

Biology and Pathogenesis of Whitefly Transmitted Begomoviruses Causing Tomato Leaf Curl Disease - Indian and Global Scenario

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In India, diseases caused by whitefly transmitted begomoviruses are on increase affecting cultivation and economic yield of vegetables including tomato, potato, pepper and chilli. Tomato is cultivated in diverse agro-climatic zones in India, throughout the year thus perpetuating virus inoculum and the vector, whitefly population. Tomato leaf curl disease manifests in India in elite cultivars and hybrids. Perusal of the literature and the investigation conducted at Indian Agricultural Research Institute and Indian Institute of Horticultural Research showed that, at present 14 begomoviruses are the causative agents of the leaf curl disease in India. Of these fourteen viruses, two *Tomato leaf curl New Delhi virus* (ToLCNDV) and *Tomato leaf curl Palampur virus* (ToLCPaV) have bipartite genome, DNA A and DNA B. One virus, *Tomato leaf curl Gujarat virus* (ToLCGuV) exists as monopartite in some states and as bipartite in Uttar Pradesh. The other eleven viruses are monopartite. The monopartite tomato leaf curl viruses are characteristically associated with a satellite component half of the length of DNA A which is referred to as betasatellite. The DNA betasatellite is dependent on DNA A for replication, encapsidation and whitefly transmission. The association of betasatellite leads to severe symptom expression, increased viral DNA accumulation and breakdown in host defence. The study conducted on diversity and pathogenicity of tomato begomoviruses established that, earlier understanding that distribution of bipartite virus only in northern region and monopartite viruses in southern region is not any longer correct. In fact at present, monopartite begomovirus like *Tomato leaf curl Karnataka virus* (ToLCKaV) is present throughout India. Among the two bipartite viruses, ToLCNDV is the most devastating pathogen. Contrary to widely held belief, this bipartite virus is very much present in

southern India, in cucurbitaceous hosts. The virus is emerging as a challenging pathogen due to the following; i) the virus infects potato, cotton, bhendi (okra), papaya and lot of other hosts ii) the virus is reported outside India, in Pakistan, Iran and Oman iii) a condition which is seen only in Indian continent ; it is frequently (around 45%) associated with betasatellites. Four betasatellites have been found with ToLCNDV, in different regions. Though it is a bipartite virus it can *trans* replicate betasatellites and systemically spread even in the absence of DNA B component. Agroinoculation of cloned components of ToLCNDV showed, there is no resistance source available against this virus. The majority of monopartite tomato begomoviruses we studied were associated with cognate betasatellites. Agroinoculations with cloned components showed that the resistance to *Tomato leaf curl Bangalore virus* (ToLCBaV), claimed to be present in many of the hybrids/cultivars in southern India is knocked down by betasatellites. Of all the monopartite begomoviruses, *Tomato leaf curl Joydebpur virus* (ToLCJoV) is highly virulent, and DNA A alone could cause severe symptoms in tomato cv. Pusa ruby. Correct identification of the begomovirus and the betasatellite with which it is associated is essential for any precise screening for resistance programme. The existing genes and new gens can be validated once if the virus and the betasatellite association is understood clearly.

