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First report of Banana bunchy top disease (BBTD) on Banana (Saba variety) in Cagayan Valley Region, Philippines

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Abstract

The study on the occurrence and symptomatology of banana bunchy top disease (BBTD) was conducted to determine the occurrence and study the symptoms and associated signs that characterized BBTD in the banana farms in the province of Cagayan, Philippines. A survey and mapping were used to the major banana growing municipalities namely: Allacapan, Lasam, Gattaran and Baggao, in the province of Cagayan, North-eastern part of the Philippines. The data were analyzed using the frequency counts, weighted means, and percentages. The geo-referenced locations of the banana farms were analyzed using the QGIS software. BBTD - infected plants were described, occurrence was mapped and associated insect vector was investigated. Results revealed that the most observable symptoms in the field involved stunting, ragged margins, upturned leaves, chlorotic reducing lamina width, petiole length and distance of the leaves. The whole growing banana plants may grow but obviously resulting to stunting. Banana crops that are infected with BBTV in the vegetative phase will not produce fruit. Black aphids (*Pentalonia nigronervosa*) are found always associated with the banana plants and thus transmit the virus. Occurrence of BBTD was determined in September 2020 to September 2021 at Allacapan, Lasam, Gattaran and Baggao, Cagayan barangays/locations while typical symptoms of BBTD were first observed in all of the banana growing locations in the province of Cagayan, Philippines. Symptomatology and association of aphids confirmed the presence of BBTD. This is thought to be the first report of BBTD on banana (*Musa* spp.) in the province of Cagayan, Philippines.

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Introduction

In the Philippines, banana is one of the most important fruit crops (Damasco *et al.*, 2019). In Cagayan Valley, banana is the prime commodity under fruit crops. Like, any important crop, banana is attacked by pests and diseases. To date, the most devastating virus disease affecting yield losses of banana plantations in Africa, the South Pacific, and Asia, like the Philippines, is the banana bunchy top disease (BBTD) caused by the Banana bunchy top virus (BBTV). However, the incidence and distribution of BBTD have never been reported in Cagayan Valley Region, Philippines. From 2010 to 2012, the Philippine production of banana with more than 9.2 million metric tons, followed by a sharp decline in 2013 as a direct result of the damage wrought by typhoon Pablo. In terms of area planted, from a high of about 454,000 hectares in 2012, this declined to about 446,000 hectares in 2013 and further down to 443,000 hectares in 2014 and 2015 (PSA, 2014-2017). The most significant commercial production are located in Davao Region in Mindanao and Cagayan Valley in Luzon.

In Cagayan Valley, banana is the prime commodity under fruit crops. During the first quarter of 2019, the production was pulled down by 45.48%, with a shortage of 15,680 metric tons from 2018 of 34,481 metric tons due to super typhoons *Omping* and *Rosita* in second semester of 2018 (PSA, 2019). Aside from the typhoon, other factors, such as changing weather patterns, pests, and diseases, affect the production of bananas. One of the significant constraint diseases is the banana bunchy top disease.

Banana bunchy top disease (BBTD) caused by the banana bunchy top virus (Babuvirus, Nanoviridae) is one of the most economically important diseases of bananas in many production regions of the world, including the Philippines (Dale, 1987). Banana plants can only be infected from (1) infected plant materials and (2) the banana aphid when carrying the virus. When people give away young banana plants or suckers to others, the BBTV can spread (Johansen, K *et al.*, 2014).

The virus is transmitted in a persistent and circulative but non-propagative manner by the banana aphid, *Pentalonia nigronervosa* (Hafner *et al.*, 1995, Hu *et al.*, 1996). The aphid is a tiny black insect that, once feeding on an infected banana plant, becomes a carrier of the BBTV. The wind can carry many kilometers of aphids, which may further spread the BBTV. Hook *et al.*, showed that the incubation period of BBTV or the appearance of symptoms in banana plants ranged from 25 to 85 days after aphid inoculation (Johansen, K *et al.*, 2014). Initial symptoms in infected plants include marginal chlorosis, dark green dots, and streaks along the veins that often extend down the midrib and petiole. Infected plants become progressively stunted with malformed and more upright leaves, eventually resulting in a 'bunchy' appearance. Plants infected early with BBTV do not bear fruit, and fruits of later infected plants are typically deformed and unmarketable.

Hence, yield losses in severely infected plants can be as high as 100%. The virus is systemic, meaning that the disease is transmitted from the infected mother plant to subsequent suckers, and eventually, the whole mat dies (Hong-Ji, 2000b). Additionally, the virus spreads to suckers through the rhizome, and the entire banana mat eventually becomes infected (Dale and Harding 1998). It has been reported that the rate of BBTV re-infection in the field ranges from 5% in well-managed farms to 20% and 75% in medium- and traditionally-managed farms, respectively (Magnaye and Espino, 1990).

This study deals with the occurrence of the banana bunchy top in the major banana-producing areas in Cagayan province using GIS. Through GIS, it can capture, store, check, and display data related to positions on Earth's surface. GIS can show many different kinds of data in one map, enabling people to see, analyze, and understand patterns and relationships (Gonzales A.T. *et al.*, 2018). Since this research determined the distribution of BBTD in Cagayan province, the use of GIS is deemed needed.

Generally, this study determined the occurrence and distribution of banana bunchy top disease (BBTD) in banana plantations in Cagayan province, specifically

in the municipalities of Allacapan, Lasam, Gattaran and Baggao using Geographic Information System (GIS). Specifically it aimed to determine the distribution and prevalence of BBTB and examine, describe, and document the BBTB symptoms from BBTB banana plantations in the Cagayan province.

Materials and methods

Survey and BBTB mapping

Site selection

Banana areas with historical BBTB infection in the major banana growing areas in the Cagayan Valley region were considered in the survey. The roving survey was conducted to ascertain percent disease incidence in banana farms in the municipalities of Cagayan. The specific location for the survey was selected after consulting the Department of Agriculture and the Municipal Agriculture Office.

Baseline Data Gathering for Banana Plantation

The data was collected based on records of all reported banana growers and farmers in the province. The banana plantations were then validated by reconnaissance survey with the aid of Global Positioning System (GPS). The occurrence of BBTB was the prime focus of the survey. The survey was dependent on the top banana growers and top banana plantations determined in baseline data gathering. The number of respondents was pre-determined based on the initial data generated.

Reconnaissance Survey

The banana plantations were then validated by reconnaissance survey with the aid of Global Positioning System (GPS) and a surveyform developed by National Mapping and Resource Information Authority (NAMRIA). The surveys determine geographic locations (using GPS) and the agricultural land use systems of banana farmers and growers (using NAMRIA survey form). Land use (banana) systems data gathered were capital intensity, market orientation, labor intensity, mechanization and power usage in relation to mechanization, farm size, infrastructure requirements, cropping characteristics and cultural management practices including nutrient and pest

managements, harvest and post-harvest operations, land preparation and water management.

Spatial Analysis

All data to be gathered including the geo-referenced banana locations and the qualitative data was spatially analyzed using Quantum Geographic Information System 2.18.4 (QGIS 2.18.4) software. The software was also used to generate the banana map of Cagayan province.

Disease distribution and incidence of BBTB

Disease surveys and mapping was conducted on three (3) major banana farm locations in each municipality (a total of 90 municipalities) in the province of the Cagayan. Important data like banana variety distance of planting, age of banana plants and related cultural practices were gathered. Associated and related pathogen that was encountered during the survey /detection and diagnosis was gathered and its relationship to the disease development was elaborated during the conduct of the experiment.

For disease incidence, from each municipality, three plantations were located to cover the total banana plantations for this survey. Samples were collected from individual field to confirm the disease and numbers of infected plants was counted to calculate the percentage disease incidence. The percent disease incidence was recorded at random in different locations by counting number of plants infected out of total number of plants observed using the formula given below:

$$\text{Per cent (PDI)} = \frac{\text{No. of plants infected}}{\text{Total no. of plants observed}} \times 100$$

Detection of BBTB

This study on BBTB affecting banana in Cagayan province was carried out at the Plant Pathology Laboratory at the Institute of Plant Breeding (IPB) at the University of the Philippines, Los Baños, Laguna.

Results and discussion

Site selection

The site selection was based from the results of the gathered secondary data at the Office of the Provincial

griculturists (OPA) at Cagayan. The banana areas with historical BBTVD infection in the major banana growing areas were considered in the survey. The list of banana growers were gathered and verified through actual visits to the different municipalities of Cagayan. Four municipalities were selected in Cagayan province namely: Allacapan, Lasam, Gattaran and Baggao. After gathering all the list of potential growers courtesy calls and orientation was conducted at the Office of the Municipal Agriculturist (OMA).

BBTVD disease incidence

The highest disease incidence was observed in Baggao Cagayan with 44% followed by 16% in Lasam and Allacapan and the lowest is in Gattaran with 10.5%. The disease incidence was based on the farmers experiences on the field. The disease commonly called by the farmers "tungro". The disease incidence was validated during the actual field mapping using the GPS geo tracker app (Fig. 1).

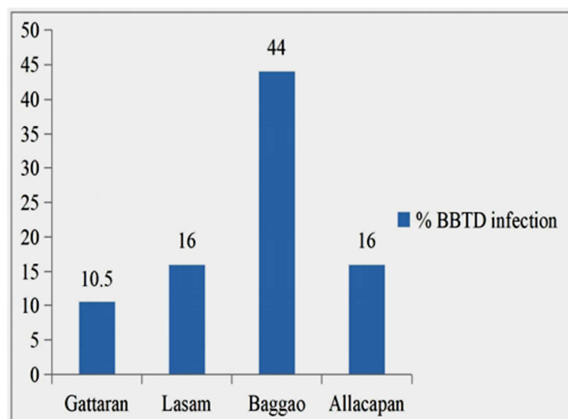


Fig. 1. The disease incidence was validated during the actual field mapping using the GPS geo tracker app.

Typical BBTVD symptoms vector associated

Typical banana plants with stunted growth, short, bunched leaves (Fig. 2.c), with the "Morse-code" patterns (dot-dash) symptom (Fig. 2.d); and j-hooks pattern towards the leaf mid ribs. Yellowing of the leaf margins also suggests BBT, though this can be caused by other problem (Fig. 2.a&b). According to local banana farmers in Cagayan, these abnormalities in the their banana plants have been observed many years ago spread through their planting materials. This is also the historical and background of BBTVD

that the disease persist since the first time is was discovered. BBTVD was first recorded in Fiji in 1879 and has spread to number of countries in the south Pacific, Asia and Africa (Magee, 1927, Thomas, and Iskra-Caruana, 2000; Geering 2009a). In the survey, the black aphids scientifically known as *Pentalonia nigronervosa* was found associated with banana bunchy top disease and symptoms in the survey. The findings corroborate with the report of Magee, (1927); Thomas, and Iskra-Caruana, (2000); and Geering (2009a) that three species of aphid, *Aphis gossypii*, *Rhopalosiphum maidis* and *Pentalonia nigronervosa* are known to transmit the virus in a non- persistent manner through plant to plant transmission.

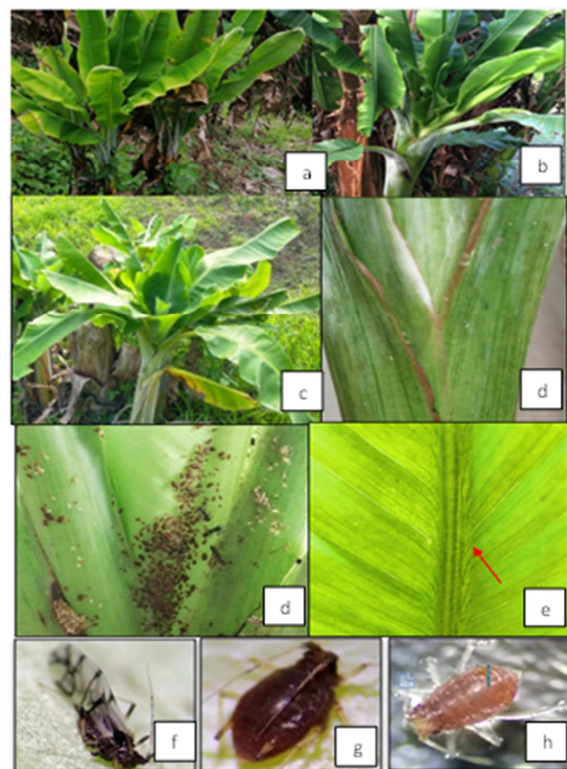


Fig. 2. Typical symptoms of BBTVD in banana (a-b). yellowing of the leaf margins ; (c) stunted growth (d) Morse-code"or dot-dash symptom (e) j-hook toward midrib and (f) male; (g) female adult and (i) nymph of *Pentalonia nigronervosa*.

BBTVD was first recorded in Fiji in 1879 and has spread to number of countries in the south Pacific, Asia and Africa (Magee, 1927, Thomas, and Iskra-Caruana, 2000; Geering 2009a). Accordingly, S. V. Balasubramanian (2014), explained that aphids retain infective, after removal from a virus source, for at

least 20 days and probably for life. Both nymphs (Fig. 2 h) and adults (Fig 2f & g) can acquire the virus, though more efficiently by the former, and reported transmission rates for individual aphids are in the range 46–67%. However, there is no evidence for transmission of BBTV to parthenogenetic offspring or for replication of the virus in the aphid. Magee 1940b, Hu *et al* 1996, Anhalt and Almeida 2008). BBTV is also efficiently transmitted in vegetative planting material, both conventional corms, corm pieces (bits) and suckers, and through micropropagation. All meristems from an infected corm will eventually become infected.

Mapped banana farms in selected municipalities at cagayan province

The map shows the BBTD infection at Brgy Capagaran, Allacapan, Cagayan. The BBTD incidence showed 19.29% which means that the infection is nearly to the economic impact of about 20% of the BBTD incidence. The GPS recordings of banana plantations in the four barangays were collected on third week of October 2020 to second week of March 2021 using the geo-tracker app installed in the smart phones. The 25% of the total population of the plants in an area was the basis in tracking the sample plants.

For Brgy Capagaran and Capalutan, a BBTD infection was observed as shown on the Fig. 3, a-b. A mat that contained at least one plant with visible BBTD symptoms was considered as infected. In barangay Capagaran,, the presence of aphids was also observed. This aphid is the carrier of this banana bunchy top virus disease. The GPS recordings of banana plantations in two barangays were collected on second week of April 2021. As shown on the fig.s, there is a BBTD infection. A total of 15 hectares were mapped in these barangays.

Summary

In Cagayan province, a study was conducted to determine the occurrence and distribution of banana bunchy top disease in the banana farms using the Geographic Information System (GIS). A survey and mapping were used to the major banana growing municipalities namely: Allacapan, Lasam, Gattaran

and Baggao. The BBTD samples were collected and tracked during the actual visits in the banana farms. The gathered data from the respondents were analyzed using the frequency counts, weighted means, and percentages. The geo-referenced locations of the banana farms were analyzed using the QGIS software.

Results revealed that the banana growers had no management to the BBTD or commonly called “tungro”. For the yield, majority of the banana growers in Allacapan had a yearly harvest ranging from 1000-5000 kilograms which means that low yield was obtained by the farmers. The GPS recordings of the banana farms were collected from March to May 2021. This was used to generate map for Gattaran and Allacapan. The map generated shows BBTD infection. Therefore, a further trial on the collected samples, the symptomatology to detect the presence and type of virus should be conducted. Furthermore, training on the banana production and BBTD identification and its management shall also be conducted.

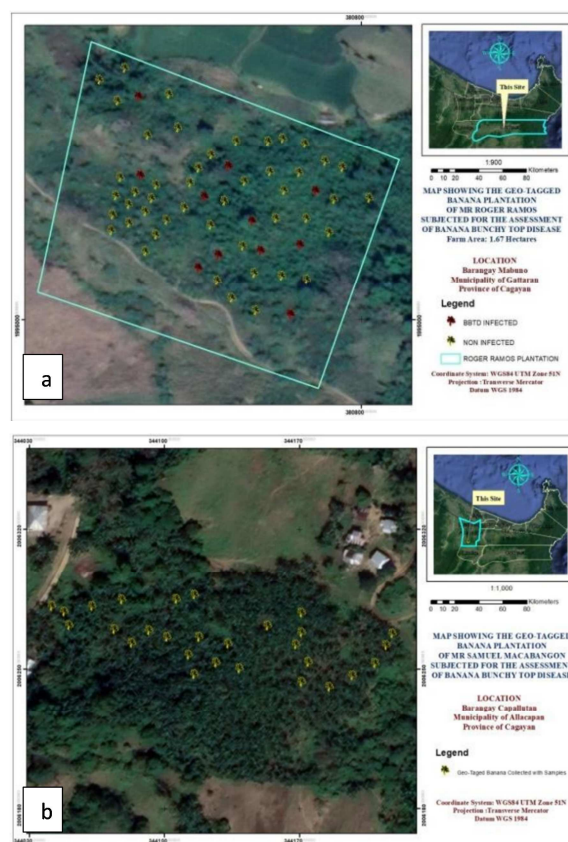


Fig. 3. Mapped indicating the surveyed areas at (a) Capagaran, Allacapan; (b) Capalutan, Allacapan; in Cagayan.

Conclusion

Based on the results of the study, the actual field visits and tracking of the banana samples using the geo tracker application was a reliable technique in assessing the visual symptoms of the banana bunchy top virus diseases (BBTVD). It is concluded that the areas with banana bunchy top disease (BBTD) were in Piña Weste, Piña Este, San Carlos and Mabuno, Gattaran and Mapurao, Capagaran, Capalutan and Nagattatan in Allacapan, Cagayan.

Recommendations

It is recommended that a follow up study would be conducted to confirm with the results. Likewise, another study would be recommended to continue the surveillance of this disease and to DNA sequence of the virus to confirm the results not only to the covered municipalities but to all banana farms in the province. It is further recommended that to control the widespread of this disease, training on BBTVD identification and its management shall be conducted to all banana farmers. Moreover, training on banana production shall be included also to create awareness on the recommended practices for banana production.

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