

Original Research Article

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Study of Bunchy Top of Banana Virus (*BBTV*) and its Control by Integrated Disease Management (IDM)

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ABSTRACT

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India is the top country by Banana production in the world as of 2019, bananas production in India was 30.5 million tonnes that accounts for 26.02% of the world's bananas production. The top 5 countries (others are China, Indonesia, Brazil, and Ecuador) account for 53.94% of it. The world's total bananas production was estimated at 117 million tonnes in 2019. In India, states like Andhra Pradesh, Gujarat, Tamil Nadu, Maharashtra, Kerala, Uttar Pradesh, Bihar and Madhya Pradesh contribute more than 70 per cent of the country's banana production. Banana and plantain (*Musa spp.*), produced in 10.3 million ha in the tropics, are among the world's top 10 food crops. They are vegetative propagated using suckers or tissue culture plants and grown almost as perennial plantations. They are vulnerable to pests and pathogens, especially viruses which causes reduction in yield and are also hinders to the international exchange of germplasm. The most economically important viruses of banana and plantain are Banana bunchy top virus (*BBTV*), a complex of banana streak viruses (*BSVs*) and Banana bract mosaic virus (*BBrMV*). *BBTV* is known to cause the most serious economic losses contributing to yield reduction of up to 100% and responsible for a dramatic reduction in cropping area. The *BSVs* exist as episomal and endogenous forms are known to be worldwide in distribution. In India and the Philippines, *BBrMV* is known to be economically important.

Introduction

A banana is an edible fruit, botanically a berry, produced by several kinds of large herbaceous flowering plants in the genus *Musa*. In some countries, bananas used for cooking may be called plantains. Banana basically a tropical crop grows well in a

temperature range of 15°C-35°C with relative humidity of 75-85% (1,2,3). In India this crop is being cultivated in climate ranging from humid tropical to dry mild subtropics through selection of appropriate varieties. A soil that is not too acidic and not too alkaline rich in organic material with high nitrogen content adequate phosphorus level and plenty of

potash are good for banana. In banana fanning suckers generally may be infected with some pathogens and nematodes. Similarly due to the variation in age and size of sucker, crop is not uniform harvesting is prolonged and management becomes difficult but about 70% of the farmers are using suckers as planting material while the rest 30% of the farmers are using tissue culture seedlings. Therefore in introduction propagation i.e. tissue culture plant is recommended for planting. They are healthy, disease free, uniform in growth and early yielding (4,5,6).

Banana crop is widely grown in India and has great socio economic and religious significance. Banana is the fourth important food ingredient in terms of gross value exceeded only by rice, wheat and milk product. Banana is one of the major and economically important fruit crop of India. Banana occupies 23% area among the total area under crop in India. Most of Banana grown by planting suckers. The technology development in agriculture is very fast, it results in developing tissue culture technique. It is an important crop for small and marginal farmers (7-9). In India, around 20 cultivars viz. Dwarf Cavendish, Robusta, Monthan, Poovan Nendran, Red Banana, Nyali, Safed Velchi, Basarai, Ardhapuri Rasthali Karpurvalli, karthali and Grand Nain etc. mainly Grand Nain is gaining popularity and may soon be the most preferred variety due to its tolerance to biotic stresses and good quality bunches. Fruit develops attractive uniform with better self-life and quality than other cultivars. The major banana growing states in India are Assam, Andhra Pradesh Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh Maharashtra, Tamil Nadu West Bengal.

Banana bunch top virus (*BBTV*) is a plant pathogenic virus which is caused by single stranded DNA virus called *BBTV*. It was first identified in Fiji in 1879 and then spread

around the world since then. *BBTV* classification given as follows.

Taxonomic : Tree

Domain : Virus

Group : “ssDNA viruses”

Group : “DNA Viruses”

Family : Nanoviridae

Genus : Babuvirus

Phylum : Cressnaviricota

Family : Nanoviridae

Kingdom : Shotokuvirae

Order : Mulpavirales

Species : *Banana bunchy top virus*

International Common names

English : Cabbage top of banana; curly top of banana Spanish : cogollo recimoso del banana

French : maladie du bunchy top du bananier; sommet touffu du bananier.

English acronym : *BBTV*

EPP Code : *BBTV00 (Banana bunchy top virus)*

Materials and Methods

Plant material the plot which was observed in the field of Krishna Kokate At- Lavang Tal.Malshiras, Dist-Solapur area about 1 H.A. having 3000 plants by distance 7 x 5 feet cultivated in the month of 10th January 2021 of cultivar *G-9* type.

Out of 3000 plants we observed severity Bunchy top of Banana virus affected plants aserre156, In severe cases infection severity increased 30-40%. This disease is transmitted by banana. Aphids and other vector e.g. Thrips, Jassids, White Flies etc.

Suckers which develop after a “Mother plant” has been infected with *BBTV* are usually a severely stunted with leaves that do not expand normally and remain bunched at the top of the *pseudostem*. These leaves are stiff and erect are shorter and narrower than normal leaves and have chlorotic edges. Sucker with these symptoms will not bear fruit.

Matured plants infected with *BBTV*, new leaves arrange with difficulty are narrower than normal are wavy rather than flat and have yellow (Chlorotic) leaf margins. They appear to be “bunched” at the top of the plant. The symptom for which this disease is named. Severely infected banana plants usually will not fruit but if fruit is produced the banana hands and fingers are likely to be distorted and twisted.

The initial symptoms of banana bunchy top virus consist of dusk green streaks in the veins of lower portions of the leaf midrib and the leaf stem (*petiole*). The streaks also occur but are less prominent in the veins of the leaf blade (*Lamina*). This symptoms is sometimes referred to as “Morse code streaking” because the streaks are irregular and resemble a series of “dots” and dashes.

These are the most conspicuous symptoms of *BBTD*, and indicate an advanced stage of the disease within a given area. The keikis (suckers) which develop after a mother plant has been infected with *BBTV* are usually severely stunted, with leaves that do not expand normally and remain bunched at the top of the *pseudostem*. These leaves are stiff and erect, are shorter and narrower than

normal leaves, and have chlorotic (yellow) and wavy edges. Note that the mother plant in this photograph (with dead leaves hanging down) died some time ago and was not harvested.

A small, isolated young plant is depicted with severe *BBTD* symptoms (erect, bunched, yellow leaves). The plant was found growing in a vacant lot with no other banana plants within many meters. This suggests an advanced stage of disease in the area; all pre-existing mother plants in the adjacent vicinity have perhaps died. Leaves are stiff, erect, have some yellow leaf margins, and are bunched.

Leaf abnormalities (leaf distortion, marginal leaf yellowing, interveinal yellowing, stiffness, erectness, small size, Jhooks, Morse code) in the youngest, emerging leaf are typical of banana bunchy top. Examining the most newly emerging leaf for symptoms is the most reliable way to diagnose *BBTD* visually.

When severely diseased, large or mature banana plants with *BBTV* infection can exhibit symptoms which resemble very closely the obviously bunchy symptoms commonly seen on the young or small plants in advanced stages of the disease.

A larger plant with somewhat less obvious bunching symptom than the plant shown on page 11. Usually, the “bunchy” symptom on larger plants is not as dramatic as on small plants or keikis. These less dramatic symptoms indicate that a plant was probably not infected at an early growth stage, but after it had matured somewhat.

Banana leaf showing Morse code (dot/dash) symptoms in leaf veins (red arrow), from plant shown. The symptom is best observed by holding up the banana leaf between your eyes and a source of light (i.e., the sun). Some green hooks are visible along the left-hand

side of the leaf midrib in this image. *BBTV*-infected banana leaf showing distinct green J-hooks symptom along the leaf midrib (red arrow).

***BBTV* disease symptoms: Petiole symptoms (Morse code)**

Healthy banana leaves do not have Morse code symptoms or green J hooks.

(Left) Morse code streaking on petiole of large, *BBTV*-infected plant (red arrow).

(Right) Adjacent plant without *BBTV* has no Morse code streaking on petioles (white arrow).

Severe Morse code streaking symptoms (red arrow) on banana leaf petioles. Note the green “dot and dash” striping along the veins.

Results and Discussion

India is top country in production of Banana as well as consumption of Banana. Banana is cheaper but nutritious food to Indian people. Most of the states of India are promisingly consumed banana as table food for good health. India account 26.02% of worlds Banana production.

In Maharashtra Jalgaon District is leading the area and production of banana. Rest of Jalgaon other regions including western Maharashtra is promisingly increasing area under Banana crop. In Maharashtra widely grown cultivar is Grand Nain (i.e. Grand-9) type. It is high yielding and most widely accepted in India and world. *BBTV* virus affected banana orchard shows symptoms like stunted growth in young suckers remains bunched portion at the pseudostem. Mature plants infected with *BBTV* have yellow (*Chlorotic*) leaf margins and appear to be bunched at the top.

Usually will not bear fruit. If occur the fruits are small and twisted. At initial stage *BBTV* shows dark green streaks at the lower portion of Banana leaves. As the disease infection of *BBTV* increases it results in yield and quality of Banana orchard. The vector responsible for the transmitting the *BBTV* is banana aphid i.e. *Pentalonia nigronervosa*. Also *BBTV* transmitted through affected plant pastes suckers.

Total 3000 banana plants were assessed in this study & *Grand Nain* (G-9) variety. Banana bunched top disease was reported incidence ranging from 30-40% on other hand occurrence and aphids incidence of 40%.

BBTV severity was assessed in assessed on infected mats by using scale range of 1-5. The scores 3-5 which are character by marginal leaves chlorosis to a bunched top appearance were more frequent than the score 1-2 which represent initial symptoms manifested by dark green streaks.

The *Pentalonia nigronervosa* colonies have found on both symptomatic and asymptomatic mats. The mats containing winged aphids which scoring 3-5 were the potential vectors transmitting *BBTV* from plant to varied according to location.

In the localities of Solapur district 95% farmers indicated that no *BBTV* resistant *Musa paradisiaca* varieties were present in their plantations.

Grand Nain (G-9) variety reported widely grown across large parts of Khandesh and western Maharashtra. During the observations about 30- 40% incidence were observed.

Pentalonia nigronervosa is only vector known to be transmitting *BBTV* and reproducing efficiently on banana which reporting Diekmann, M., and Putter, C.A.J. (1996) poor

maintenance and dense canopy might be help to increase aphid vector population. The dense canopy also partially prevents rainfall from reaching the leaves and Pseudostem of banana

suckers, there by favouring the aphids multiplication. (Thomas, J. F., ISKRA-Caruaana, M. L., & Jones, D. R. (1994).

Fig.1 Spacing – 7x 5 ft. under drip irrigation system) *BBTV* infected Plant



Fig.2 BBTV disease symptoms: Advanced symptoms on small plants



Nymphs

Adult

Damage: The nymphs and adults congregate under the outer base of the pseudostem.



Aphid colonies



Bunchy top disease caused by *P.nigrornervosa*

Life stages of Banana rust thrips, *C.signipennis*



Egg



Nymphs



Adult

Fig.3



Fig.4 BBTV disease symptoms: Advanced symptoms on small plants (continued)



Fig.5 BBTV disease symptoms: Advanced symptoms on small plants (continued)



Fig.6 *BBTV* disease symptoms: Advanced symptoms on large plants.



Fig.7 *BBTV* disease symptoms: Advanced symptoms on large plants (continued)



Fig.8 *BBTV* disease symptoms: Leaf symptoms (*Morse code*, *Green hooks*)



Fig.9 *BBTV* disease symptoms: Leaf symptoms (*Morse code*, *Green J- hooks*)

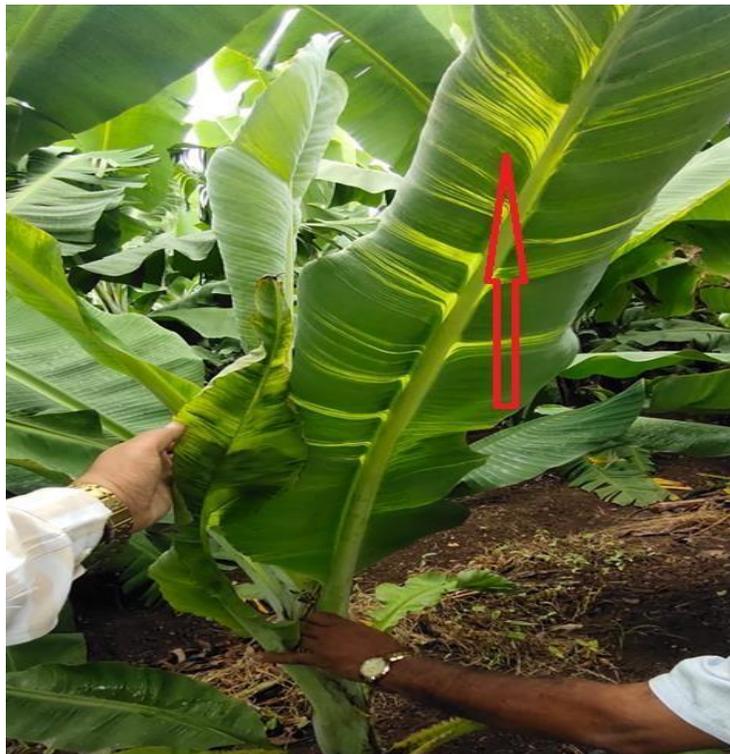


Fig.10 *BBTV* disease symptoms: Leaf symptoms (*Morse code*, *Green J- hooks*)

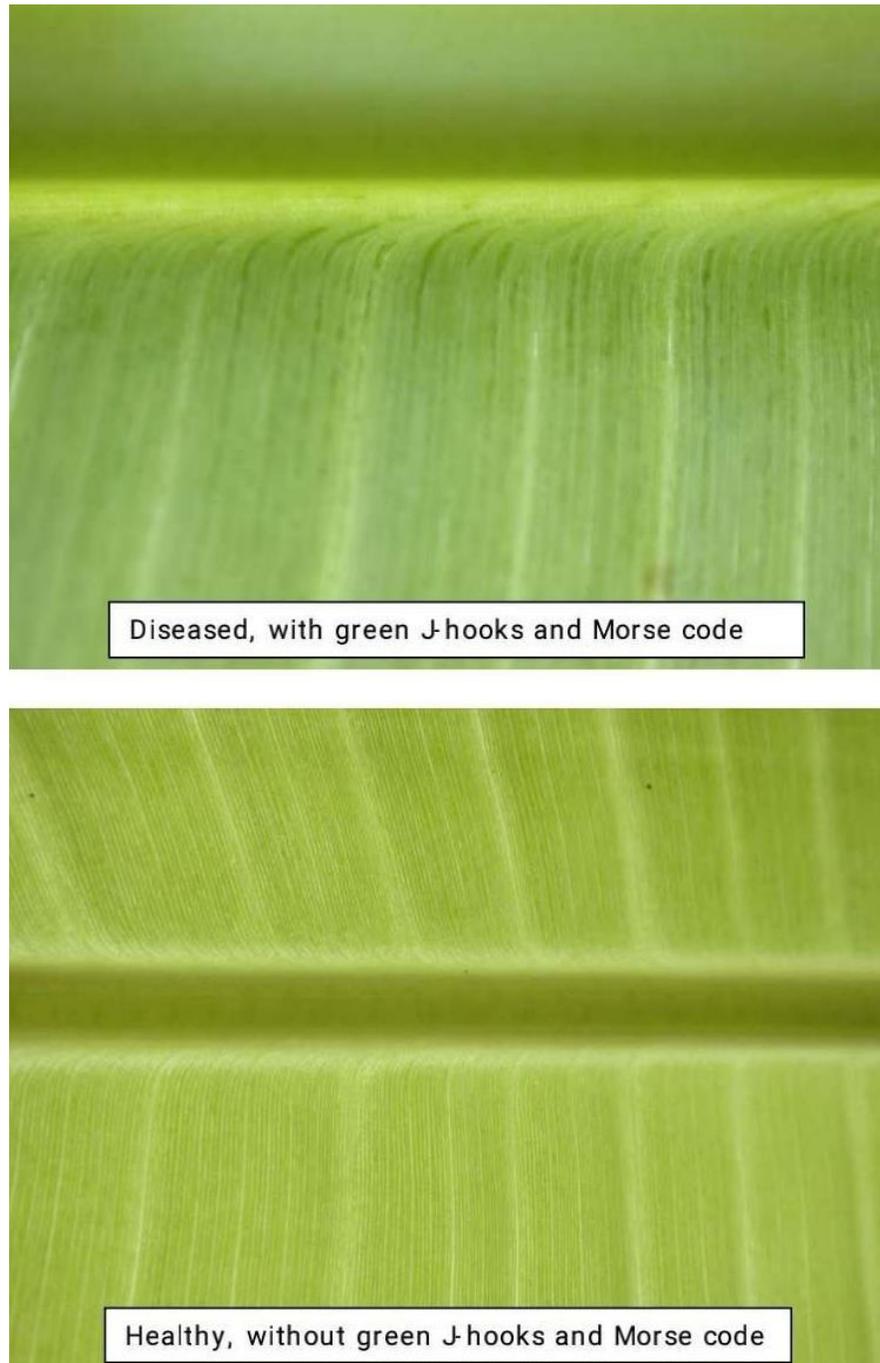


Fig.11 *BBTV* disease symptoms: petiole symptoms (*Morse code*)



Fig.12 *BBTV* disease symptoms: petiole symptoms (*Morse code*)



Fig.13

ELISA (Enzyme-linked immunosorbent assay) for diagnosis of banana bunchy top disease



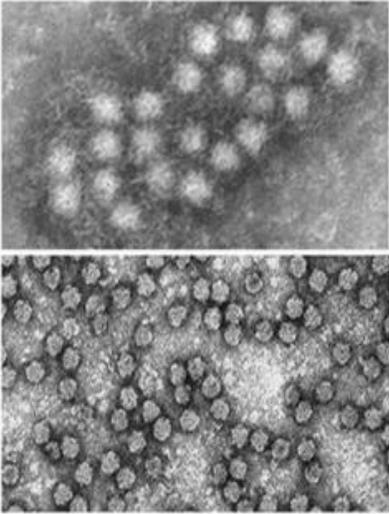
A diagnostic kit is used to test banana plant sap for the presence of banana bunchy top virus (BBTV).



Don't forget to cut a piece of the leaf midrib (the main vein) to include in your sample



A color change (dark wells) indicates the sap samples tested positive for BBTV. Each well in the plate represents a plant or sample.



Banana bunchy top virus (BBTV)

Although farmers could recognize and had local names for *BBTV* symptoms, they were not well informed about how the disease can be managed. Unfortunately, once established *BBTV* has never been eradicated from countries where it occurred. (Jones, 2009). This requires partnership between communities and government working together for a common

purpose. (Merge, 1938)

ELISA (Enzyme- Linked Immunosorbent Assay) is currently used test for the detection of *BBTV* virus.

From the above discussion *BBTV* is serious viral disease which cause yield reduction up to

100% in severe cases. It can be controlled by *IDM (Integrated Disease Management)* method. Which includes cultivation of disease and destruction of affected plant part and by control vector causing *BBTV* i.e. Banana Aphid as well as other sap sucking insects by using chemical pesticides e.g. *Imidachlopride 17.5 EC, Asataf, Cypermethrin 5% EC, Dimethoate etc.*

ELISA Test for Banana Bunchy Top Virus (BBTV)

BBTV is diagnosed by identifying symptoms of diseased plants or by submitting a banana leaf sample for virus testing

ELISA (Enzyme-linked immunosorbent assay) is a chemical test for diagnosis of banana bunchy top disease, using banana plant sap from leaves.

The ELISA sampling protocol and submission process is described below

How to sample for banana bunchy top virus ?

Select the 3rd (third) leaf from the top of the plant, not counting the youngest unfurled "cigar leaf." Cut a section from the center of the leaf, including the midrib. Submit the leaf lamina and the midrib together.

Keep the sample in a plastic bag in a cool, dry place and mail or bring it to the nearest UH-CTAHR Cooperative Extension Service office.

Banana and plantain are high priority crops in the developing countries because of their contribution to dietary energy, nutrition, and income for the millions of resource-poor farmers who grow over 85% of the world's banana. During the last decade, banana and plantain production around the world

increased by 27% (*FAOStat, 2014*), indicating the high demand.

The fruit are particularly valued in resource-poor agriculture because they yield, irrespective of the seasons. Viral, bacterial, and fungal pathogens and nematodes pose a particular concern as they can be moved through planting materials between fields and across borders.

Virus disease not only causes yield reductions but is also a major constraint to the exchange of germplasm. And tissue culture is a easy and effective technique to create disease free banana crop.

For the control of Banana virus i.e. Bunchy top of Banana, *IDM (Integrated Disease Management)* method is most effective. Which includes virus free plant selection from tissue culture technique, collection and destruction of affected plant. Proper nutrient management to keep plant health. Control of virus vector by insecticides or by chemical methods e.g. *Imidachlopride, Dimethoate, Cypermethrine etc.*

Hence, the *IDM* is the only way to control the Bunchy top of Banana virus effectively.

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