* spp.) is widely cultivated by the people of South Sumatra. Banana Bunchy Top disease is caused by Banana bunchy top virus (BBTV), which is transmitted by the vector *Pentalonia nigronervosa* Coquerel (Hemiptera: Aphididae) and asymptomatic banana used for propagation. This study aimed to investigate the role of *P. nigronervosa*. in determining the distribution pattern of this disease in South Sumatra. The research used survey methods in several districts and cities in South Sumatra, namely Ogan Ilir, Ogan Komering Ilir, OKU East, OKU South, OKU Induk, Palembamg, Prabumulih, Banyuasin, Musi Banyuasin, and Lubuk Linggau. Samples were taken using purposive sampling method if BBTV-infected bananas in an area. The results showed *P. nigronervosa* was only found in Ogan Ilir and OKU Induk districts, but in fact this disease was spread in 10 districts and cities. A total of 14 banana cultivars in South Sumatera were infected by BBTV transmitted by *P. nigronervosa*, namely Mas, Cavendish, Putri, Lilin, Nangka, Ambon, Udang, Barangan, Kepok, Gedah, Rottan, Raja, Kapas and Raja Nangka. The highest banana population and percentage of banana plants infested by BBTV was found in the Ogan Ilir district in Mas and Lilin cultivars.

Keywords: BBTV, Distribution pattern, insect vector, *Pentalonia nigronervosa,* plant diseases

1. Introduction

Banana (*Musa* spp.) is one of the most famous horticultural plants for direct or processed consumption [1, 2]. Bananas are spread worldwide and can grow in areas with a tropical climate [3,4]. People of South Sumatra widely cultivate bananas to meet their daily needs. Bananas are planted in the yard, riverbanks, roadside, fields, and garden [5]. The cultivated bananas are planted in intercropping and monoculture systems [3, 5], but most have not received intensive care, so banana production is still low. Bananas can be used to support food security in Indonesia [6, 7]. Bananas contain vitamins and minerals, which can increase energy for the human body [2]. However, the cultivation of banana plants is inseparable from the attack of plant pest organisms and the influence of abiotic factors [8,9]. Banana bunchy top virus (BBTV) is one pest that can cause a decrease in production and death of banana plants [10]. BBTV disease was first discovered in 1889 in Fiji, Oceania. BBTV is spread by the vector insect *Pentalonia nigronervosa* Coq. (Hemiptera: Aphididae)[11,12].

P. nigronervosa has a piercing-sucking mouthpart, so it can easily transmit BBTV to banana plants. This insect is a primary host in banana plants, so it can breed and live on bananas [13, 14]; it can be found in all parts of the banana plant, such as the base stem, young leaves, and leaf midribs. *P. nigronervosa* is very likely to transmit the BBTV virus on banana plants, in which the virus is stored in the intestine, hemolymph, and salivary glands. The development of *P. nigronervosa* can be influenced by temperature and humidity, so this insect is mainly found on the lower surface of banana plant leaves 15,16]. Because of the high humidity in the lower surface of banana plant leaves, the banana plant is suitable for *P. nigronervosa* as a place to eat, breed, and live. *P. nigronervosa* has a

wide host range and can be found in the family of Musaceae and Heliconiaceae. In Indonesia, several studies on BBTV and *P. nigronervosa* have been conducted by [22), which examined BBTV in wild bananas in West Java and in the distribution of Pentalonia and BBTV in Lampung [23]. BBTV disease is one of the diseases transmitted by *P. nigronervosa* Its symptoms were the edges of banana leaves will turn yellow, young banana leaves experience chlorosis, infected leaves experience green mosaic, new leaves grow narrow and upright, and bananas do not grow tall or bananas become stunted [11,14]. Bananas infected with BBTV experience impaired growth and development, and may cause bananas not to bear fruit. The fruit is small if the infected banana bears fruit [17]. *P. nigronervosa* transmits BBTV disease on banana plants, which causes a decrease in banana production and causes banana fruit to have no economic value [18]. The purpose of this study was 1) examine the presence of *P. nigronervosa* in banana plantation, 2) BBTV distribution

2. Methods

2.1. Research Location

The research location is an area in South Sumatra consisting of districts and cities. This research method was a survey in regencies and cities consisting of Ogan Ilir, Ogan Komering Ilir, Ogan Komering Ulu Timur, South Ogan Komering Ulu, Ogan Komering Ulu Induk, Palembang, Prabumulih, Banyuasin, Musi Banyuasin and Lubuk Linggau (Figure 1). These areas are characterized by banana cultivation. The areas surveyed were lowland with banana cultivation. The banana plants observed were grown in yards, roadsides, rice fields, and gardens by farmers.

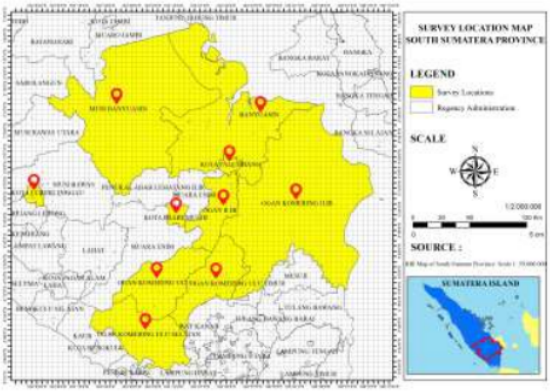

Figure 1. Sampling location of bananas in South Sumatra, Indonesia

2.2. Sampling Method

The purposive sampling method was used to determine sampling plants in districts and cities in South Sumatra. Sampling was conducted when BBTV-infested banana plants were found. The BBTV-infested banana plant was used as the midpoint of the sample area, and an imaginary circle line was drawn with a center line of 56 meters. Observations were about bananas infested by BBTV and *P. nigronervosa* in an area of ± 1 hectare. All banana varieties, the number of bananas and bananas infested with BBTV, and the number infested with *P. nigronervosa* were retrieved in sample areas. Subsequent sampling should be 120 meters away from the sample point taken as a point. Banana plants within the sample area center point were taken at coordinate points using a cellular phone camera with the Timestamp application. The observed variables were *P. nigronervosa* population, healthy and infested banana cultivars, and percentage of infested cultivars.

2.3. Data Analysis

Disease incidence was determined by counting the number of healthy plants and plants with damage, following the formula [19]

$$P = \frac{n}{N} x\ 100 \quad (1)$$

P = Incidence of disease BBTV; n = Number of diseased banana plants; N= Number of banana plants observed

3. Results

3.1. Population of P. nigronervosa

P. nigronervosa is a vector insect transmitting BBTV. It has piercing-sucking mouthparts. The body color of *P. nigronervosa* varies from reddish to slightly brownish and has different body sizes for each instar. *P. nigronervosa* has morphological characteristics of a brownish-red body. *P. nigronervosa* was found on three banana cultivars: Mas, Putri, and Lilin. The three banana cultivars have AA and AB genomes. BBTV most infested three banana cultivars in all cities and districts namely Putri, Lilin, and Mas cultivars the largest population of *P. nigronervosa* was found in Mas banana cultivar (973 individues); Lilin banana cultivar (157 individues); and Putri banana cultivar (61 individues). Population of *P. nigronervosa* was found in Ogan Ilir and OKU Induk districts (Table 1).

Table 1. Population of *Pentalonia nigronervosa* and severity of BBTV diseases

Banana Cultivar	Population of *P. nigronervosa* (individues)	Severity of diseases
Mas	973*	++
Cavendis	0	+
Putri	61**	+++
Lilin	157*	+++
Nangka	0	+
Ambon	0	+
Udang	0	+
Barangan	0	+
Kepok	0	+
Rotan	0	+
Raja	0	+

Notes: +++) high, ++) moderate, +) low, *) found in Ogan Ilir District, **) found in OKU Induk District

The symptoms of BBTV disease transmitted by *P. nigronervosa* were banana leaves changing shape to become smaller, edges of leaves turning yellow, while young banana leaves growing piled up and not scattered, and leaf bones being green as well. *P. nigronervosa* can be found on young and old plants ready to bear fruit. They transmitted BBTV disease from small to old plants. Large banana plants experience similar symptoms as small plants. Newly grown leaves accumulate on the banana plant, and the edges of the leaves turn yellow while the center of the leaves are green. The yellow leaves eventually turned entirely brown, and finally the leaf died. Banana plants infected with BBTV on the leaf midrib were crispy when broken. BBTV-infected bananas can cause the banana plant not to bear fruit and die. If banana plant bears fruit, the fruit does not grow normally, and the banana fruit becomes small (Figure 2).

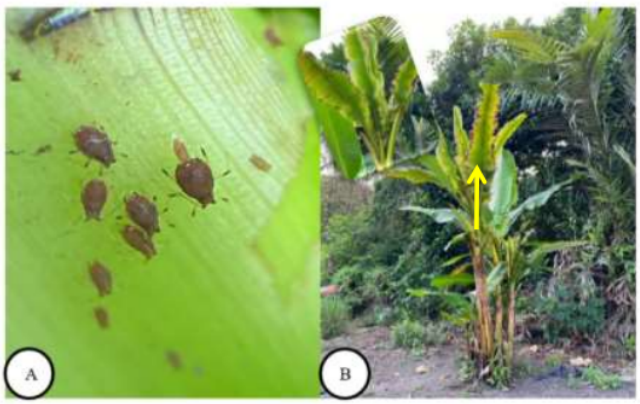

Figure 2. A. *Pentalonia nigronervosa* on banana plants, B. BBTV infestation symptoms on Banana Mas Variety.

P. nigronervosa Coq. is the most effective insect vector of BBTV. This insect is persistent in transmitting BBTV. This persistence allows the virus to survive in the insect's body for a long time. When this insect moves from sick to healthy plants, it can immediately transmit the disease. Transmission by *P. nigronervosa* is done by poking its stylet into the plant tissue. Through the stabbing, the insect sucks plant fluids, starting with the release of fluids in its body. The viral fluid released will enter the tissue of healthy banana plants. In addition, *P. nigronervosa* will breed on diseased plants and then move when the plant dies. These insects form wings when the population increases and food becomes scarce. *P. nigronervosa* can live and develop based on banana plants, the midrib, and young leaves. *P. nigronervosa* is easy to reproduce because it does not require male insects to reproduce on banana plants.

3.2. Banana varieties and *P. nigronervosa* infestation

There were 14 banana cultivars found to be infected with BBTV transmitted by *P. nigronervosa*., namely, Mas, Cavendish, Putri, Lilin, Nangka, Ambon, Udang, Barangan, Kepok, Gedah, Rottan, Raja, Kapas and Raja Nangka. The highest number of banana cultivars infected with BBTV was found in Ogan Ilir district (nine banana cultivars). In contrast, the lowest number of cultivars was found in OKU Selatan district, with only one cultivar. BBTV most infested three banana cultivars in all cities and districts namely Putri, Lilin, and Mas cultivars (Table 2).

The banana population observed in the study varied from one district to another districts. The highest observed banana population was in the Ogan Ilir district, with 3674 stems, while the lowest was in the Ogan Komering Ilir district, with 45 stems. The different banana populations in each district and city were influenced by the number of bananas infected with BBTV caused by *P. nigronervosa*. The greater the number of bananas observed, the higher the population of bananas and bananas infested with BBTV. The highest population of BBTV-infested bananas was found in Ogan Ilir Regency, with 1,226 banana stems. In comparison, the lowest population of BBTV-infested bananas with seven stems was found in Ogan Komering Ilir Regency (Table 3).

Table 2. Number of banana cultivars infested with BBTV caused by *P. nigronervosa*. in South Sumatera

Districts/cities	Number of cultivar-infected BBTV	Name of cultivars
Ogan Ilir	9	Putri, Cavendish, Mas, Lilin, Udang, Nangka, Gedah, Ambon and Tanduk
Ogan Komering Ilir	3	Putri, Mas, and Lilin
OKU Timur	5	Kepok, Lilin, Kapas, Raja Nangka and Putri
OKU Selatan	1	Putri
OKU Induk	5	Kepok, Putri, Gedah, Raja and Ambon
Palembang	5	Putri, Lilin, Cavendish, Barangan and Tanduk
Prabumulih	2	Lilin and Ambon
Banyuasin	7	Udang, Putri, Kepok, Lilin, Barangan, Gedah and Rotan
Musi Banyuasin	3	Lilin, Putri and Raja
Lubuk Linggau	4	Raja Nangka, Kapok, Mas, Lilin.

Table 3. Banana populations observed in South Sumatra

District/City	Population of banana plant (stems)			
	Total	healthy	Infected BBTV	infected (%)
Ogan Ilir	3,674	2,445	1,226	33.37
Ogan Komering Ilir	45	38	7	15.56
OKU Timur	369	259	110	29.81
OKU Selatan	215	195	20	9.30
OKU INDUK	430	380	48	11.16
Palembang	231	205	26	11.26
Prabumulih	970	947	23	2.37
Banyuasin	642	567	75	11.68
Musi Banyuasin	456	399	57	12.50
Lubuk Linggau	550	418	27	4.91

The highest percentage of BBTV infestation on banana plants caused by *P. nigronervosa* was in Ogan Ilir (35%), while the lowest one in Prabumulih (2.37 %). The percentage of BBTV infestation on banana plants can reduce the number of tillers and the banana population (Figure 3).

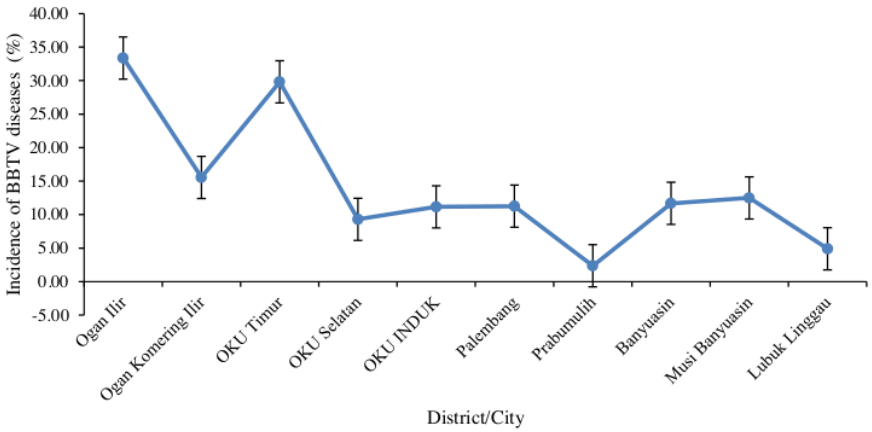

Figure 3. Incidence of BBTV disease on banana plants caused by *P. nigronervosa*

4. Discussion

These insects give birth to nymphs in the reproduction process because the embryo develops in the body of an adult insect. Adult insects will form wings when the population is dense, and the host is dead. *P. nigronervosa* has unique characteristics from the flea group; the body is blackish brown, has long antennae, and has dark-colored femurs [14]. Populations of *P. nigronervosa* were found on three banana cultivars, Mas, Putri and Lilin (Table 1). All of them grew in a clean environment near the house yard. Based on the results of research, a clean environment can make *P. nigronervosa* breed and lived on these cultivars [24]. In addition, the presence of *P. nigronervosa* can be characterized by the presence of red ants. In this symbiotic relationship, the ants utilized aphids because *P. nigronervosa* will secrete liquid honey dew which was a source of food for the ants [16].

The banana genome strongly influences the presence of *P. nigronervosa* [24]. Banana mas, Putri and Lilin cultivars were favoured by *P. nigronervosa*. Based on research, banana cultivars that have AA and AB genomes were most favored by *P. nigronervosa* [25]. In transmitting banana dwarf disease, *P. nigronervosa* secretes viruses inhaled simultaneously with infected fluids when this insect feeds [20]. Viruses inhaled by *P. nigronervosa* enter the gut of the insect. They are translocated to the hemocoel of the vector insect, and the viruses are released into plant tissues when saliva is produced during feeding [21]. Banana plants affected by BBTV disease have shrunken leaves and yellowing of the leaf margins. The leaves grow in an accumulation called a rosette [18]. Banana cultivars infected with BBTV in South Sumatra varied. The cultivars consisted of bananas that can be eaten immediately and bananas must be processed first to be eaten. Ogan Ilir district has the highest number of BBTV-infested bananas because the district is a major route for passing vehicles. It is suspected *P. nigronervosa* can be carried by the wind due to passing vehicles. Many of the banana cultivars planted were found to be directly edible banana cultivars. These cultivars were very susceptible to BBTV, and the community did not realize that their banana plants were unhealthy. Banana plants infected with BBTV were left alone by the community, and no special treatment was given to the disease.

The population of BBTV-infected bananas was also highest in Ogan Ilir District, because the observed population of bananas was also high. The spread of BBTV was very fast; probably, Ogan Ilir district was heavily travelled by transportation, which was thought to help spread *P. nigronervosa*. This insect has wings that can be carried by the passing winds of transformation, land on banana

plants, and transmit the disease. The percentage of BBTV infestation in Ogan Ilir district is the highest due to the high number of diseased plants. The level of BBTV infestation in the South Sumatera region varies due to the banana cultivars in the region. Banana cultivars greatly influence the population of *P. nigronervosa* in transmitting BBTV [18, 26].

5. Conclusion

P. nigronervosa was only found in Ogan Ilir and OKU Induk districts, but in fact this BBTV disease was spread in 10 districts and cities. A total of 14 banana cultivars in South Sumatera were infected by BBTV transmitted by *P. nigronervosa*, namely Mas, Cavendish, Putri, Lilin, Nangka, Ambon, Udang, Barangan, Kepok, Gedah, Rottan, Raja, Kapas and Raja Nangka. The highest banana population and percentage of banana plants infested by BBTV was found in the Ogan Ilir district in Mas and Lilin cultivars.

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