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K. R. JADHAO  
G. R. ROUT\*

Department of Agricultural  
Biotechnology,  
College of Agriculture, Orissa University  
of Agriculture & Technology,  
Bhubaneswar 751 003, India  
\*For correspondence.  
e-mail: grrout@rediffmail.com

## New isolate of *Chilli leaf curl virus* on capsicum (Bell Pepper) under protected cultivation in Dharwad, Karnataka, India

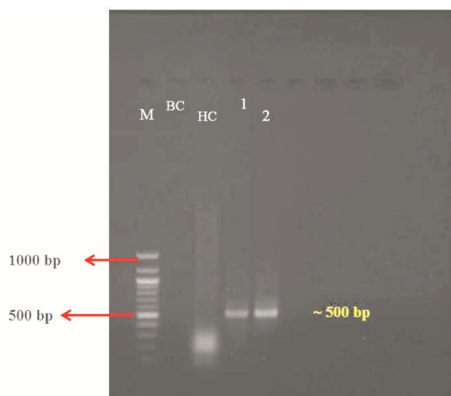
During September 2017, capsicum (*Cap-sicum annuum* L. var. grossum Sendt.) plants in a poly-house at Hi-tech Horticulture, University of Agricultural Sciences, Dharwad showed typical leaf curl symptoms, viz. upward curling of leaf margins, yellowing, reduced lamina, short internodes (Figure 1). DNA was extracted from symptomatic and asymptomatic leaf samples of capsicum plants<sup>1</sup> and PCR amplification was done with *Chilli leaf curl virus* (ChiLCV) coat protein specific primers<sup>2</sup>. Gel electrophoresis on 0.8% agarose revealed ~500 bp size amplicons in all symptomatic samples and no amplification was observed in asymptomatic samples, confirming the presence of ChiLCV on capsicum (Figure 2). Sequencing of PCR products carrying CP gene of *Chilli leaf curl virus-Capsicum-Dharwad* (ChiLCV-Ca-DWD) and results of the BLAST ([www.ncbi.nih.gov/BLAST](http://www.ncbi.nih.gov/BLAST)) search performed to identify sequence homology clearly demonstrated that the CP gene sequence of ChiLCV-Ca-DWD matched with (95%, 96%, 97%, 98% and 99%) Pepper LCV-Varanasi (JN192448.1), Pepper

LCV-Lahore (JN880419.1), ChiLCV-Amritsar (GU136803.1), ChiLCV-Jodhpur (HM007104.1) and ChiLCV-Sonipat (KJ649706.1) viruses respectively. It is clear from the results that ChiLCV is associated with leaf curl symptoms on capsicum. Cluster analysis grouped the ChiLCV-Ca-DWD isolate into two main clusters with similarity co-efficient from

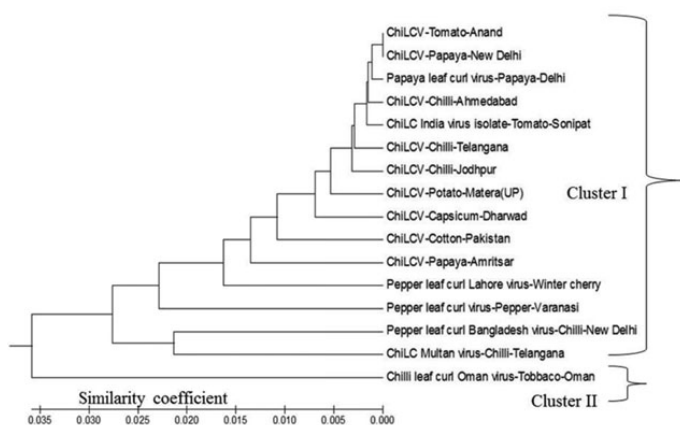
0.000 to 0.035, indicating a good level of diversity. Grouping of the sixteen isolates on the basis of nucleotide relationship resulted in two major divergent groups I and II. ChiLCV-Ca-DWD infecting capsicum in Dharwad locality formed cluster I showing 35% diversity with cluster II. ChiLCV infecting capsicum in Dharwad was found to



**Figure 1.** Leaf curl symptoms, viz. upward curling, puckering, reduced leaf size, stunted growth on capsicum (Bell Pepper).



**Figure 2.** PCR amplification of CP gene of ChiLCV infected capsicum samples. Lanes M, 100–1000 bp marker; BC, Buffer control; HC, Healthy control, 1, 2, ChiLCV-Ca-DWD infected capsicum samples.



**Figure 3.** Phylogenetic relationship of CP gene of ChiLCV-Ca-Dharwad with other ChiLCV isolates reported on different crops.

be closely related to ChiLCV-Potato-Matera, ChiLCV-Chilli-Jodhpur and ChiLCV-Chilli-Telangana respectively (Figure 3). Based on sequence homology studies and phylogenetic analysis, the present study revealed that ChiLCV-Ca-DWD isolate has a high degree of similarity (~99%) to the *Begomovirus* species. To our knowledge, this is the first report of ChiLCV associated with leaf curl disease on capsicum (Bell Pepper) in Karnataka.

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C. CHANNAKESHAVA\*  
M. S. PATIL

*Department of Plant Pathology,  
College of Agriculture,  
University of Agricultural Sciences,  
Dharwad 580 005, India*

\*For correspondence.  
e-mail: channakeshava.agri@gmail.com

## Drowned valleys of Vaigai and Tamiraparani rivers in the Gulf of Mannar region, India

Due to the low gradient of the eastern slopes of the Eastern and Western Ghats of the Indian Peninsula, the easterly flowing Bay of Bengal-bound rivers display stabilized life histories with well-developed landforms of youthful, mature and old stages<sup>1–3</sup>. The studies carried out in Tamil Nadu (TN) deltas revealed the energy levels and their interfaces between the fluvial and marine dynamics during the evolution of the deltas<sup>4</sup>. The input of tectonics over the development of TN deltas has also been brought out in recent studies enumerating the tectonic–fluvial–marine interface dynamics during the evolution of these deltas<sup>3,5</sup>. However,

the two rivers in TN, namely the Vaigai and Tamiraparani, show abrupt truncation in their delta fronts. But the difference between these two is the Vaigai lobate delta, which covers over 2300 km<sup>2</sup> with thousands of arcuately arranged concentric rings of crescent shaped sandy lobes and intervening depressions/water bodies encircling the apex of the delta located in the northwest and spreads up to the present coast in the southeast (Figure 1). This has been attributed to the constant tectonic uplift of the land and consequent progradation of the delta<sup>4</sup>. However, such huge prograding delta seems to have been truncated in the

mainland west of Rameswaram Island (Figure 1). Similarly, the Tamiraparani river which has developed wider floodplains in the central plains in its mature stage, has not developed any major delta in the east along the coast in its old stage<sup>4</sup>. In this context, to unfurl the mysterious truncation of the life-histories of Vaigai and Tamiraparani rivers, the offshore region of these rivers has been studied in parts of the Gulf of Mannar (GoM) region of the Indian Ocean.

In the present study, the GEBCO (General Bathymetric Chart of the Oceans) data were downloaded for GoM and the adjacent regions of India and Sri