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Research Paper

Pepper Vein Banding Virus-An Over view

Biology

KEYWORDS : Pepper vein banding virus, Potyvirus, Chillies, Host range, Symptoms

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ABSTRACT

Pepper Vein Banding Virus (PVBV) belongs to Potyviridae family of viruses that cause severe crop loss to chillies and pepper. Morphology, genomic organization, distribution, host range, symptoms of infection, mode of transmission, vectors, economic impact and control measures of PVBV are reviewed and discussed.

Introduction

Plant viruses are obligatory intracellular parasites live on their host plants causing severe damage to crop yield. Plant viruses were discovered over a century ago when the science of virology was born (Creager, 2002). Pepper vein banding virus (PVBV) belongs to the genus Potyvirus and is one of the most prevalent viruses infecting chillies in South India (Anindya et al., 2004; Joseph and Savithri, 1999; Ravi et al., 1997). The genus Potyvirus is the largest plant virus group and is economically very important (Hull, 2002). Most of these viruses have wide host range and transmitted through mechanical sap inoculation by several species of aphids in a non-persistent manner. The *Potyviridae* are a family that encompass more than 30% of known plant viruses which are having great agricultural significance. They are flexuous filamentous rod-shaped particles. Their genome is composed of positive-sense RNA which is surrounded by a protein coat made up of a single viral encoded protein called a capsid. All induce the formation of virus inclusion bodies called cylindrical inclusions ('pinwheels') in their hosts.

Potyviruses induce characteristic cylindrical (pinwheel) inclusion bodies (Edwardson 1974) which can be visualized through electron and light microscopy (Christie and Edwardson 1977). They are composed of a single protein (~70 kDa) made in their hosts from a single viral genome product (Riechmann et.al 1992). In the field, potyviruses are often found in mixed infections. The damage caused by these viruses depends on the strains of the virus, cultivars of the host plants, ontogenic stage of the plant at which infection occurs and whether the infection is by single viral strain or involving multiple viruses.

Eight potyviruses have been reported to infect peppers: potato virus-Y (PVY) (Jeyarajan and Ramakrishnan, 1961), pepper veinal mottle virus (PVMV) (Prasada Rao, 1976), tobacco etch virus (TEV) (Bidari and Reddy, 1986), pepper vein banding virus (PVBV) (Prasada Rao, 1976), chilli veinal mottle virus (CVMV) (Satya Prakash et al., 2002) and pepper mottle virus (PeMtV) (Sandhu and Chohan, 1980). Insecticide application of infected plants is usually inadequate in reducing virus spread (Laird and Dickson 1963). Current study intends to provide an overview on pepper vien banding virus as a plant pathogen with its host range, distribution, symptoms, economic impact and control measures.

Pepper Vein Banding Virus (PVBV)

Among the chilli crops, *Capsicum annuum* Linn. is most widely cultivated and represents one of the important spice crops. India is a leading country in chili cultivation and export in the world. Chillies are vulnerable to a variety of diseases and these diseases can be caused by fungi, bacteria, viruses and phytoplasma (Singh, 2005). Thirty five different viruses have been reported to cause infections to *Capsicum* spp (Peppers) (Green and Kim 1991) of which nineteen have been reported from India. They include poty virus, potex virus, cucumo virus, tobacco mosaic virus, tospo virus, nepo virus, carla virus and gemini virus.

Pepper vein banding virus (PVBV) is a positive sense single stranded RNA and is a flexuous, non-enveloped, rod-shaped virus (Ravi et al., 1997). The genome of PVBV is 9771 nucleotides in length. The 5' end of the PVBV genome is linked to Vpg (Viral Protein genome-linked) and a poly A tail is linked to 3' end of the genome. The genome of PVBV has a single large ORF. The ORF can be translated to a polyprotein of 340 kDa size. This polyprotein undergoes proteolytic processing by N-terminal proteinase (P1), helper component proteinase (HC-Pro) and NIa proteinase (Carrington et al., 1989; Riechmann et al., 1992) which are the three viral proteinases. Cross-reactivity studies with other potyviral antisera showed that PVBV is serologically closer to peanut mottle virus (Ravi et al., 1997).

Distribution of PVBV and Host Range

In India, PVBV was first reported by Prasada Rao (1976) and is reported to be distributed throughout the chilli growing areas of Karnataka (Ravi, 1991). PVBV distribution in other counties is given in Table 1. (Soh et al. 1977; Zitter 1975; Purcifull et al. 1975; Nelson and Wheeler 1978; Nelson and Zitter 1982, Alegbejo and Uvah 1987; Fajinmi 2006)

Table 1. Distribution and host range of PVBV

No.	Place	Country	Major hosts
1.	Karnataka	India	family Solanaceae
2.	Uttar Pradesh	India	Capsicum annuum L.
3.	Nigeria	Africa	Capsicum annuum L.
4.	West Malaysia	Malaysia	C apsicum frutescens, Capsicum annuum L
5.	North Carolina	North America	C frutescens

Mode of Transmission and Vectors

Transmission of virus has been reported to happen by mechanical sap inoculation. Sap sucking aphids have been identified as the major vectors of the virus . Populations of aphid vectors increased in all agro-ecological zones on the onset of rainy season, and decline onset of the dry season. Important aphid vectors include *A. craccivora, A. gossypii* and M. *persicae*. Table 2 provides information on various vector species transmitting the virus among different host plants (Bidari and Reddy, 1990; Ravi, 1991). Viruses adhere to sucking pump and foregut of aphids through which the transmission takes place. Aphid transmissibility and specificity are also dependent upon the coat protein (CP). In the CP, a DAG amino acid motif at the N terminus is required for aphid-transmissibility (Atreya *etal*., 1990, 1991, 1995). PVBV elicits faint vein clearing on the young leaves followed by dark green continuous vein-banding. Later the leaves show various types of mosaic-mottling and turn thread-like in few cases. Most of the leaves become reduced in size and get distorted. Inter nodal length gets shortened imparting stunted appearance for the affected plant. Common symptoms exhibited by different host plants are illustrated in Table 2. Infected plants blossom poorly and bear fewer and smaller fruits (Ong and Ting 1977; Ong et al. 1979; Abu Kassim 1986).

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Table 2. Vectors and symptoms of infestation of PVBV on different hosts.

No	Name of the host plant	Mode of infection	Symptoms
1.	Capsicum annuum L.	A. craccivora	dark green mottling
2.	C. microcarpum	A. gossypii	distortion of leaves
3.	C. pendulum	A. spiricola	color deviation on immature fruit
4.	C. frutescence L	M. persicae	faint vein clearing on young leaves
5.	N. unguiculata L	Aleyrodidae (White fly)	necrotic local lesions along with veinal necrosis

Economic Impact

Chilli is raised over an area of 1832 thousand hectares in the World, with a production of 2959 thousand tons given by Department of Agriculture and Cooperation India 2010. Largest chilli producing countries which stand in top 10 are India, China, Ethiopia, Myanmar, Mexico, Vietnam, Peru, Pakistan, Ghana and Bangladesh. These countries are accounted for more than 85% of the world production in 2009 (Rajendra et al 2010). The major share of chilli production is contributed by India with 36% share in global production, followed by China (11%), Bangladesh (8%), Peru (8%). Around 14 lakh tons of chilli per year is produced by India. China (4.5 lakh tons per year), Mexico (4 lakh tons) and Pakistan (3.5 lakh tons) are other major producers of chillies. In India, almost all states throughout the country grow chilli, with Andhra Pradesh being the largest producer contributing about 26% to the total area of chilli cultivation followed by Maharashtra (15%), Karnataka (11%), Orissa (11%), Madhya Pradesh (7%). Other states contributing nearly 22% to the total area under chilli cultivation. Viruses cause damage in chili. 50% of the yield reduction is seen in early growth stage (Ong et al. 1980).

Control Measures:

The key components in the disease control of pepper is clean seeds, greenhouse sanitation, crop rotation, and cultural measures in the field (Zitter, T. A 1971). Recommended control measures against chilli viruses are spraying of insecticides like diazinon, malathion, metasystox at 10 days interval starting from early growth stage of the plant (Sobitha Devi and Reddy, 1995; Patel *et al*., 1997). Neem oil, neem guard, repellin and biosol among neem products have been developed for control of the vectors. But these neem products were less effective than the synthetic insecticides (Chakraborti,2000; Rajasri *et al*.,1991). Deweeding the agricultural plot before raising the crop, cultivation of nonsusceptible tall barrier crops resistant to PVBV such as corn have been reported as alternating strategies for minimizing theinfection (Basavarajappa and Rajasekhar, 2001; Ragupathi and Veeraragava-thatham,2002). Introduction of natural enemies/predators such as lady bird beetles, lacewings, syrphid fly larvae, and parasitic wasps in to the garden can control the aphid population effectively.

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