

# EPPO Datasheet: *Curtovirus betae*

Last updated: 2023-05-11

## IDENTITY

**Preferred name:** *Curtovirus betae*

**Taxonomic position:** Viruses and viroids: Monodnaviria:  
Shotokuvirae: Cressdnaviricota: Repensiviricetes: Geplafuvirales:  
Geminiviridae

**Other scientific names:** *BCTV*, *Beet curly top curtovirus*, *Beet curly top virus*, *Beet mild curly top virus*, *Beet severe curly top virus*, *Cal/Logan BCTV*, *Colorado BCTV*, *Pepper curly top virus*, *Pepper yellow dwarf virus*, *Potato green dwarf virus*, *Sugarbeet curly leaf virus*, *Sugarbeet virus 1*, *Tomato yellows virus*, *Western yellow blight virus*, *Worland 4 BCTV*

**Common names:** curly leaf of sugarbeet, curly top of beet, curly top of sugarbeet, green dwarf of potato, western yellow blight, yellows of tomato

[view more common names online...](#)

**EPPO Categorization:** A1/A2 (formerly)

[view more categorizations online...](#)

**EU Categorization:** A1 Quarantine pest (Annex II A)

**EPPO Code:** BCTV00



[more photos...](#)

## Notes on taxonomy and nomenclature

Varsani *et al.* (2014) redefined curtoviruses from many separate viruses into a single virus, *Beet curly top virus*, with many strains. There are currently many strains of beet curly top virus that differ in symptomatology and severity on hosts including BCTV-Svr, BCTV-Mld, BCTV-Wor, BCTV-PeCT, BCTV-PeYD, BCTV-SpCT, BCTV-CO (Lam *et al.*, 2009; Chen *et al.*, 2010; Varsani *et al.*, 2014; Chen *et al.*, 2017; Strausbaugh *et al.*, 2017; Peinado *et al.*, 2018).

Curtoviruses contain 7 ORF (open reading frames) or coding regions, with 3 on the virion sense DNA strand and 4 on the complementary sense strand. They also contain a conserved stem loop intergenic region. A related virus group, becurtoviruses are also members of the family Geminiviridae (Heydarnejad *et al.* 2013). Members of this group include Beet curly top Iran virus (BCTIV) and Spinach curly top Arizona virus (SCTAV). Becurtoviruses have 5 ORFs with 3 on the virion sense strand that are closely related to the corresponding ORFs of curtoviruses, and 2 ORFs on the complementary-sense strand that lack any similarity. Becurtoviruses have a slightly different sequence from curtoviruses in their stem loop intergenic region.

## HOSTS

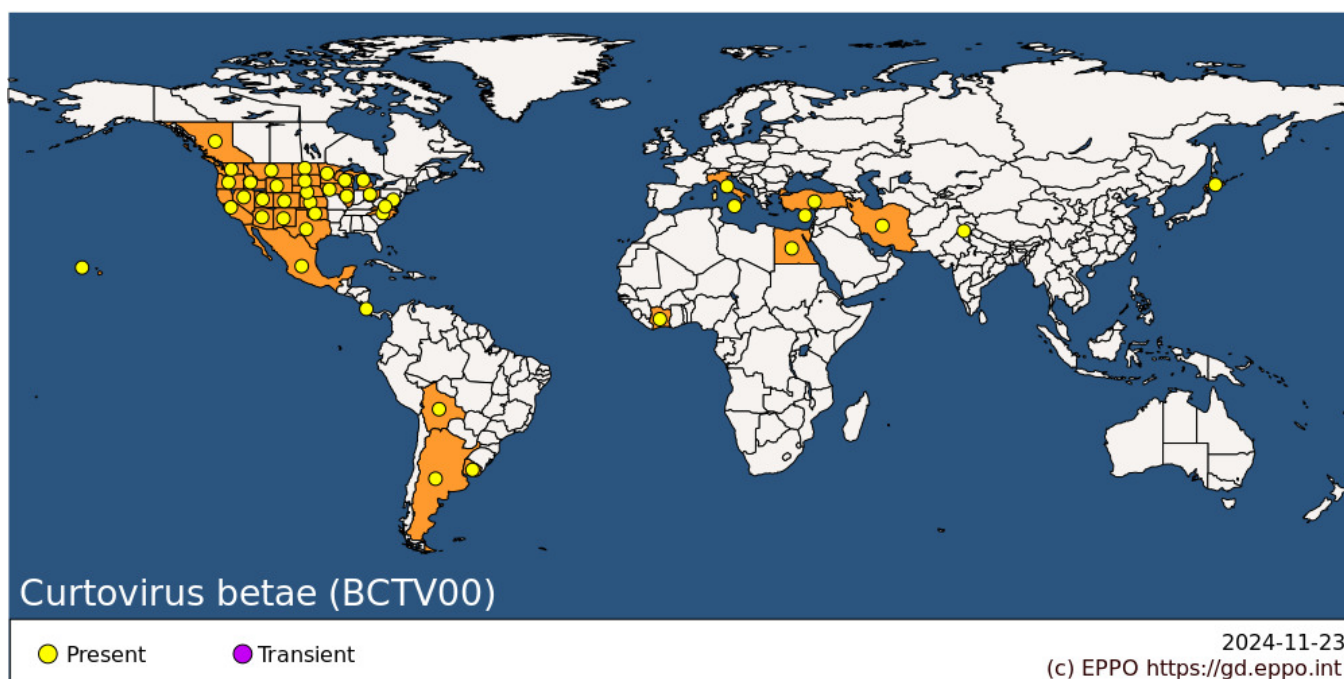
BCTV has an extremely wide host range, but its most economically important crop hosts are bean (*Phaseolus vulgaris*), common coriander (*Coriandrum sativum*), cucurbits, peppers (*Capsicum* spp.), potato (*Solanum tuberosum*), spinach (*Spinacia oleracea*), sugarbeet (*Beta vulgaris*) and tomato (*Solanum lycopersicum*) (Bennett, 1971; Creamer *et al.*, 2003; Strausbaugh *et al.*, 2008, Chen *et al.*, 2010; Chen & Gilbertson, 2016). In addition to its crop hosts, a number of other species, including weeds, in many families are reported as hosts, including in Asteraceae, Brassicaceae, Chenopodiaceae, Geraniaceae and Solanaceae.

**Host list:** *Acmispon americanus*, *Acmispon strigosus*, *Amaranthus deflexus*, *Amaranthus graecizans*, *Amaranthus retroflexus*, *Armoracia rusticana*, *Atriplex argentea* var. *expansa*, *Atriplex bracteosa*, *Atriplex fruticulosa*, *Atriplex patula*, *Atriplex rosea*, *Bassia scoparia*, *Beta vulgaris*, *Brassica oleracea* var. *capitata*, *Brassica rapa*, *California macrophylla*, *Cannabis sativa*, *Capsella bursa-pastoris*, *Capsicum annuum*, *Capsicum baccatum*, *Capsicum chacoense*, *Capsicum chinense*, *Capsicum frutescens*, *Celosia argentea*, *Chenopodium murale*, *Chenopodium leptophyllum*, *Citrullus lanatus*, *Coreopsis tinctoria*, *Coriandrum sativum*, *Cosmos bipinnatus*, *Cucumis melo*, *Cucurbita pepo*, *Datura ferox*, *Dianthus plumarius*, *Dysphania ambrosioides*, *Erodium botrys*, *Erodium cicutarium*, *Gnaphalium chilense*

, *Lasthenia minor*, *Lepidium nitidum*, *Malva parviflora*, *Malva pusilla*, *Medicago polymorpha*, *Microseris douglasii*, *Mirabilis jalapa*, *Modiola caroliniana*, *Monolepis nuttalliana*, *Moricandia arvensis*, *Pelargonium x hortorum*, *Persicaria amphibia*, *Persicaria lapathifolia*, *Persicaria maculosa*, *Petroselinum crispum*, *Petunia hybrids*, *Phacelia ramosissima*, *Phaseolus vulgaris*, *Physalis acutifolia*, *Plantago erecta*, *Polygonum aviculare*, *Raphanus sativus*, *Scabiosa atropurpurea*, *Solanum douglasii*, *Solanum lycopersicum*, *Solanum tuberosum*, *Sonchus asper*, *Spinacia oleracea*, *Streptanthus lasiophyllus*, *Tropaeolum majus*, *Viola cornuta*, *Viola tricolor*, *Xanthium spinosum*, *Xerochrysum bracteatum*, *Zinnia elegans*

## GEOGRAPHICAL DISTRIBUTION

BCTV is thought to have originated in the eastern Mediterranean area and to have spread from there to America (Bennett, 1971). The virus has been widely recorded from Canada to Mexico, and there are also records in other parts of the world.



**EPP0 Region:** Cyprus, Italy (mainland, Sicilia), Türkiye

**Africa:** Cote d'Ivoire, Egypt

**Asia:** India (Punjab), Iran, Japan (Hokkaido)

**North America:** Canada (British Columbia), Mexico, United States of America (Arizona, California, Colorado, Hawaii, Idaho, Illinois, Iowa, Kansas, Maryland, Michigan, Minnesota, Montana, Nebraska, Nevada, New Mexico, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, South Dakota, Texas, Utah, Virginia, Washington, Wisconsin, Wyoming)

**Central America and Caribbean:** Costa Rica

**South America:** Argentina, Bolivia, Uruguay

## BIOLOGY

The virus is not easily transmitted by mechanical means. BCTV is primarily found in phloem tissue, where it causes necrosis and hyperplasia (Bennett, 1971). Virus replication occurs in the plant nucleus.

The vectors of BCTV are phloem-feeding leafhoppers. *Circulifer* (= *Neoliturus*) *tenellus* is the only vector of BCTV in North America, while in the Middle East, *C. opacipennis* and *C. haematoceps* have also been reported as vectors (Kheyri and Alimoradi, 1969; Taheri *et al.*, 2012). The virus is transmitted in a persistent circulative manner and does not multiply in the leafhopper vector. The leafhoppers can acquire the virus within 1 hour of feeding on infected material, with a 4-hour latent period sufficient to transmit the virus. The leafhoppers can retain the virus for up to 30

days (Soto & Gilbertson, 2003).

Many strains differing in virulence, symptomatology and host range have been reported, especially in North America (Thomas & Mink, 1979).

## **DETECTION AND IDENTIFICATION**

### **Symptoms**

Some symptoms induced by BCTV infection, such as plant stunting and thickened curled leaves are similar throughout its host range (Bennett, 1971).

In sugarbeet, the most reliable, early diagnostic feature is an inward rolling of the leaf margins and a clearing of the minute veins on the youngest, innermost leaves. Subsequently, development of pin prick-like protuberances on the veins of the lower leaf surfaces is characteristic. Leaves often become chlorotic, thick, crisp and brittle.

In tomatoes in the field, there is an inward rolling of leaflets along the midrib; the petiole and midrib frequently curve downwards, giving the leaf a drooping but not wilting appearance. Leaves become thickened and crisp and may later turn yellow with purple veins. Fruits, if formed, ripen prematurely and seeds are abortive. Leaves of tomato plants grown in glasshouses lack the purple venation. Inward curling of leaflets occurs, especially in older plants. There is a marked stunting of plants infected at an early stage, leading to whole plant chlorosis and possible death.

In other crops, in addition to stunting of plants and thickened curled leaves, symptoms include:

- - on peppers, chlorosis, crisp brittle leaves, stiff plant stems, lack of fruit set, and small rounded fruit if infection occurs after fruit set. Plants do not grow taller after infection (Creamer, 2003).
- - on cucurbits, stunting of leaves, poor fruit set, and sometimes increased vertical growth.
- - on bean, stunting and curling of leaves. Some bean varieties show chlorosis and reduced fruit set.
- - on spinach and other leafy vegetables, stunting and curling of leaves, and chlorosis.
- - on potato, yellowish, inward-rolled leaflets and sometimes a bending of the petioles. In advanced stages of infection, dwarfed shoots frequently develop in the axis of leaves near the tip of the plant. Infected plants can become chlorotic and die. - on hemp (*Cannabis sativa*), symptoms vary, but include stunted plants with thin curled leaves, chlorosis, mottling, and thickened bushy plants with symptoms differing among plants and locations (Giladi *et al.*, 2020; Chiginsky *et al.*, 2021).

Weed hosts rarely show distinctive symptoms of BCTV infection (Creamer *et al.*, 1996).

### **Morphology**

Small geminate particles 18-22 nm in diameter, single or paired (geminivirus) (Thomas & Mink, 1979).

### **Detection and inspection methods**

Detection of BCTV infection is based on specific symptoms on each crop host. Detection of BCTV is possible using polymerase chain reaction (PCR) with virus-specific primers based on the capsid region (Creamer *et al.*, 2005; Chen *et al.*, 2010), which will detect most strains of BCTV (except BCTV-PeCTV), and does not cross-react with

becurtoviruses. PCR can also be carried out with strain-specific primer sets (Chen *et al.*, 2010). BCTV can also be detected by ELISA using virus-capsid specific antibodies (Durrin *et al.*, 2010), which, as for the PCR on the capsid region, will react with most strains of BCTV (but not all) and will not cross-react with becurtoviruses.

## **PATHWAYS FOR MOVEMENT**

BCTV is moved locally by its insect vectors. Internationally, it may be carried in infected host material, or possibly in the vector. There are no reports of the virus being seed-borne or tuber-borne and, therefore, such plant parts are not considered as possible infection sources.

Although seedlings of sugarbeet and tomato may be traded, they are less likely to be infected than mature plants and they show distinct symptoms when infected. In addition, tomato and pepper plants are poor sources for virus acquisition by the leafhopper vectors because they are not preferred hosts (Hudson *et al.*, 2010). Infected sugarbeet roots intended for planting, including breeding stocks, could potentially be a pathway.

## **PEST SIGNIFICANCE**

### **Economic impact**

The disease was first recognized causing important damage in 1888, in Nebraska (USA), and has since caused frequent and often very destructive outbreaks throughout the Western USA. Economic impact varies by location and crop in the Western USA, with periodic severe outbreaks in California in tomatoes, in New Mexico in peppers, in Colorado in tomatoes and hemp, and in Wyoming and Idaho in sugarbeets (Creamer *et al.*, 2003; Strausbaugh *et al.*, 2008; Chen & Gilbertson, 2016). Some strains are currently found only in a limited geographic region. Other strains are only found infecting certain crop plants and weeds. Some strains only cause symptoms on certain crop hosts. Infection rate may be above 50% per field in a certain years, with an infected plant producing no yield for tomatoes and peppers, and reduced sugar content for sugarbeets. In the EPPO region, in contrast, BCTV is not considered a significant pest. In Türkiye, beet curly top Iran becurtovirus was recently reported as the main viral agent responsible for beet curly top disease in sugarbeets (Yildirim *et al.*, 2023).

### **Control**

Management of the virus is possible through a combination of measures, which is dependent on location and crop. Insecticide sprays to control the vector are applied in the breeding areas of the leafhoppers in California in the spring and in and around crop fields when leafhopper levels increase (CDFA, 2019). The disease is managed in sugarbeet through the use of seed-applied systemic insecticides (Strausbaugh *et al.*, 2012). There is some reported resistance to the virus in bean (*Phaseolus vulgaris*, dry bean type - Larsen *et al.*, 2010), while resistance has been identified in wild sugarbeet relatives (Eujayl *et al.*, 2018). Cultural controls, such as changing planting date, overseeding with late thinning, kaolin clay applications and improved weed management have been used in peppers (Creamer *et al.*, 2005).

### **Phytosanitary risk**

BCTV used to be an EPPO A2 quarantine pest (EPPO, 1982), on the basis of the reported problems in North America. However, in view of the probable origin of the virus in the eastern Mediterranean area, its presence in several Mediterranean countries, its failure to spread in the EPPO region, the limited natural distribution of its vectors and its very minor importance in Europe, it was deleted from the EPPO list in 1984. There is a certain danger that severe strains of the virus could spread into the EPPO region in areas where sugarbeets, tomatoes and peppers are grown. The risk is highest in areas with warm dry climates where the leafhopper vector could become established on weed hosts.

## **PHYTOSANITARY MEASURES**

Plants for planting of *Beta vulgaris* are the main pathway for entry of the virus (see Pathways for movement). The EU requires that, for plants for planting of *Beta vulgaris* (other than seeds), no symptoms of BCTV should have been

observed at the place of production since the beginning of the last complete cycle of vegetation (EU, 2023). Only plants with roots are relevant for phytosanitary requirements, as seeds and tubers do not carry the virus.

## REFERENCES

- Bennett CW (1971) The curly top disease of sugarbeet and other plants. *Monograph, American Phytopathological Society* No. 7, 81 pp.
- CDFA (2019) Curly top Virus: Program Details. California Department of Food and Agriculture. [https://www.cdfa.ca.gov/plant/ipc/curlytopvirus/ctv\\_hp.htm](https://www.cdfa.ca.gov/plant/ipc/curlytopvirus/ctv_hp.htm) [Accessed on 28 March 2023].
- Chen L-F & Gilbertson RL (2016) Transmission of curtoviruses (*Beet curly top virus*) by the beet leafhopper (*Circulifer tenellus*). In *Vector Mediated Transmission of Plant Pathogens* (ed Brown JK), pp.243-262. American Phytopathological Society, St. Paul, MN.
- Chen L-F, Batuman O, Aegerter BJ, Willems J & Gilbertson RL (2017) First report of curly top disease of pepper and tomato in California caused by the Spinach curly top strain of Beet curly top virus. *Plant Disease* **101**, 1334.
- Chen L, Brannigan K, Clark R & Gilbertson RL (2010) Characterization of curtoviruses associated with curly top disease of tomato in California and monitoring for these viruses in beet leafhoppers. *Plant Disease* **94**, 99-108.
- Chinginsky J, Langemeier K, MacWilliams J, Albrecht T, Cranshaw W, Fulladolsa AC, Kapuscinski M, Stenglein M & Nachappa P (2021) First insights into the virus and viroid communities in hemp (*Cannabis sativa*). *Frontiers in Agronomy* **3**, 778433.
- Creamer R (2003) Beet curly top virus. In *Compendium of Pepper Diseases* (eds Pernezny K, Roberts P, Murphy JF, Goldberg NP), pp. 26-27. APS Press., St. Paul, MN.
- Creamer R, Carpenter J & Rascon J (2003) Incidence of the beet leafhopper, *Circulifer tenellus* (Homoptera: Cicadellidae) in New Mexico. *Southwestern Entomologist* **28**, 177-182.
- Creamer R, Hubble H & Lewis A (2005) Curtovirus infection of chile pepper in New Mexico. *Plant Disease* **89**, 480-486.
- Creamer R, Luque M & Howo M (1996) Epidemiology and incidence of beet curly top geminivirus in naturally infected weed hosts. *Plant Disease* **80**, 533-535.
- Creamer R, Sanogo S, El-Sebai O, Carpenter J & Sanderson R (2005) Kaolin-based foliar reflectant affects physiology, incidence of *Beet curly top virus*, but not yield of chile pepper. *HortScience* **40**, 574-576.
- Durrin J, Nikolaeva O, Strausbaugh C & Karasev A (2010) Immuno-detection of two curtoviruses infecting sugar beet. *Plant Disease* **94**, 972-976.
- EPPO (1982) Data sheets on quarantine organisms No. 89, Beet curly top virus. *EPPO Bulletin* **12**(1), 157-162.
- EU (2023) Commission Implementing Regulation (EU) 2019/2072 of 28 November 2019 establishing uniform conditions for the implementation of Regulation (EU) 2016/2031 of the European Parliament and the Council, as regards protective measures against pests of plants, and repealing Commission Regulation (EC) No 690/2008 and amending Commission Implementing Regulation (EU) 2018/2019. Consolidated version 32019R2072, 11/01/2023. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019R2072> [Accessed on 28 March 2023].
- Eujayl I, Strausbaugh C & Lu C (2018) Registration of sugarbeet doubled haploid line KDH13 with resistance to Beet curly top. *Journal of Plant Registrations* **12**, 288.
- Giladi Y, Hadad L, Luria N, Cranshaw W, Lachman O & Dombrovsky A (2020) First report of beet curly top virus infecting *Cannabis sativa* in western Colorado. *Plant Disease* **104**, 999.

- Heydarnejad J, Keyvani N, Razavinejad S, Massumi H & Varsani A (2013) Fulfilling Koch's postulates for beet curly top Iran virus and proposal for consideration of a new genus in the family Geminiviridae. *Archives of Virology* **158**, 435-443.
- Hudson A, Richman DB, Escobar I & Creamer R (2010) Comparison of the feeding behavior and genetics of beet leafhopper (*Circulifer tenellus*, Baker) populations from California and New Mexico. *Southwestern Entomologist* **35**, 241-250.
- Kheyri M & Alimoradi I (1969) *The leafhoppers of sugarbeet in Iran and their role in curly-top virus disease*. Sugarbeet Seed Institute Karaj, Entomological Research Division, Tehran, Iran.
- Lam N, Creamer R, Rascon J & Belfon R (2009) Characterization of a new curtovirus, *Pepper yellow dwarf virus*, from chile pepper and distribution in weed hosts in New Mexico. *Archives of Virology* **154**, 429-436.
- Larsen RC, Kurowski CJ & Miklas PN (2010) Two independent quantitative trait loci are responsible for novel resistance to beet curly top virus in common bean landrace G122. *Phytopathology* **100**, 972-978.
- Peinado SA, Achata Bottger J, Chen, L-F, Gilbertson RL & Creamer R (2018) Evidence of curtovirus competition and synergy in co-infected plant hosts. *African Journal of Microbiology Research* **12**, 254-262.
- Soto MJ & Gilbertson RL (2003) Distribution and rate of movement of the curtovirus *Beet mild curly top virus* (family *Geminiviridae*) in the beet leafhopper. *Phytopathology* **93**, 478-484.
- Strausbaugh CA, Eujayl IA & Wintermantel WM (2017) *Beet curly top virus* strains associated with sugar beet in Idaho, Oregon, and a Western U.S. collection. *Plant Disease* **101**, 1373-1382.
- Strausbaugh CA, Wenninger EJ & Eujayl IA (2012) Management of severe curly top in sugar beet with insecticide. *Plant Disease* **96**, 1159-1164.
- Strausbaugh CA, Wintermantel WM, Gillen AM & Eujayl IA (2008) Curly top survey in the western United States. *Phytopathology* **98**, 1212-1217.
- Taheri H, Izadpanah K & Behjatnia SAA (2012) *Circulifer haematoceps*, the vector of beet curly top Iran virus. *Iranian Journal of Plant Pathology* **48**(1), 45.
- Thomas P & Mink GI (1979) Beet curly top virus. *CMI/AAB Descriptions of Plant Viruses* No. 210. Association of Applied Biologists, Wellesbourne, UK.
- Varsani A, Martin DP, Navas-Castillo J, Moriones E, Hernández-Zepeda C, Idris A, Murilo Zerbini F & Brown JK (2014) Revisiting the classification of curtoviruses based on genome-wide pairwise identity. *Archives of Virology* **159**(7), 1873-1882.
- Y?ld?r?m K, Kavas M, Küçük ?S, Seçgin Z, Saraç ÇG (2023) Development of highly efficient resistance to Beet Curly Top Iran Virus (Becurtovirus) in sugar beet (*B. vulgaris*) via CRISPR/Cas9 System. *International Journal of Molecular Sciences* **24**(7), 6515. <https://doi.org/10.3390/ijms24076515>

## ACKNOWLEDGEMENTS

This datasheet was extensively revised in 2023 by Rebecca Creamer (New Mexico State University, NM, USA). Her valuable contribution is gratefully acknowledged.

## How to cite this datasheet?

EPPO (2024) *Curtovirus betae*. EPPO datasheets on pests recommended for regulation. Available online. <https://gd.eppo.int>

## Datasheet history

This datasheet was first published in the EPPO Bulletin in 1982 and revised in the two editions of 'Quarantine Pests for Europe' in 1992 and 1997, as well as in 2019. It is now maintained in an electronic format in the EPPO Global Database. The sections on 'Identity', 'Hosts', and 'Geographical distribution' are automatically updated from the database. For other sections, the date of last revision is indicated on the right.

CABI/EPPO (1992/1997) *Quarantine Pests for Europe (1<sup>st</sup> and 2<sup>nd</sup> edition)*. CABI, Wallingford (GB).

EPPO (1982) Data sheets on quarantine organisms, Beet curly top virus. *EPPO Bulletin* **12**(1), 157-162.



Co-funded by the  
European Union