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Tomato Leaf Curl – A Serious Impidment in India

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Abstract

Tomato Leaf Curl is a serious problem in India & throughout the world. The first reported Tomato Leaf Curl Virus was monopartite begomo virus which was identified in Australia. Nowadays it has a wide range of strains in India, based on the centre of occurrence among which Tomato Leaf Curl New Delhi Virus was 1st identified during 1993 and the last reported strain was from Joydebpur during 2013, named as Tomato Leaf Curl Joydebpur Virus. The virus is generally transmitted through white fly but some strains like ToLCGV, ToLCKV, ToLCNDV are transmitted by sap also. Up to now six resistant genes are identified from different wild sources against Leaf Curl Virus. A lot of triple resistant varieties are developed by three way cross and then continuously backcrossing for six to seven generations. Arka Rakshak is the 1st Triple disease resistant variety from IIHR in which pyramiding of *Ty2 & Ty3* has been done. After that many other varieties are released from different private & public sectors.

Keywords – Bipartite, Hypertrophy,Multipartite.

Introduction

After potato, tomato (*Solanum lycopersicum* L., syn. *Lycopersicon esculentum* Mill.) is the world's second most popular vegetable crop. It is the most important processed vegetable and an essential ingredient in culinary preparations. Tomatoes are infected with many viruses, the most damaging of which is the Begomo virus (Tomato Yellow Leaf Curl Virus Syn. Tomato Leaf Curl Virus). The disease has spread across the world, infecting crops in both protected and open fields. TYLCV has become a significant production issue in many tomato-growing regions of India in the last two decades or so. Under normal conditions, the

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causal virus can be transmitted by the Sweet Potato Whitefly (*Bemisia tabaci* Genn.). ToLCVs have been found in a variety of crop and weed species in India. In Southern India, maximum temperature and rainfall are significant factors in disease spread, while in the North, minimum temperature and relative humidity have an effect on the whitefly population. Intensive agricultural and the introduction of new genotypes and cropping pattern have further aggravated the situation. To diminish this situation Extensive research on conventional breeding has led to development of resistant genotypes from which resistant gene has also been mapped.

Origin of Virus

According to Stanley *et al.* (2005) and Fauquet and Stanley (2005), the family Geminiviridae is divided into 4 genera (Mastrevirus, Curtovirus, Topocuvirus, Begomovirus) based on biological properties, genomes, insect vector (whitefly, leafhopper, or treehopper), and host selection (either mono- or dicotyledonous hosts).The largest group in this family belongs to the genus Begomo virus, which is named after its type member "Bean golden mosaic virus".

The Tomato Yellow Leaf Cur Virus is responsible for the most devastating tomato disease (TYLCV). TYLCV is the generic name for a group of viral species found in tropical and subtropical regions of the world that cause severe disease in economically important crops like tomatoes, resulting in yield losses of up to 100 percent. In the 1930s, TYLCV was first discovered in the Jordan Valley of Israel.

Other TYLCV species have been identified in Yemen (TYLCYV), Saudi Arabia (TYLCSAV), and East Asia, including TYLCV-C from China (Liu *et al.* 1998) and TYLCTHV from Thailand (Rochester et *al.* 1994), with the latter being the only TYLCV with two genomic components (designated DNA-A and DNA-B). Tomato leaf curl virus (ToLCV) is a virus that infects tomatoes and is transmitted by whiteflies. It has been found in India, Australia, Taiwan, Oman, and Panama. The first begomo viral satellite discovered, referred to as tomato leaf curl virus-sat (ToLCV-sat), was identified in tomato plants infected with the monopartite begomovirus tomato leaf curl virus (ToLCV) originating from Australia.

In India, Tomato leaf curl disease (ToLCD) was first reported by Vasudeva in 1948 from Northern India and Sam Raj in 1950 from Central India.

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Virus Infection

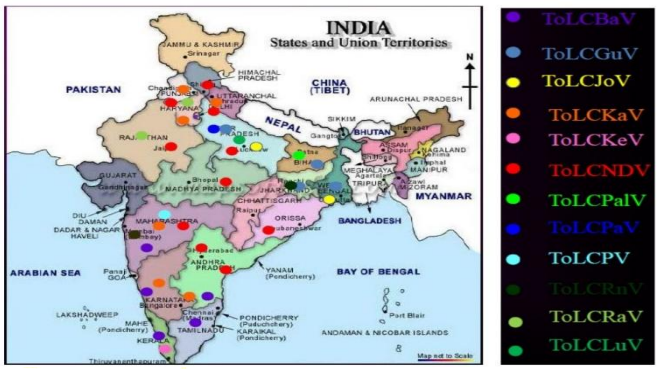
The virus can infect plants at any stage of their development and growth. Muniyappa *et al.* found that yield loss in summer-planted tomato crops is lower (6.4–52.2%) than in winter-planted crops (52.5–100%).Summer crop disease symptoms appear after 15 days of post-inoculation, while winter crop symptoms appear after 25 days. The yield loss varies depending on the days after contamination: 94.9, 90.0, 78.0, and 10.8 percent when plants are contaminated 2, 4, 6, and 10 weeks after planting

GENOMIC CONSTITUENT

The disease is caused by different species having circular single-stranded DNA (ssDNA), of the

Genus: - Begomovirus,

Family: - Geminiviridae



Monopartite viruses which originally reported from tomato

S. No	Name of the virus species	Acronym	Locality	Year of report
1.	Tomato leaf curl Bangalore virus	ToLCBV	Bangalore	2000
2.	Tomato leaf curl Karnataka virus	ToLCKV	Karnataka	2002
3.	Tomato leaf curl Patna virus	ToLCPaV	Patna	2010
4.	Tomato leaf curl Rajasthan virus	ToLCRV	Rajasthan	2011
5.	Tomato leaf curl Pune virus	ToLCPuV	Pune	2011
6.	Tomato leaf curl Kerala virus	ToLKeV	Kerala	2011
7.	Tomato leaf curl Ranchi virus	ToLCRV	Ranchi	2011
8.	Tomato leaf curl Joydebpur virus	ToLCJoV	Joydebpur	2013

Bipartite viruses originally reported from tomato

9.	Tomato leaf curl New Delhi virus	ToLCNDV	New Delhi	1993
10.	Tomato leaf curl Gujarat virus	ToLCGV	Gujarat	2003
11.	Tomato leaf curl Palampur virus	ToLCPalV	Palampur	2008
12.	Tomato leaf curl India virus	ToLCIV	-	-

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Symptoms: -

Symptoms of ToLCV includes:

- leaf curling,
- vein yellowing,
- puckering of leaves,
- excessive branching,
- stunting,
- colour changes from pale yellow to deep yellow,
- small size of leaves,
- also causes the extreme leaf distortion, and premature drop of flower and fruits.

At cellular level, structural changes have been observed like accumulation of dark granules and the aggregate of virus-like particles in the cytoplasm and hypertrophy of nucleus.

Transmission: -

Vasudeva *et al.* (1948) discovered that the virus is transmitted by the sweet potato whitefly (*Bemesia tabaci*) and that it can infect a variety of hosts. According to Butter *et.al.*100% transmission of the virus with 10 whiteflies/plant at the temperature ranging from 33 to 39°C. It is also found that ToLCNDV, ToLCGuV, and ToLCKaV can be transmitted through sap.

Begomo virus Species and Its Genome Organization: -

Tomato leaf curl virus is a member of the genus Begomo virus, which belongs to the Geminiviridae family. On a global scale, India is home to 16 percent of all Gemini viruses. The International Committee on Taxonomy of Viruses (ICTV) has officially recognised 322 begomovirus species from around the world that cause infection in various crops. India is responsible for 82 of them. Around 19 species of begomo virus have been identified as being responsible for tomato leaf curl disease.

Northern India is dominated by Tomato Leaf Curl New Delhi Virus and Tomato Leaf Curl Palampur Virus, while Southern India is dominated by Tomato Leaf Curl Bangalore Virus.Except for a few species that are bipartite, most begomo virus species are monopartite (having only one DNA-A molecule) (having DNA-A and DNA-B as genomic component). Monopartite viruses have DNA-A that can infect the plant and cause symptoms, whereas Bipartite viruses have DNA-B that relies on DNA-A for replication.

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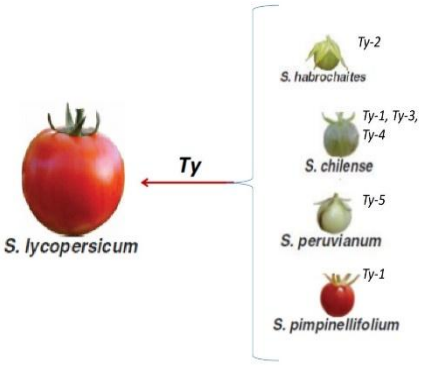
RESISTANCE GENE FOR LEAF CURL VIRUS:



Resistance to Tomato Leaf Curl virus shows polygenic inheritance. It is controlled by dominant gene *Ty*. Until now, six genes (*Ty* genes) derived from different tomato wild species have been identified *Ty-6*, to chromosome 10 of tomato. ***Ty-6*** is effective against **both monopartite** Tomato yellow leaf curl virus (TYLCV) and **bipartite** Tomato mottle virus (ToMoV). Gene action is incomplete dominance.

Resistant gene	**Chromosome no**	**Resistant source**
Ty-1	6	*S. chilense*
Ty -2	11	*S. harbochaitis*
Ty-3	6	*S. chilense*
Ty-4	3	*S. chilense*
Ty-5	4	*S. peruvianum*
Ty -6	10	*S. chilense*

- ✓ *Ty-1* and *Ty-3*: pyramid genes commercially used in North India
- ✓ *Ty-2*: commercially used in South India

Development of Triple Disease Resistance Line: -

IIHR-2202 **X** **IIHR-1816(NCEBR-1)**

(CNL-2123-DC1F1-111-17-21-2-12) (Moderately resistant to EB)

(ToLCV + BW)(*Ty 2* based)

↓

F_1 X IIHR-1618

↓

BC_1F_1

(ToLCV + BW+ EB Resistant plants selected under artificial field condition)

↓

BC_1F_7

TLBER 7-12-15-28, 7-12-15-29, 7-4-11-29, 7-4-11-34 With triple disease resistant selected

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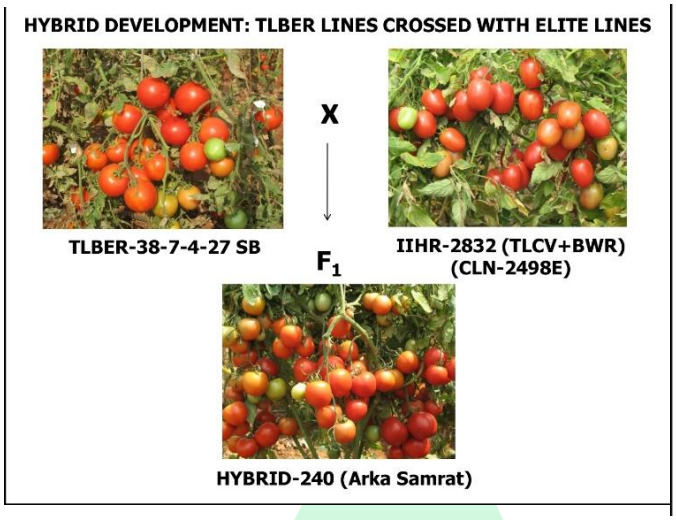

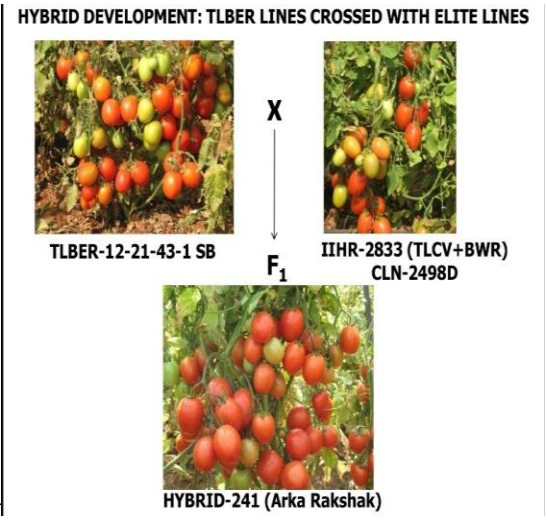

Resistance Varieties: -

Variety	Resistance Gene
Abhinava	*Ty-1*
Hissar Anmol (H 24)	*Ty-2*
Arka Ananya	*Ty-2*
Vyabhav	*Ty-2*
Lakshmi	*Ty-2*
NS-501	*Ty-2*
Kashi Amul	*Ty 3*
Arka Vishesh	*Ty 1 + Ty 2*
Arka Apeksha	*Ty 1 + Ty 2*
Arka Rakshyak	*Ty-2+ Ty 3*
Arka Samrat	*Ty-2+ Ty 3*
Arka Abhed	*Ty 2+ Ty 3*

Conclusion: -

The Tomato Leaf Curl Virus is one of the most serious obstacles to the effective cultivation of this crop in India. Aside from the viral symptoms, symptoms triggered by whitefly sucking perplex the breeder and add to the difficulties in developing a management strategy. A detailed understanding of the virus complexes' heterogeneity as well as epidemiology can be an alternative to developing a management strategy. The aim of this study was to combine Ty2 to Ty3 and see how pyramiding affected tomato infection by three different begomovirus

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species. The diagnostic ability of the markers linked to *Ty* genes was assessed and marker-assisted selection was used to develop pyramided tomato lines from the crosses between *Ty* stocks. Nowadays these gene pyramids are used to develop several multiple disease resistant varieties like Arka Rakshak, Arka Abhed etc.

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