

Specificity of Host-pathogen Interaction of Banana Bunchy Top Disease

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Abstract: An attempt was made to investigate host-vector relationship of Banana Bunchy Top Disease. The affinity of different host plants was investigated via black banana aphid (*Pentalonia nigronervosa*) for the transmission of BBTV to *Canna indica*, Cucumber (*Cucumis sativus*), Tobacco (*Nicotiana tabacum* cv. *Samsun*), Chenopodium (*Chenopodium amaranticolor*) and Cotton (*Gossypium hirsutum*). The host plants, at 3-4 leaf stage were exposed to viruliferous *P. nigronervosa* for 24 hours. Similarly four different insect-vectors viz. *Aphis gossypii*, *Myzus persicae*, *Rhopalosiphum padi* and *Bemisia tabaci*, beside *P. nigronervosa* were tried for transmission studies under controlled conditions. The vectors were allowed inoculation access period of 24 hours following an acquisition-feeding period of 8-10 days in separate cages on healthy banana. None of the vectors except *P. nigronervosa* was found to transmit BBTV to banana. Likewise *P. nigronervosa* was also found restricted to its original host banana for propagation and BBTV transmission.

Key words: Banana bunchy top disease, BBTV, Hosts-vectors specificity

Introduction

Banana (*Musacae spp.*) is one of the most important fruit crops of Pakistan. Banana is of major importance to food security as well as providing a valued source of income through local and international trade. Export bananas are the developing world's fourth most important commodity and, as a fruit, rank first.

Banana Bunchy Top Disease (BBTD) caused by Banana Bunchy Top Virus (BBTV) is one of the major limiting factor and the most damaging virus disease for banana production throughout the world including Pakistan. The disease was first reported from Fiji in 1889 and later on, spread to a number of countries of Asia, Africa, Australia and South Pacific regions; but has not yet been reported from America (Burns *et al.*, 1995; Smith *et al.*, 1998) except Hawaii (Hu *et al.*, 1996). BBTV is an aphid borne isometric (18-20 nm), multi-component (at least nine DNA components) circular single stranded DNA (cssDNA) virus belonging to "nanavirus" group (Dale *et al.*, 1998). Infected banana plants produce distorted leaves with dark green streaks, stunted growth and bunchy appearance at the top of the plant and quite often do not produce fruit (Smith *et al.*, 1998).

In Pakistan, the area under banana cultivation reduced from 23,500 ha to 11,300 ha, and production from 209,800 tones to 44,200 tones by the end of 1992 (Soomro, 1997) due to BBTV epidemic in 1989. However, due to colossal crop losses, the prices of banana went up manifold and people began to grow more banana in relatively newer areas (Soomro, 1997). Thus, during 1997-98, the area under banana was 26,000 ha but the production remained low at 93,600 tones (Anonymous, 1999).

Since the eruption of the disease in 1989-92, apparently limited areas seem to be free from BBTV infection as it is continuously spreading to new areas. A number of factors had played role in disease spread including non-availability of disease-free certified suckers at affordable price and use of infected planting material, lack of strict quarantine measures, presence of the virus vector throughout the banana belt, but most of all, the lack of awareness among growers had played an important role in virus/disease dissemination (Soomro, 1997). Banana fields poorly maintained are often surrounded by other crops, and many times inter-cropped with vegetables, especially the young plantations.

BBTV and its vector *Pentalonia nigronervosa* Coquarrel are reported to have limited hosts, mainly in *Musacae* family (Hu *et al.*, 1996). However, taro *Colocasia esculenta* has been reported as symptomless host of BBTV (Ram & Summanwar, 1984). The virus has also been detected serologically in white

ginger (*Hedychium coronarium*) and *Canna* (*Canna indica*) by Su, (1993). Previously, *Canna* had been suspected as a possible host of BBTV (Vakili, 1969). Regarding the transmission of BBTV, *P. nigronervosa* is considered to be the only vector worldwide (Wardlow, 1972), but some reports suggest that BBTV could be transmitted to cucumber (*Cucumis sativus*) through other aphids like *Myzus persicae*, *Aphis gossypii* and *A. spiraeicola* (Rao, 1980).

Above mentioned reports suggest that banana may not be the only host of BBTV and that the virus may also be transmitted by vectors other than *P. nigronervosa*. Therefore, present study was designed to know the exact relationship of host and vector in BBTD. The main objective of the study was to determine the host range of BBTV among the hosts grown in and around the banana plantations in Sindh province to establish their role, if any, in disease spread and as possible reservoirs of BBTV and transmission of BBTV by other common insect vectors of viruses on the basis of their association with field crops in Pakistan.

Materials and Methods

Plant material: Healthy banana suckers (c.v. *Dwarf Cavendish*), collected from banana growing areas of Sindh were grown in pots containing clay, sand and peat in equal ratio and were maintained in growth room conditions at 25-30°C. Photoperiod of 16:8 hours (light:dark) was provided by high intensity mercury lamps. Full strength Hoagland nutrient solution 100ml/plant was added to each plant at two weeks interval. Banana plants of three months age having 3-5 leaves on average were used in the experiment.

Virus source: Infected banana plants showing typical BBTV symptoms were collected from district Nawabshah, Sindh and the presence of virus was confirmed serologically. Infected plants were maintained in insect free glass house at National Agricultural Research Centre (NARC), Islamabad.

Propagation and maintenance of *P. nigronervosa*: Banana aphids (*P. nigronervosa*) were collected from apparently BBTV free fields of northern Sindh and kept in transparent perspex cages (36.25 x 36.25 x 56.25 cm) on healthy banana plants under growth room conditions at 15-25°C with 80% relative humidity, maintained by putting warm water containers in cages. The aphids were frequently shifted to new plants with the help of a fine paintbrush in order to minimize overcrowding. During this study period none of the banana plants used for rearing and maintenance of *P. nigronervosa* developed any BBTV symptoms.

Rearing of insect-vectors: Insect vectors (*Aphis gossypii*, *Rhopalosiphum padi*, *Myzus persicae* and *Bemisia tabaci*) were reared and maintained separately on healthy banana plants under growth room conditions at 15-25°C providing 60% relative humidity in insect proof transparent perspex cages as mentioned above.

Host range studies: Test plants were raised in pots containing sterile soil in insect proof perspex cages at 20±5°C in a growth room conditions. At 3-4 leaf stage a group of 10 viruliferous *P. nigronevosa* per plant were transferred to test plants for inoculation feeding period of 24 hours. Four plants of each species were inoculated and one was kept non-inoculated. Similarly in each set of test plants one banana plant was also included as control. Aphids were killed mechanically and by applying systemic insecticide (Temik) to the soil. The test plants were shifted to glass house at 30°C and symptoms were observed for upto three months.

Vector range studies: Adult forms of non-viruliferous vectors including *P. nigronevosa* were transferred to BBTB-infected banana plants separately in cages for acquisition feeding period of 8-10 days. Ten viruliferous vectors were shifted to each test plant in perspex cages for inoculation feeding period of 24 hours. In each set, four plants were exposed to vectors and one was kept as control. After inoculation feeding period, insects were killed mechanically as well as by applying systemic insecticide (Temik) in the pots. The plants were later shifted to glass house at 30°C and were observed for symptom development for upto three months.

Results and Discussion

In present investigations we were able to transmit BBTB to banana through *P. nigronevosa* but not with *Aphis gossypii*, *Myzus persicae*, *Rhopalosiphum padi* and *Bemisia tabaci* (Table 1). Nevertheless, these insects species did feed on banana during their rearing, which confirms the host status of banana to the above insect vectors, although they were unable to transmit the BBTB. The reproduction pattern and intensity of all insect cultures on banana plants was clearly different and low, while *P. nigronevosa* fed well and reproduced efficiently on banana which also confirms the hypothesis that only *P. nigronevosa* is a specific pest of banana.

Among host plants tested, only banana showed typical BBTB symptoms while rest of the plants remained symptom-less. All control (positive) banana plants developed typical BBTB symptoms within at-least 40 days post inoculation resulting to 100% infection further confirming the idea that hosts other than *Musa spp.* probable donot play any role as a reservoir of BBTB.

Our results further confirmed the reports of Dale, (1987) and Hu *et al.* (1996) that *P. nigronevosa* is the only potential vector of BBTB while banana as the best-propagated host of BBTB. Rao (1980) reported that they were able to transmit BBTB through aphids *Myzus persicae*, *Aphis gossypii* and *A. spiraeicola* to *Cucumis sativus*, *C. melo*, *Gynura aurantiaca* and *Catharanthus roseus*. However, we were not able to transmit BBTB to banana by using other vectors except *P. nigronevosa*. In the present investigation, group of ten viruliferous aphids was able to transmit BBTB to banana, however, we have also transmitted BBTB with single viruliferous banana aphid with inoculation feeding period of 24 hours resulting in 100% infection (data not shown) which is also reported by Hu *et al.* (1996). *P. nigronevosa* is mainly associated with banana worldwide and only colonizes *Musa spp.* which shows its strong affinity for banana, however, limited hosts outside this genus have also been reported (Thomas *et al.*, 1994).

Relatively few studies have been done on host range studies of BBTB because BBTB is not sap transmissible and secondly, *P. nigronevosa* is known to have a very strong host

preference itself. All the test plants used in this study remained symptomless except banana, used as control, which showed typical BBTB symptoms within 40 days of post inoculation period (Table 1). There are reports of *Canna* being the possible host of BBTB (Vakilii, 1969), but in the present study and in the studies of Magee, (1940) and Hu *et al.*, (1996) BBTB was not transmitted to *Canna spp.*

Table 1: Specificity of host-vector relationship of BBTB

Host plants	Vectors				
	1	2	3	4	5
Banana cv. Dwarf Cavendish	+	-	-	-	-
<i>Gossypium hirsutum</i> cv. S-12	-	-	-	-	-
<i>Nicotiana tabacum</i> cv. Samsun	-	-	-	-	-
<i>Cucumis sativus</i>	-	-	-	-	-
<i>Chenopodium amaranticolor</i>	-	-	-	-	-
<i>Canna indica</i>	-	-	-	-	-

1 = *Pentalonia nigronevosa* 2 = *Aphis gossypii*
 3 = *Myzus persicae* 4 = *Rhopalosiphum Padi*
 5 = *Bemisia Tabaci* + = Characteristic BBTB symptoms appeared
 - = No BBTB symptoms

On the basis of our studies we have shown that banana is the only host of Pakistani isolate of BBTB and *P. nigronevosa* as its only vector in Pakistan. Thus, other crops in and around banana fields and commonly found insect vectors in banana growing areas do not play any role in disease spread. Therefore, it can be concluded that Banana Bunchy Top Disease has a specific host-vector relationship and thus suggests that BBTB has no alternate hosts/vectors so far that played any role in its spread in Pakistan.

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