



Tomato Chlorotic Dwarf Viroid

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Tomato (*Solanum lycopersicum*) is an important vegetable crop in Hawai'i, grown in field and greenhouse operations. It is also a common host of many pests and pathogens in Hawai'i, including mites, insects, fungi, nematodes, bacteria, and viruses. Another group of pathogens, known as viroids, are also a major hindrance to tomato production around the world. Until recently, there have been no reports of viroid infection in tomato or any other crop in Hawai'i. In 2017, however, a disease caused by *Tomato chlorotic dwarf viroid* (TCDVd) was identified in greenhouse-grown tomato for the first time in the state.

Virus vs. Viroid

Viruses and viroids are both sub-cellular pathogens that require living host cells to replicate. Disease symptoms caused by viruses and viroids in plants are often similar. Viruses possess either RNA or DNA genomes that have genes that encode proteins and are usually encapsidated by a protective protein shell. Conversely, viroids are circular RNA molecules that do not possess any genes and lack a protein shell. Most viruses are transmitted plant-to-plant by insect vectors, whereas examples of viroid transmission by



Fig. 1. Symptoms of *Tomato chlorotic dwarf viroid* (TCDVd) infection on tomato: plant showing stunted growth and chlorotic foliage with downward curling of leaves and leaflets (epinasty).

insects are rare. To date, viroids have only been found in plants and pose no threat to human or animal health.

Symptoms in Tomato

Symptoms caused by TCDVd can vary in severity depending on the tomato variety and environmental conditions. Typical symptoms include stunting of the plant by reduction in internode length (Fig. 1), as well as foliar irregularities such as chlorosis, necrosis, and purpling of leaflets (Fig. 2), and epinasty (downward curling of the leaflet margin) (Fig. 1). The symptoms caused by TCDVd can be the same as those caused by other viroids (co)-infecting tomato such as *Columnea latent viroid*, *Potato spindle tuber viroid*, and *Tomato apical stunt viroid*.

Spread of TCDVd

TCDVd is primarily spread plant-to-plant by grafting, contaminated tools, and leaf or stem contact of neighboring plants. Even touching a healthy plant after an infected plant can result in transmission. There are no insect vectors known to spread TCDVd, although it is possible that chewing insects and bumblebees can spread viroids from plant to plant in a manner similar to mechanical transmission. TCDVd can enter the seed of infected plants, resulting in infected seedlings after

germination. The local, regional, or global distribution of infected seed represents the most likely pathway for long-distance spread of the pathogen.

Host Range of TCDVd

In addition to tomato, TCDVd has been found in petunia (*Petunia x hybrida*), trailing verbena (*Verbena x hybrida*), dwarf periwinkle (*Vinca minor*), and scarlet angel's trumpet (*Brugmansia sanguinea*). Laboratory inoculation experiments indicate TCDVd is also able to infect ornamental flowers such as lobelia (*Lobelia erinus*), marigolds (*Calendula officinalis*, *Tagetes* spp.), and dahlia (*Dahlia* spp.), as well as pepper (*Capsicum annuum*), eggplant (*Solanum melongena*), and several weed and herbaceous species such as jimsonweed (*Datura* spp.), *Nicotiana* spp., and other solanaceous plants (*Solanum* spp.).

Current Geographic Range of TCDVd

TCDVd was first discovered in tomato seedlings grown in Manitoba, Canada, from seed imported from the Netherlands. Symptoms resembled those caused by a related but distinct viroid, *Potato spindle tuber viroid* (PSTVd). TCDVd has since been found in India (2006), Czech Republic (2008), Mexico (2008), Japan (2008), France (2010), Slovenia (2011), and Norway (2012). In some of these locations, TCDVd has only been found in petunia plants. In the USA, TCDVd has been found infecting greenhouse tomatoes in Arizona and Colorado. The viroid has been successfully eradicated in several of these locations.

Reporting and Management of TCDVd

If TCDVd is suspected at a farm or home garden, immediately contact either the Hawaii Pest Hotline (808-643-7378/PEST) and the College of Tropical Agriculture and Human Resource's Cooperative Extension Service (<https://www.ctahr.hawaii.edu/site/map.aspx>). There are currently no diagnostic assays available for detection of TCDVd in the field, so samples will need to be collected for laboratory analysis.

TCDVd is a pathogen that can be successfully managed and even eradicated. For both greenhouse and field operations, sanitation is of critical importance. Once it has been confirmed that TCDVd is present in a farm or garden, all host plants in the area, whether visibly affected or not, should be immediately removed or destroyed.



Fig. 2. Clockwise from upper left: early symptom onset; chlorosis on leaflet margins; advanced chlorosis; severe purpling and necrosis.

Plants can be sprayed with an approved herbicide or buried, since the viroid will not survive or remain viable in dead plants. If tilling plants under with farm equipment, be sure to thoroughly clean and disinfect equipment after working in areas with diseased plants. Workers should wear gloves and protective suits when removing infected plants. These should be removed and disposed of before working with healthy plants. This will prevent spread of the viroid through contaminated hands or clothing. In greenhouse operations, once the infected and surrounding plants are removed, the pots, medium, and/or hydroponic equipment should be either replaced or thoroughly sanitized using an effective disinfectant. All tools such as pruning shears should also be replaced or thoroughly sanitized by heat (using a propane torch) or disinfectant after use. Studies have shown that 2% Virkon S (DuPont) or fresh (made daily) 10% bleach solutions are effective at sanitizing tools, even with short exposure periods (<10 seconds). If possible, a disinfectant should be run through irrigation or

hydroponic systems, followed by clean water.

Once infected plants have been removed from an area and tools and equipment have been sanitized, it is essential to continue monitoring for newly infected plants to prevent re-establishment of the viroid. Seeds and seedlings should be obtained only from reputable sources and certified to be free of TCDVd and other pathogens. Hand tools should be regularly sanitized during pruning or harvesting. Ideally this tool sanitation should be done before working on a new plant.

Disclaimer

Any mention of company names or products does not imply endorsement by UH CTAHR. Always confirm pesticides are registered for the State of Hawai'i before use. Be sure to read, understand, and follow the label instructions of any pesticide prior to application.

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