# Biology and Control of Virus Diseases of Banana with Reference to Banana Bunchy Top Disease

**Reshu Chaudhary[*] and R.S. Sengar**

*Department of Ag. Biotechnology, College of Agriculture, Sardar Vallabhbhai Patel University of Agri. & Tech., Meerut*
*E-mail: [*]reshuchaudhary55@gmail.com*

**Abstract—***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 a 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.*

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

## 1. 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 $15^0$C-$35^0$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. Inevitably, many important diseases, including viruses and Fusarium wilt, were readily transmitted from one crop cycle to the next.

In banana farming, 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 vitro* clonal propagation i.e. tissue culture plants are recommended for planting. They are healthy, disease free, uniform in growth and early yielding.

## 2. NATIONAL STATUS OF BANANA AREA, PRODUCTION AND YIELD

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 is 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 Grandnaine etc. mainly Grandnaine 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 yellow colour with better self-life and quality than other cultivars. The major banana growing states in India are Assam, Aandhra Pradesh, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Tamil Nadu, West Bengal (Fig. 2).

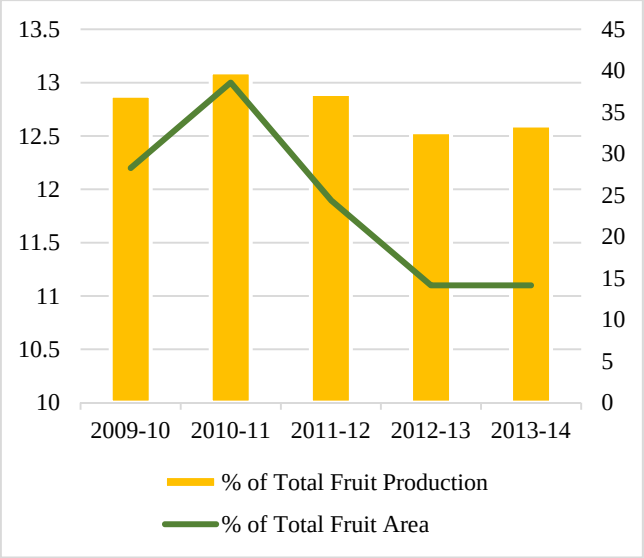



**Fig. 1. Area and Production of Banana in India (2009-2014)**

Source: All India 2013-14 (Final Estimates), Department of Agriculture & Cooperation.

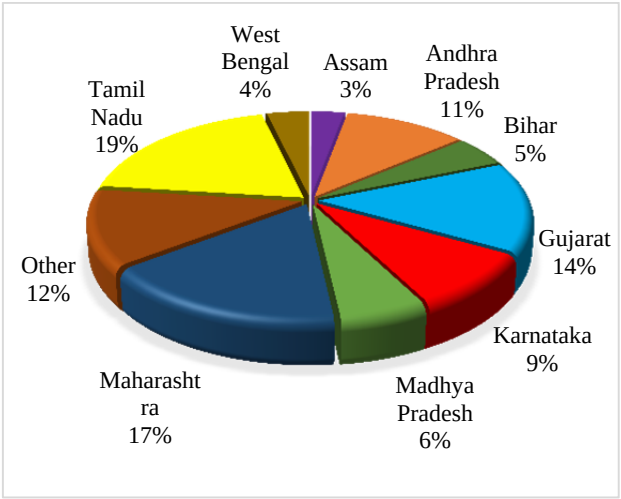
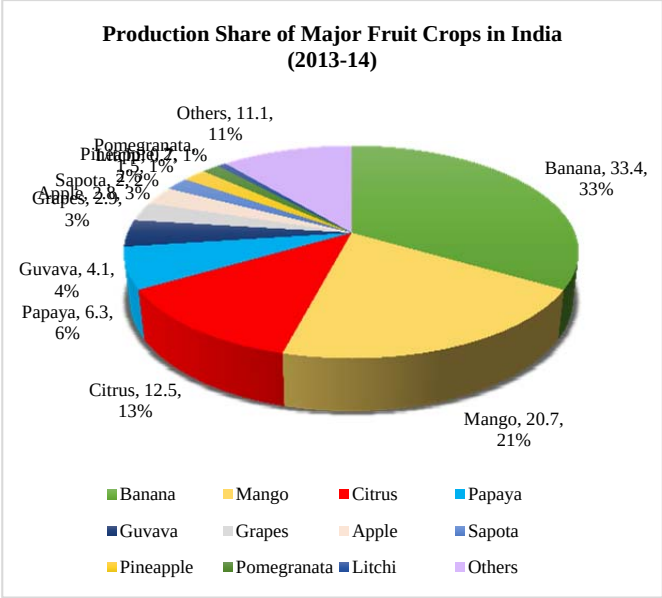
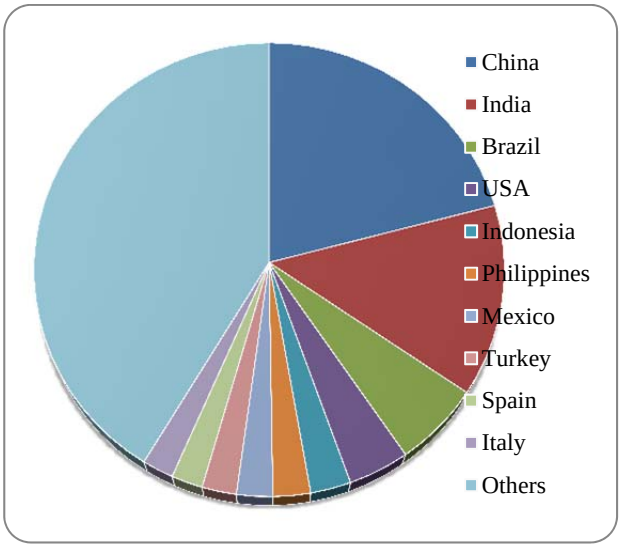



**Fig. 2. Top Banana producing states in India (2013-14)**

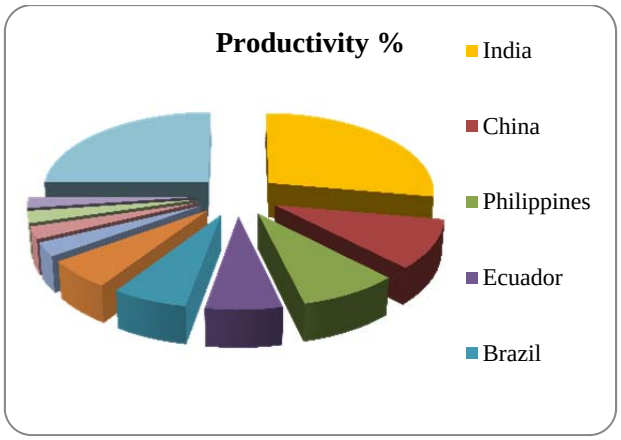
Source: All India 2013-14 (Final Estimates), Department of Agriculture & Cooperation.




Source: All India 2013-14 (Final Estimates), Department of Agriculture & Cooperation.




Leading Fruit Producing Countries in the World




Major Banana Producing Countries in the World

### 3. 2. MAJOR VIRUS DISEASES OF BANANA

## Banana bunchy top disease

Banana bunchy top disease (BBTD) is the most devastating virus disease of banana and plantain and is prevalent in the Old World (Dale, 1987). The disease was first recorded during an epidemic in Cavendish banana (AAA) in 1889 in Fiji (Magee, 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) (Simmonds, 1931). Available records indicate the wide dissemination of BBTD 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, 1927; Magee, 1927, 1953; Wardlaw, 1961). At present, BBTD occurs in 36 countries in Africa, Asia, and Oceania (Blomme et al., 2013; Diekmann; Kumar et al., 2011). Except for Hawaii (USA) (Conant, 1992) there are no records of BBTD in the New World.

## 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 (Nelson, 2004). Leaves produced are progressively shorter, narrow, and brittle in texture; these bunch together at the top and hence provide the name of the disease (Thomas & Jones, 1994). 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 (Nelson, 2004). Occasionally, bracts of male flower buds turn to a leafy structure and exhibit dark green dots and streaks (Thomas et al., 1994). 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. Emerging suckers from such plants usually exhibit moderate symptoms or none.

### Geographic distribution and host range

BBTV is now known to occur in 36 countries; 14 are in Africa (Blomme et al., 2013; Kumar et al., 2011) and 22 in Asia and Oceania as shown in Fig. 3 (Diekmann & Putter, 1996). BBTV recorded in Hawaii (Conant, 1992) was the only report of its occurrence in the New World. In Africa, occurrence of BBTD was first recorded from Egypt in 1901 (Fahmy, 1927), where there was an economically damaging spread of the disease in 1953 (Dale, 1987). BBTD was first discovered in SSA in the 1950s from DRC (Wardlaw, 1961) and later in Gabon, Burundi, Central African Republic, Equatorial Guinea, Rwanda, Malawi (Kenyon, Brown, & Khonje, 1997), Zambia (Gondwe, 2007). BBTV is known to infect natural and synthetic hybrids of Musa paradisiaca, abaca (M. textilis) (Manila hemp) (Sharman, 2008) and Ensete ventricosum (Selvarajan & Balasubramanian, 2013). Searches for BBTV were negative in plants belonging to the species Alpinia, Heliconia, Canna, and Strelitzia, often found growing in the Musa production zones (Geering & Thomas, 1997). One report on BBTV detection in Colocasia esculenta in India (Ram & Summanwar, 1984) was not proved unequivocally (Geering & Thomas, 1997; Hu et al., 1996).

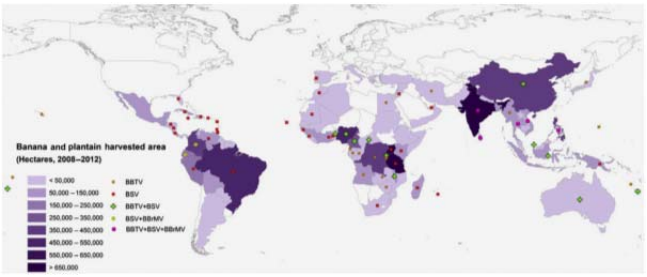



**Fig. 3 Banana and plantain production in various countries and distribution of the three major banana viruses, BBTV, BSVs, and BBrMV. (Average production data for banana and plantain for the years 2006–08. http://faostat.fao.org/)**

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 (Espino1993; Ngatat et al., 2013). Various Musa clones vary in their degree of susceptibility, even among cultivars with only an A genome composition (e.g., Gros Michel) (Hooks, 2009 Magee, 1948). 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 (Van den Houwe et al., 2012; Thomas, 1995). These virus-free

plants are then used as mother stocks for the mass propagation of virus-free planting material (Su, 2007). 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, 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 (QPPR, 2002). Presently, virus-free TC plants are widely used to manage BBTV in Taiwan, the Philippines, and India (Molina et al., 2009).

## 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.

## 4. 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% (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 creat disease free banana crop.

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