Sainmatika: Jurnal Ilmiah Matematika dan Ilmu Pengetahuan Alam
Volume 22 No. 2, December 2025 DOI 10.31851/sainmatika.v22i2.20009
https://jurnal.univpgri-palembang.ac.id/index.php/sainmatika

The Attack Level of *Banana Bunchy Top Virus* (BBTV) on Pisang Tanduk (*Musa paradisiaca* L.) in South Sumatera

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ABSTRACT

Pisang tanduk (*Musa paradisiaca* L.) is a plant with very abundant fruit. Banana horns are characterized by a fruit length that is longer than other types of banana, ranging from 25-30 cm. However, banana productivity is still very low due to the *Banana Bunchy Top Virus* (BBTV) disease. This research in 12 regencies/cities in the South Sumatra region. This research applies a purposive sampling method by determining the coordinates of the horn banana plantation and photographing them with a timestamp camera. The results of this field practice show that the symptoms of BBTV attacks are characterized by the presence of small/dwarf banana trees with hardened and straight/erect leaf veins facing the top and changing color to yellowish. The district/city with the largest percentage of attacks was in the Palembang area with 69% of the total number of bananas found. From this field practice it can be concluded that the distribution of horn bananas in the South Sumatra region is not evenly distributed. Communities should reduce the use of pesticides and continue to carry out land sanitation on banana plantations to reduce the population of weeds associated with pisang tanduk.

Keywords: BBTV, Percentage of attacks, Pisang tanduk

INTRODUCTION

Pisang tanduk are easy to grow and produce abundant fruit (Yuniwati *et al.*, 2011; Eveline & Hindarto, 2020; Mutmainnah *et al*., 2023). Pisang tanduk are characterized by their longer fruit length compared to other banana varieties, ranging from 25 to 30 cm. Another difference is that when boiled, horned bananas become more chewy, can produce oil, and have a less sweet taste when eaten. The fiber content in horned bananas also helps lower bad cholesterol levels, thereby optimizing heart function (Ajeng *et al*., 2023; Nirmagustina *et al*., 2024; Rakhmawati *et al*., 2022; Ranjha *et al*., 2022). The lignin content in banana peel typically increases as the fruit ripens, with the protein content of dried banana peel ranging from 6-9% (Hospital *et al*., 2018; Kumari *et al*., 2023; Rawat *et al*., 2024). However, the productivity of pisang tanduk remains very low. The decline in production is primarily due to improper cultivation techniques and pest and disease infestations, particularly banana dwarf disease (Balqis, 2021).

Banana dwarf disease is a dangerous banana disease caused by the *Banana Bunchy Top Virus* (BBTV)

(Arimbawa *et al*., 2022; Chakraborty *et al*., 2021; Palma *et al*., 2022; Rahayuniati *et al*., 2021). Once infected, this disease is extremely difficult to control or eradicate. *Banana Bunchy Top Virus* (BBTV) belongs to the genus Babuvirus of the family Nanoviridae, which has a single-stranded DNA genome and is naturally transmitted to plants through various species of thrips via non-propagative circulatory transmission (Tricahyati et al., 2022b). Symptoms of banana plants infected with the dwarf virus include the formation of broken greenish-brown lines or spots along the leaf veins, stiffer leaves, narrower leaf blades, and leaves that are easily broken (Hahuly *et al*., 2025; Nelson, 2004; Sutrawati & Ginting, 2020). The virus is persistently transmitted to banana plants by *Pentalonia nigronervosa* (Pertiwi *et al*., 2022; Robson *et al*., 2007).

P. nigronervosa Coquerel (Hemiptera: Aphididae), known as the banana aphid, is believed to originate from Southeast Asia and is currently found in almost all banana plantations (Foottit *et al*., 2010; Mathers *et al*., 2020). Like most aphids, *P. nigronervosa* obtains its food by inserting its long stylet directly into the phloem vessels and sucking the fluid from within those vessels (Suparman *et al*., 2015). This can cause plants to exhibit deformities such as curling or wrinkling, although such deformities are very rarely observed in banana plants. *P. nigronervosa* is economically significant due to its role as a vector for the banana bunchy top virus (BBTV) (Foottit *et al*., 2010; Hospital *et al*., 2018; Kumari *et al*., 2023; Mathers *et al*., 2020). The purpose of this research is to investigate the symptoms of Banana Bunchy Top Virus (BBTV) infection in horn bananas in the South Sumatra region.

MATERIALS AND METHODS

This research was conducted in districts/cities located in the South Sumatra region. The tools and materials used in this study were questionnaires, measuring tapes, writing instruments, cameras, and banana cultivars of the horn variety that showed symptoms of *Banana Bunchy Top Virus* (BBTV) (Figure 1). The method used in this study was purposive sampling to determine the coordinates of the horn banana plantation. Then, observation and participatory techniques were used to observe plants showing symptoms of BBTV.

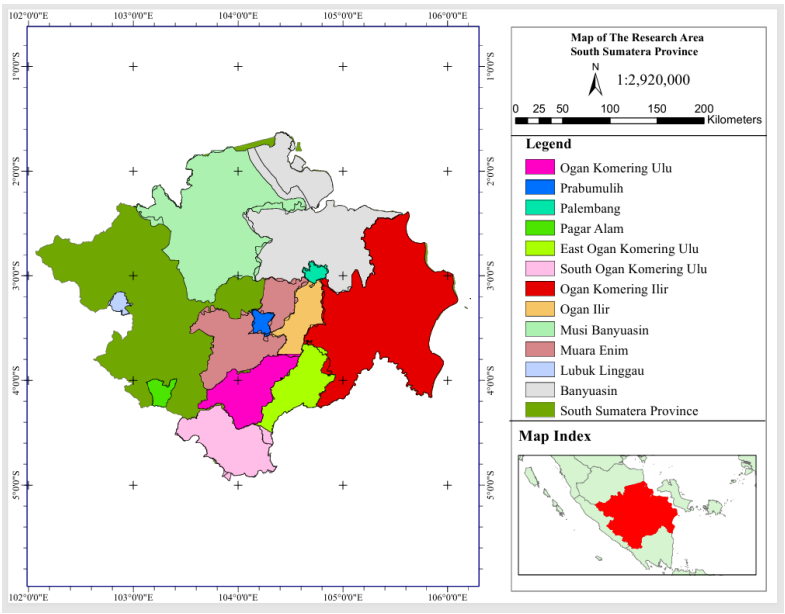

Figure 1. Location of observations in the Province of South Sumatra

The research location was determined purposively (Purposive sampling) in the regencies/cities of South Sumatra, consisting of Musi Banyuasin Regency, Banyuasin Regency, Palembang City, Ogan Ilir Regency, Ogan Komering Ilir Regency, OKU Timur Regency, OKU Induk Regency, Prabumulih City, Muara Enim Regency, Lahat Regency, and Lubuk Linggau City. A survey was then conducted to directly identify banana plants infected with the BBTV virus. Field data collection was carried out by determining the center point of an imaginary circle for sampling from banana plants already infected with BBTV. The first cluster of banana plants used as the center of the imaginary circle was the BBTV-infected banana, while the second cluster and subsequent clusters were banana plant clusters within the imaginary circle with a radius of 50 m and a diameter of 100 m (Figure 2).

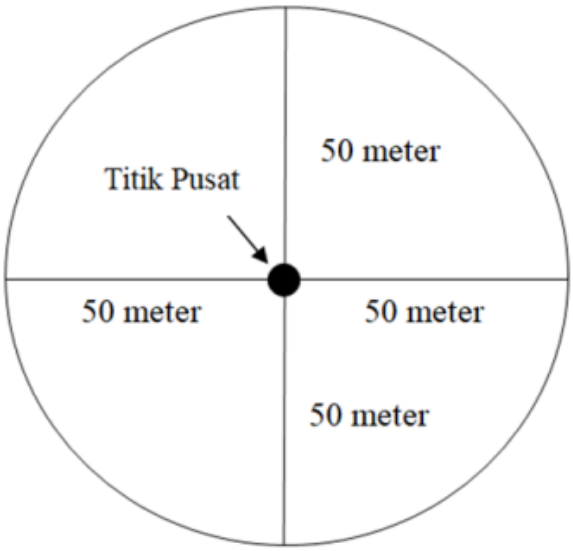

Figure 2. Imaginary circle for sampling horn bananas

In this research, all banana plants within the imaginary circle were observed to see whether they showed symptoms of BBTV infection. In addition to symptoms, the presence of Pentalonia nigronervosa leafhoppers was also an important reference point that needed to be observed. Data collection in the form of coordinate data for all horned bananas was aimed at determining the pattern of distribution of plants infected with BBTV. The number of clumps refers to the number of clusters of horned banana plants growing together in a certain area. In addition to observing the number of clumps, this study also observed the number of banana plant stems. The number of stems refers to the total number of banana stems in each clump observed. From each banana plant whose coordinates had been determined, the total number of stems in one clump was then calculated. The dwarf disease vector was examined on the observed banana plant parts. The location of these leafhoppers can be found on the tips or shoots of banana plants, characterized by their black or reddish-brown color and oval shape. The percentage of infestation was observed on all infected banana plants. The percentage of plants infected with dwarf disease (BBTV) can be

calculated using the formula: (Prabaningrum dan Moekasan, 2016):

$$I = \frac{n}{N} 100\%$$

Notes:
I = Attack Intensity (%)
n = Number of Plants Affected by Pests
N = Number of Plants Observed

Data Analysis

The data analyzed in this study were banana plants that showed symptoms and were infected with Banana Bunchy Top Virus (BBTV). All analyzed data will then be presented descriptively in the form of tables and figures.

RESULTS AND DISCUSSION

The most easily recognizable symptom of BBTV infection is the presence of small/dwarf trees that differ from normal trees, with hardened leaf veins that are straight/upright and facing upwards (Figure 3). The leaves of horned bananas will undergo a color change, with the edges of the leaves and leaf veins turning yellowish. In more severe attacks, banana plants may be found dead as a result of the banana dwarf disease. Dwarf disease is not only found in bananas that have borne fruit, but also in banana suckers. This is because banana dwarf disease is transmitted by the leafhopper vector Pentalonia nigronervosa or can also be spread through vegetative propagation materials (shoots, suckers, or tissue culture plantlets). Therefore, it is possible that the shoots/suckers from the observed horned bananas have also been infected with BBTV.

Figure 3. Banana tanduk (A) Healthy and (B) infected with BBTV

The results obtained in this study were conducted in the South Sumatra region. The areas affected by BBTV on horned bananas include Lubuk Linggau,

Musi Rawas Utara, Prabumulih, and Palembang. The area with the highest number of clusters was Prabumulih, with 27 clusters, while the areas with the fewest clusters were Lubuk Linggau and Palembang, each with 16 clusters (Table 1).

Table 1. Number of pisang tanduk clusters in South Sumatra

District/city	Subdistrict/ Village	Coordinate Point		Altitude (M)	Number of Clusters
		Longitude (S)	Latitude (E)		
Lubuk Linggau	Batu Urip	3° 16' 0"	102° 53' 35"	124,4	8
	Siring Agung	3° 15' 5"	102° 55' 49"	104,4	8
Musi Rawas Utara	Tanjung Beringin	2° 49' 44"	102° 49' 29"	58,4	3
	Noman Baru	2° 48' 47"	102° 50' 6"	54,2	1
	Noman Baru	2° 48' 47"	102° 50' 6"	54,2	4
	Beringin Jaya	2° 45' 10"	102° 52' 57"	53,0	4
	Lawang Agung	2° 41' 19"	102° 53' 41"	59,0	1
	Lawang Agung	2° 41' 19"	102° 53' 41"	59,0	2
	Karang Waru	2° 41' 8"	102° 53' 26"	52,6	2
Prabumulih	Karang Raja	3° 27’ 20"	104° 14’ 6"	56,2	4
	Karang Raja	3° 27’ 20"	104° 14’ 6"	52,0	5
	Karang Raja	3° 27’ 20"	104° 14’ 6"	55,6	6
	Wonosari	3° 25' 41"	104° 13' 34"	58,8	12
Palembang	Kebun Bunga	2° 54' 54"	104° 43' 15"	13,7	1
	Kebun Bunga	2° 54' 54"	104° 43' 15"	13,7	4
	Kebun Bunga	2° 54' 54"	104° 43' 15"	13,7	5
	Kebun Bunga	2° 54' 54"	104° 43' 15"	13,7	6

The percentage of horned banana clusters in the Prabumulih area is 36%, Musi Rawas Utara is 22%, Palembang and Lubuk Linggau are each 21%. (Figure 4).

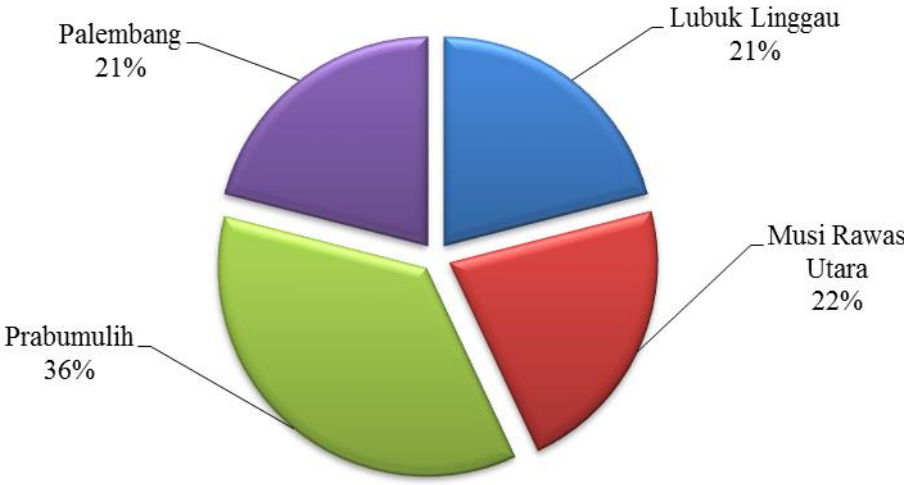

Figure 4. Percentage of pisang tanduk banana clusters in South Sumatra

The results of the survey conducted during the research activity in the province of South Sumatra. The district/city with the highest percentage of attacks was Palembang City, accounting for 28% of the total number of bananas found. Meanwhile, in Lubuk Linggau, Musi Rawas Utara, and Prabumulih, the attack percentage is the same at 0%. This makes Palembang City have a 100% attack percentage and higher than other districts/cities. The highest number of pisang tanduk trees is found in Palembang City, with a total of 32 trees, 23 healthy pisang tanduk trees, and 9 infected horned banana trees. Meanwhile, the fewest number of banana trees is found in Lubuk Linggau, with 20 trees, 20 healthy banana trees, and 0 infected banana trees (Table 2).

Table 2. Percentage of BBTV attacks on pisang tanduk plants in South Sumatra

District/city	Number of Stems	Number of Stems		Percentage (%)
		Healhty	Attacked	
Lubuk Linggau	20	20	0	0
Musi Rawas Utara	25	25	0	0
Prabumulih	26	26	0	0
Palembang	32	23	9	28

Based on the survey results during the research, the percentage of BBTV attacks on pisang tanduk can be determined by calculating the number of healthy stems and the number of infected stems, which then yields the percentage of BBTV attacks on horned bananas. The district/city with the highest percentage of attacks is Palembang City at 69%. Meanwhile, the regions of Lubuk Linggau, Musi Rawas Utara, and Prabumulih have the same infestation percentage of 0% (Table 3).

Table 3. Percentage of BBTV attacks on pisang tanduk in South Sumatra

District/city	Subdistrict/ Village	Coordinate Point		Altitude (M)	Number of Stems		Percentage (%)
		Longitude (S)	Latitude (E)		Healhty	Attacked	
Lubuk Linggau	Batu Urip	3° 16 '0"	102° 53' 35"	124,4	16	0	0
	Siring Agung	3° 15' 5"	102° 55' 49"	104,4	4	0	0
Musi Rawas Utara	Tanjung Beringin	2° 49' 44"	102° 49' 29"	58,4	4	0	0
	Noman Baru	2° 48' 47"	102° 50' 6"	54,2	1	0	0
	Noman Baru	2° 48' 47"	102° 50' 6"	54,2	4	0	0
	Beringin Jaya	2° 45' 10"	102° 52' 57"	53,0	4	0	0
	Lawang Agung	2° 41' 19"	102° 53' 41"	59,0	7	0	0
	Lawang Agung	2° 41' 19"	102° 53' 41"	59,0	0	0	0
	Karang Waru	2° 41' 8"	102° 53' 26"	52,6	5	0	0
Prabumulih	Karang Raja	3° 27’ 20"	104° 14’ 6"	56,2	7	0	0
	Karang Raja	3° 27’ 20"	104° 14’ 6"	52,0	7	0	0
	Karang Raja	3° 27’ 20"	104° 14’ 6"	55,6	3	0	0
	Wonosari	3° 25' 41"	104° 13' 34"	58,8	9	0	0

p-ISSN 1829 586X
e-ISSN 2581-0170

Palembang	Kebun Bunga	2° 54' 54"	104° 43' 15"	13,7	13	9	69
	Kebun Bunga	2° 54' 54"	104° 43' 15"	13,7	5	0	0
	Kebun Bunga	2° 54' 54"	104° 43' 15"	13,7	6	0	0
	Kebun Bunga	2° 54' 54"	104° 43' 15"	13,7	8	0	0

The percentage of pisang tanduk stems in the South Sumatra region shows that Palembang Regency has the highest percentage at 100%, Musi Rawas Utara at 0%, Prabumulih at 0%, and Lubuk Linggau at 0%. (Figure 5). The number of banana plants affected refers to the number of banana plants per plant found to be infected with dwarf disease (BBTV), calculated based on the visual appearance of the symptoms observed on the infected plants. Infected banana plants can be identified by the difference in size compared to healthy banana plants**.**

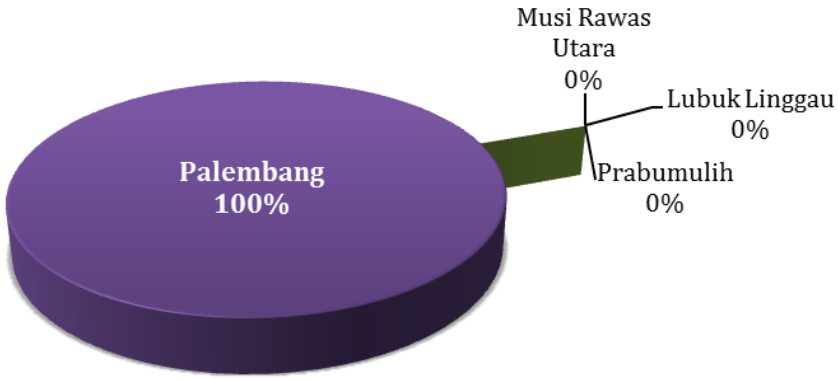

Figure 7. Percentage of banana tree trunks affected by BBTV in South Sumatra

This research was conducted in districts/cities located in the South Sumatra region (Musi Banyuasin District, Banyuasin District, Palembang City, Ogan Ilir District, Ogan Komering Ilir District, East OKU District, OKU Induk District, Prabumulih City, Muara Enim District, Lahat District, North Musi Rawas, and Lubuk Linggau City). This research was conducted in Palembang Regency/City, which has the highest percentage of BBTV attacks on horned bananas. The research observations were conducted through direct surveys and interviews with local communities regarding the availability of horned bananas. Horned bananas are known to be very beneficial for bone and brain health, such as improving liver health, increasing red blood cell count, and alleviating asthma symptoms. Banana trees can serve as an energy source for the body and can be used as a substitute for rice (if necessary) (Sirappa, 2021). Temperature is the primary factor influencing the growth of banana trees. Banana trees can grow well in open fields, but excessive exposure to sunlight can cause their leaves to burn easily.

The cultivation of horned bananas was observed at the research site, but not many plantations were found to be cultivating this variety. The population of this banana variety is relatively rare compared to other banana cultivars such as wax bananas, which can be easily found in almost every plantation (Arifki & Berliana, 2018). During the survey of local community-owned plantation land, most of the land found was overgrown

with wild plants that nearly covered parts of the banana trees. The presence of these weeds may also indicate a higher intensity of BBTV infestation compared to sanitised land (Irwansyah *et al*., 2019). Visually, banana plants infected with BBTV can be distinguished by changes in leaf colour, with the edges and veins of the leaves turning yellow. BBTV infection symptoms can be categorised into three levels: severe, moderate, and mild.

BBTV disease in banana trees is one of the diseases that causes fatal damage to banana plants, from leaf growth to banana fruit production. Serious BBTV virus infection prevents bananas from producing fruit, which ultimately leads to a decline in fruit production. Once a plant is infected with BBTV, it cannot be cured (Irwansyah *et al*., 2019). The banana dwarf virus can infect banana plants of various ages. The younger the banana plant, the more susceptible it is to banana dwarf virus infection. BBTV infection can inhibit banana plant growth in terms of plant height, leaf width, and root size. Various measures can be taken to prevent BBTV infection in banana trees. The first step is to select banana seedlings from tissue culture that are guaranteed to be free of BBTV. Next, systemic insecticides can be applied alternately, especially when the trees are still young. The most important and effective method for controlling BBTV is through the eradication/destruction of infected plants by uprooting and destroying banana plants that have been infected. Since the BBTV host is only banana plants, eradicating infected banana plants reduces the opportunity for leafhoppers to obtain the virus source and prevents the spread of BBTV-infected plant material among the community.

In the field, BBTV was found to be associated with leafhoppers, which are pests that attack bananas. The presence of leafhoppers cannot be separated from BBTV, as leafhoppers are the primary vectors in the spread of BBTV (Tricahyati *et al.*, 2022a). Like most leafhoppers, *P. nigronervosa* obtains its food by inserting its long stylus directly into the phloem vessels and sucking the fluid from within those vessels. This can cause the plant to undergo deformations such as curling or wrinkling (Suparman *et al*., 2015). To become an infectious vector, *P. nigronervosa* must feed on plants infected with the banana dwarf virus.

However, it is not only leafhoppers that are known to be pests of bananas; there are also other species such as the banana leaf roller caterpillar (*Erionota thrax*), the weevil (*Leucopholis rorida*), the banana stem borer beetle (*Cosmopolites sordidus*), banana fruit caterpillars (*Tiracola plagiata*), moths (*Nicoleia octacema*), banana fruit flies (*Bactrocera dorsalis*), and nematodes (*Rotulenchus similis*). These pests are found on leaves, stems, roots, and banana fruits, which can increase losses and reduce banana production in the market. The pests that most commonly attack banana populations are leaf mites and banana leaf rollers. In addition to pests, there are natural enemies commonly found for leaf mites, such as spiders (*Naphrys* sp), predatory beetles (*Harpactorinae* sp.), ladybirds (*Coccinella transversalis*), *Menocchilus sexmaculatus*, *Scymnus* sp., *Dioprosopa* sp., *Micraspis discolor*, *Verania lineata*, *Micraspis hirashimai*, and *Coelophora* sp. The presence of predators as natural enemies can reduce the population of pests that disrupt banana cultivation, although the spread of these pests cannot be completely eliminated from local community plantations. The most commonly found natural enemy of leafhoppers is the coccinella beetle.

p-ISSN 1829 586X
e-ISSN 2581-0170

CONCLUSIONS

The distribution of horned bananas in the South Sumatra region is not yet evenly spread, as only 4 out of 12 districts/cities have horned banana populations, namely Lubuk Linggau District, North Musi Rawas District, Prabumulih District, and Palembang District. The largest population of horned banana clusters is found in Prabumulih District, with 27 clusters. The highest number of horned banana stems is found in Palembang District, with 32 stems. The region with the highest percentage of BBTV infestation is Palembang District, at 69%.

ACKNOWLEDGEMENTS

This research was supported by the Student and Lecturer Research Team, Programme Study Plant Protection, Faculty of Agriculture, Sriwijaya University.

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