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"Study of Bunchy Top of Banana Virus and Its Control by IDM (Integrated Disease Management)"

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Abstract: -

India is the top country in Banana production in the world as 2019. Banana production in India was 30.5 M.T. that account for 26.02% of world's banana production. The top five countries are China, Indonesia, and Brazil etc. 54% world total banana production estimated at 117 M.T. in 2019. Banana and planting (*Musa* spp.), produced in 10.3 million ha in the tropics, are among the world's top 10 food crops. They are vegetatively propagated using suckers or tissue culture plants and grown almost as constant plantations. They are susceptible to pests and pathogens, especially viruses which cause reduction in yield and are also delays to the international exchange of germ psalm. The most economically important viruses of banana and plantain are Banana bunchy top virus (BBTV), is a circular single-strand (s.s.) plant DNA virus, a complex of banana streak viruses (BSVs) and Banana bract mosaic virus (BBrMV).

Keywords: Banana bunchy top virus, tissue culture, Banana viruses and diseases.

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%. 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 the past, when bananas were grown as an annual crop farmers traditionally used sword suckers as planting material, each mother plant supplied one or two suckers during the planting season from March to May. In veritably many important diseases, including viruses and Fusarium wilt were readily transmitted from one crop cycle to the next. 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 propagation i.e. tissue culture plant is recommended for planting. They are healthy, disease free, uniform in growth and early yielding. 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 (Fig. 1) 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. 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 it 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.

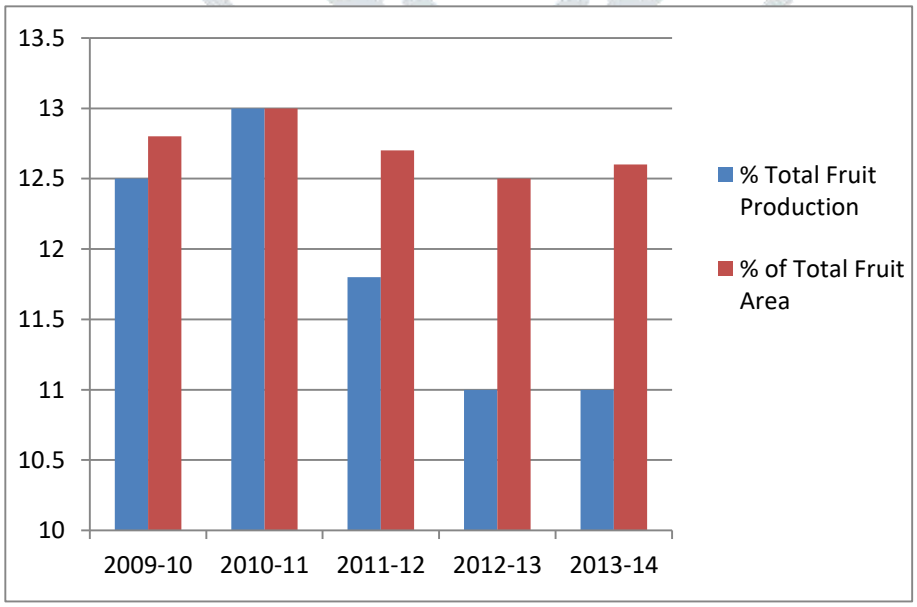

Fig. I. Area and Production of Banana in India (2009-2014) Source: All India 2013-14 (Final Estimates), Department of Agriculture & Cooperation.Banana bunch top virus (BBTV) is a plant pathogenic virus which is caused by single stranded DNA virus called BBTV.

Material and Methods:

Plant material the plot which was observed in the field of Krishna Kokate. At- Lavang Tal. Malshiras, Dist-Sholapur 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. Bunchy top of Banana virus affected plants assure 156 in severe cases infection observation 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 pseudo stem. These leaves are stiff and erect are shorter and narrower than normal leaves and have chlorites 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 (Chlorites) 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 banana are likely to be distorted and twisted.

ELISA Test - ELISA (Enzyme-Linked Immunosorbent Assay) is current BBTV test. For this purpose midrib of the third leaf from the top of suspected banana Plant,

Major Viral Diseases of Banana:

1. **Banana bunchy top disease:**

Banana bunchy top disease (BBTV) is the most devastating virus disease of banana and plantain and is prevalent in the Old World (Conant *et al.,* 1992).The disease was first recorded during an epidemic in Cavendish banana (AAA) in 1889 in Fiji (Magee *et al.,* 1927). The origin of the virus in Fiji epidemic is not clearly known; however, it is supposed to have been introduced through infected suckers from Tanna (Vanuatu) (Molina *et al., 2009*). Available records indicate the wide dissemination of BBTV in the Old World along with the movement of planting material by humans, traders and returning soldiers in the early part of the twentieth century (Fahmy*et al.*,(1927). At present, BBTV occurs in 36 countries in Africa, Asia, and Oceania (Blomme et al., 2013). Except for Hawaii (USA) (Conant, 1992) there are no records of BBTV in the New World.

2. **Symptoms and economic importance**

BBTV induces characteristic discontinuous dark green flecks and streaks of variable length on the leaf sheath, midrib, leaf veins, and petioles. New leaves emerging from the infected plants are narrower with wavy leaf lamina and yellow leaf margins (Dale *et al.*, 1987). Leaves produced are progressively shorter, narrow, and brittle in texture; these bunch together at the top and hence provide the name of the

disease (Diekmann*et al.,* 1996). Susceptible cultivars infected at a young stage and the suckers emerging from infected stools are severely stunted. Severely infected plants usually will not fruit, but if fruit is produced, the hands and fingers are likely to be distorted and twisted (Conant., (1992)Occasionally, bracts of male flower buds tum to a leafy structure and exhibit dark green dots and streaks (Diekmann*et al.,* 1996)Emerging suckers from infected plants exhibit severe symptoms. Plants infected at a later stage do not normally show leaf symptoms, but dark green streaks can be seen on the tips of the bracts.

Mass propagation of virus-free planting material this approach, backed with certification systems, is now accepted for disease control in many countries in Asia, also in Australia and Hawaii. In some countries, such as India, recurring outbreaks in farmers' fields led to the formulation and strict enforcement of certification systems and commercial production units have been accredited to produce certified tissue cultured plants. More than 22 million TC plants were certified in 2013-2014 alone (Selvarajan *et al.,* 2010) In Australia only pathogen-free stocks generated by the Queensland Banana Accredited Nursery (QBAN) are allowed to be used as foundation stock in the TC industry (FAOstat. 2014) presently, virus-free TC plants are widely used to manage BBTV in Taiwan, the Philippines, and India (Hu *et al.,* 1996).

India is the top country in Banana production in the world as 2019. Banana production in India was 30.5 M.T. that account for 26.02% of world's banana production. The top five countries are China, Indonesia, and Brazil etc. 54% world total banana production estimated at 117 M.T. in 2019.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 germ plasm. The most economically important viruses of banana and plantain are Banana bunchy lops 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 episcopal and endogenous forms are known to be worldwide in distribution. In India and the Philippines, BBrMV is known to be economically important.

Control of BBTV Control:

A ray of Hope: Integrated disease control by exclusion, eradication, and use of virus free Banana cultivars fully resistant to BBTV are not available. However, some with the B genome (AAB and ABB) are tolerant or express symptoms more slowly than those with the A genome (AA and AAA) such as the Cavendish Subgroup (Ngata*et al.,* 2013). Various Musa clones vary in their degree of susceptibility, even among cultivars with only an A genome composition (e.g. Gross Michel) (Hooks *et al.,* 2009). Tolerant clones have been utilized in the BBTD endemic. The availability of virus-free stocks is one of the major limitations in affected areas. In vitro methods have been established to generate virus-free planting

material through meristem-tip culture combined with heat therapy (Vander *et al.*, 2012). These virus-free plants are then used as mother stocks for the mass propagation of virus-free planting material. This approach, backed with certification systems, is now accepted for disease control in many countries in Asia, also in Australia and Hawaii. In some countries, such as India, recurring outbreaks in farmers' fields led to the formulation and strict enforcement of certification systems and commercial production units have been accredited to produce certified tissue cultured plants. More than 22 million TC plants were certified in 2013-2014 alone (Jones *et al.*, 2009). In Australia only pathogen-free stocks generated by the Queensland Banana Accredited Nursery (QBAN) are allowed to be used as foundation stock in the TC industry (Jones *et al.*, (2009). Presently, virus-free TC plants are widely used to manage BBTV in Taiwan, the Philippines, and India (Pentaloni*aet al.*, 1994). For the control of BBTV virus effective methods is IDM i.e. integrated disease Management which includes

1) Cultivation of virus free plant

2) Collection and destruction of affected plat.

3) Proper nutrient management systemic

4) Control of vector by insecticides or by chemical methods. e.g. Imidoclopride – 17.5% E.C.

Cypermethrin – 5% E.C.

Dimethoate.

Advantages of tissue cultured plantlets.

- Uniform growth, increases yield.
- True to the type of mother plant under well management.
- 95% - 98% plants bear bunches.
- Early maturity of crop.
- No staggered harvesting.
- Round the year planting possible as seedlings are made available throughout the year.

Following Photograps of BBTV and Banana Aphids

Contents:

1. The banana aphid (*Pentalonianigronervosa*)

a) Adults

b) Elates (winged)

c) Colonies

d) On cigar leaf

e) Under leaf lamina

2. BBTV disease symptoms

a) Advanced symptoms on small plants

b) Advanced symptoms on large plants

c) Leaf symptoms: Green hooks, Morse code streaking

d) Petiole symptoms (Morse code streaking)

e) flower symptoms (Morse code streaking).

Adult banana aphids are small to medium-sized aphids (1/25 to 1/12 inch), shiny, reddish to dark brown or almost black. They have six segmented antennae that are as long as the body. Adults start producing young aphids one day after reaching maturity. They can give birth to 4 aphids per day with an average production of 14 offspring per female.

The banana aphid (*Pentatonic nigronervosa*): Elates

Elate banana aphids have prominent, dark (brown or black) wing veins. Winged adults often develop after 7 to 10 generations of wingless individuals. Dispersing winged adults establish new colonies on other new host plants. Although they are not strong fliers, they may be carried considerable distances by light winds. Flight activity peaks between 9:00 to 11:00 AM and 5:00 PM to dusk.

The banana aphid (*Pentatonic nigronervosa*): Colonies

Colonies of the banana aphid feed on tender foliage of the young banana leaves and leaf sheaths. Small colonies occasionally occur on the leaf blade. Ants are associated with the banana aphid. The ants feed on the honeydew secreted by the aphid and, in turn establish new aphid colonies and ward off natural enemies. The aphids in this image are magnified in size.

The banana aphid (*Pentatonic nigronervosa*): Colonies on cigar leaf

A colony of banana aphids may be found and observed with the naked eye on a banana “cigar leaf” (the youngest, unfurled leaf). Banana aphids are often associated with tender plant tissues or young plants (keikis).

The banana aphid (*Pentatonic nigronervosa*): Colonies under leaf sheath

A colony of banana aphids was hiding under a leaf sheath which was pulled away from a banana pseudo stem to reveal them. A dead, long-legged ant is shown above. Like some other ant species, the long- legged ant is associated with the banana aphid. The ants feed on the honeydew secreted by the aphid and, in turn, help establish new aphid colonies and help ward off natural enemies of the aphids. To kill these aphids with some insecticide sprays is very difficult, because the spray must drench behind leaf sheaths and reach into the protected area to kill aphids where the leaf sheath and the petiole attach to the banana pseudo stem.

BBTV disease symptoms: Advanced symptoms on small plants

These are the most conspicuous symptoms of BBT, and indicate an advanced stage of the disease within a given area. The kiekies (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 pseudo stem. These leaves are stiff and erect, are shorter and narrower than normal leaves, and have chlorate (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, interregnal yellowing, stiffness, erectness, small size, Hooks, 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.

BBTV disease symptoms: Advanced symptoms on large plants.

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 kiekies. These less dramatic symptoms indicate that a plant was probably not infected at an early growth stage, but after it had matured somewhat.

BBTV disease symptoms: Subtle symptoms on large plants

Relatively mature banana plant with more subtle symptoms of BBT. The leaf bunching is not as pronounced and the leaf yellowing is not as intense, but the leaves are somewhat erect. To verify the disease, one must take a closer look at the petioles and leaves to see the Morse code and green J-hooking symptoms.

BBTV disease symptoms: Leaf symptoms (Morse code, Green hooks)

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 disease symptoms: Petiole symptoms (Morse code)

(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).

BBTV disease symptoms: petiole symptoms (Morse code)

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

Cucumber Mosaic Cucumovirus (CMV) symptoms

Typical flower and leaf symptoms for bananas infected with cucumber mosaic curcuma virus (CMV). Top: flower deformity and streaking. Middle: Leaf streaking. Bottom: interregnal choruses (yellowing). This disease may be confused with BBTV. CMV has a very wide host range, but is not considered an economically significant disease of bananas in Hawaii.

RESULT:

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. Other regions includes 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 sucker's remains bunchy portion at the pseudo stem. Mature plants infected with BBTV have yellow (Chloratic) 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.

Pentatonic nigronervasa

Also BBTV transmitted through affected plant pest sucker total 3000 banana plants were assessed in this study & Grand Nain (G-9) variety. Banana bunchy 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 chooses to a bunchy top appearance were more frequent than the score 1-2 which represent initial symptoms manifested by dark green streaks. The *Pentatonic 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 paradisiac* verities were present in their plantations.

DISCUSSION:

Grand Nain (G-9) variety reported widely grown across large parts of Khandesi and western Maharashtra. During the observations about 30- 40% incidence were observed. *Pentatonic nigronervosa* is only vector known to be transmitting BBTV and reproducing efficiently on banana which reporting poor maintenance and dense canopy might help to increase aphid vector population (Diekmann *et al.*, 1996). The dense canopy also partially prevents rainfall from reaching the leaves and Pseudo stem of banana suckers, thereby favoring the aphid's multiplication. (Wardlaw*et al.*, 1961)

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 (Vander *et al.*, 2012). This requires partnership between communities and government working together for a common purpose. (Merge, 1938) ELISA (Enzyme-Linked Immunes or bent 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 100% in severe cases. It can be controlled by IDM (Integrated Disease Management) method. Which includes cultivation of disease resistant varieties and destruction of affected plant past and by control of vector causing BBTV i.e. Banana Aphid as well as other sap sucking insects by using chemical pesticides e.g. Imidachlopride 17.5 EC, Astaf, 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 immunes orbent 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?

1. Select the 3rd (third) leaf from the top of the plant, not counting the youngest unfurled "cigar leaf."

2. Cut a section from the center of the leaf, including the midrib. Submit the leaf lamina and the midrib together.

3. 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.

CONCLUSION:

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% (Thomson *et al.,* 1995). 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 germ plasm. And tissue culture is an 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. Imidaclopride, Dimethoate, Cypermethrine etc.

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

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