



# Watermelon Crinkle Leaf-associated Virus 1 (WCLaV-1) and Virus 2 (WCLaV-2)

Taxonomy: Phenuiviridae, *Coguvirus*, *citrulli* (WCLaV-1) and *henanense* (WCLaV-2)

Watermelon crinkle leaf-associated virus 1 (WCLaV-1) and watermelon crinkle leaf-associated virus 2 (WCLaV-2) are two recently reported viruses infecting watermelon. Both viruses were first discovered in 2017 by high-throughput sequencing (HTS) in China from watermelon plants showing virus-like symptoms (Xin et al., 2017, *Front. Microbiol.* 8); however, their taxonomy was not resolved until 2021 (Zhang et al., 2021, *Arch. Virol.* 166). WCLaV-1 is now officially known as *Coguvirus citrulli* and WCLaV-2 as *Coguvirus henanense* according to the International Committee on the Taxonomy of Viruses (<https://ictv.global/>). WCLaV-1 and WCLaV-2 were found in mixed infections with several other cucurbit-infecting viruses. Subsequently, either one or both viruses have been reported in the United States in Texas (Hernandez et al., 2021, *Plant Dis.* 105), Florida (Hendricks et al., 2022, *Plant Dis.* 106), Georgia (Adeleke et al., 2022, *Plant Dis.* 106), and Oklahoma (Gilford and Ali, 2023, *Plant Dis.* 107) and in other watermelon-growing regions of the world, including Brazil (Maeda et al., 2022, *Plant Dis.* 106) and Australia (Mulholland et al., 2022, *J. Plant Pathol.* 105). There is currently no information on the production impact of either virus.

## Symptoms

Because field-collected watermelon plants that tested positive for WCLaV-1 and WCLaV-2 also were infected with other viruses, definitive symptoms are not yet established. However, plants positive for both WCLaV-1 and WCLaV-2 were reported to show symptoms of crinkling of the upper leaves (Xin et al., 2017). Mechanically-inoculated watermelon plants developed systemic crinkling, mosaic, and stunting relative to non-inoculated plants (Xin et al., 2017). Foliar yellow mottling, chlorosis (yellowing), and wrinkling with thickened, bunched, and upward curling leaves were observed on watermelon in commercial fields in Georgia, USA, that tested positive for WCLaV-1 (Adeleke et al., 2022; **Figures 1, 2, 3, and 4**).

In China, symptoms of crinkling, mosaic, and stunting were seen in laboratory plants infected only with WCLaV-1 (Xin et al., 2017). Similarly in Australia, WCLaV-1 caused subtle leaf bubbling on new growth, leaf distortion near the petiole, and vein breaking in laboratory infected plants. This was in the watermelon



Figures 1 and 2. Watermelon plants infected with watermelon crinkle leaf-associated virus 1 (WCLaV-1) and watermelon crinkle leaf-associated virus 2 (WCLaV-2) often exhibit wrinkling with thickened, bunched, and upward curling new leaves. The plants shown here tested positive only for WCLaV-1.

Credit: Sudeep Bag, University of Georgia.



**Figures 3 and 4. Watermelon plants infected with watermelon crinkle leaf-associated virus 1 (WCLaV-1) and watermelon crinkle leaf-associated virus 2 (WCLaV-2) often exhibit wrinkling with thickened, bunched, and upward curling new leaves. The plants shown here tested positive only for WCLaV-1.**

**Credit: Sudeep Bag, University of Georgia.**

cultivar Sugar Baby; however, the cultivar Candy Red was not infected in the experiments (Mulholland et al., 2022).

Symptoms of WCLaV-1 and WCLaV-2 may be confused with symptoms caused by some other viruses, including begomoviruses, such as squash leaf curl virus (SLCuV) and cucurbit leaf crumple virus (CuLCrV), as well as potyviruses.

## Epidemiology and Spread

Information on the epidemiology and spread of WCLaV-1 and WCLaV-2 is limited. Research to date suggests inefficient mechanical transmission of WCLaV-1 between watermelon plants (Mulholland et al., 2022; Xin et al., 2017), but further study is needed to fully evaluate the potential of these viruses to spread through pruning or other mechanical means. An insect or arthropod vector has yet to be identified for either WCLaV-1 or WCLaV-2; however, the nature of field incidence of the viruses suggests that a mobile vector could be involved in their spread. Related plant viruses in the family Phenuiviridae (order Bunyavirales) are known to be vectored by insects, such as planthoppers and thrips (Kormelink et al., 2011, *Virus Res.* 162). There is no experimental evidence to support transmission of WCLaV-1 and WCLaV-2 through seed.

Incidence reports have, thus far, only identified WCLaV-1 and WCLaV-2 in watermelon; it is not yet known if these viruses are able to infect other cucurbits within the Cucurbitaceae family. The results of mechanical transmission assays conducted in Australia also suggest that watermelon cultivars may differ in their susceptibility to WCLaV-1 (Mulholland et al., 2022). WCLaV-1 has also been detected in asymptomatic buffalo gourd (*Cucurbita foetidissima*) plants, indicating that this wild relative of cultivated melon could serve as a reservoir host for the virus (Hernandez et al., unpublished). Additional studies are needed to determine the host range of WCLaV-1 and WCLaV-2.

Both WCLaV-1 and WCLaV-2 often occur in mixed infection with each other and with other cucurbit-infecting viruses, including cucurbit chlorotic yellows virus (CCYV) in Florida (Hendricks et al., 2022), watermelon mosaic virus (WMV) in Australia (Mulholland et al., 2022), groundnut ringspot virus (GRSV) in Brazil (Maeda et al., 2022), and potyviruses (Mulholland et al., 2022). As such, the specific involvement of WCLaV-1 and WCLaV-2 in symptom development and plant disease has yet to be determined. Reports of WCLaV-1 and WCLaV-2 indicate greater incidence and prevalence of WCLaV-1 over WCLaV-2 under field conditions (Hernandez et al., unpublished; Hendricks et al., 2022; Maeda et al., 2022).

## Geographic Incidence

WCLaV-1 and WCLaV-2 were first identified in 2017 in China. Since then, new reports of both viruses have emanated from several cucurbit-producing regions of the world.

- **United States:** Texas (2021), Florida (2022), Georgia (2022), Oklahoma (2022).
- **Asia:** China (2017).
- **Australia:** New South Wales (2022).
- **South America:** Brazil (2022).

*Note: Years in parentheses indicate when WCLaV-1 and/or WCLaV-2 was first officially reported in that location.*

For the most up-to-date information on geographical incidence, please visit the [EVCWG website](#).

## Detection/Diagnosis

Symptoms alone are inadequate for diagnosing WCLaV-1 and WCLaV-2. There are currently no serological methods available for diagnosing either virus; detection requires the use of molecular assays that are commonly used in many research and diagnostic laboratories.

Currently, molecular assays using RT-PCR (reverse transcription polymerase chain reaction) with virus-specific primers that were developed for the detection of each virus are routinely used to detect WCLaV-1 and/or WCLaV-2 in samples (Adeleke et al., 2022; Hendricks et al., 2021; Hernandez et al., 2021; Maeda et al. 2021; Xin et al., 2017).

Contact your [local plant diagnostic laboratory](#) to determine testing capabilities.

Visit the [EVCWG website](#) for information on diagnostic laboratories in your state, protocol publications, and references describing appropriate detection methods for WCLaV-1 and WCLaV-2.

## Management

Since information on the epidemiology and economic impact of WCLaV-1 and WCLaV-2 is currently limited, specific management methods for these viruses are not yet available. Until additional information becomes available, management recommendations should focus on general best practices for the management of diseases, including those caused by viruses and insects. The use of clean plant practices when propagating watermelon transplants is also important.

**Begin with virus-free transplants.** Transplants should be visibly free of virus symptoms and insects. Purchase seeds or transplants from reputable sources.

**Use good sanitation practices in transplant production.** Grow transplants in insect-proof facilities. Keep the greenhouse floor and surrounding areas weed-free. Disinfect trays and benches between crops. Monitor for insects and apply approved treatments as needed.

**Follow local and/or regional recommendations for cucurbit production.** Consult local or regional guidelines for variety recommendations and production practices, including fertilization.

**Follow local and/or regional recommendations for disease and insect management.** Consult local or regional guidelines to determine appropriate fungicides and insecticides for the management of common diseases and insects. When appropriate, follow local recommendations for insect thresholds.

Contact your [local plant diagnostic laboratory](#) if you observe plants suspected to be infected with WCLaV-1 and WCLaV-2.

## Resources

Xin, M., Cao, M., Liu, W., Ren, Y., Zhou, X., and Wang, X. 2017. [Two negative-strand RNA viruses identified in watermelon represent a novel clade in the order Bunyavirales.](#) *Frontiers in Microbiology* 8:1514.

Visit the [EVCWG website](#) for a full list of cited references.

## Acknowledgement

This work is a publication of the Emerging Viruses in Cucurbits Working Group (EVCWG). It is supported by funding from the USDA NIFA (Agreement 2018-70006-28884) through the Southern IPM Center's grant program project S22-026. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and the EVCWG and do not necessarily reflect the views of the USDA NIFA or the Southern IPM Center.

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EVCWG Publication 2304 (May 2023)

**Author:** Olufemi J. Alabi, Texas A&M University System, and Sudeep Bag, University of Georgia.

**Senior editor:** Rebecca A. Melanson, Mississippi State University, and William M. Wintermantel, USDA-ARS.

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