

Curly top of sugar beet

beet curly top virus (BCTV)



Figure 1. Healthy sugar beet crop (left) and crop infected with beet curly top virus (right) © Oliver T. Neher, The Amalgamated Sugar Company, Bugwood.org

Background

Beet curly top virus (BCTV) is a plant pathogenic virus which causes curly top of beet disease. BCTV and its vector are believed to have originated in the eastern Mediterranean basin and spread from there to the USA, where it was one of the first viral plant diseases to be recognised in the field after being detected in Nebraska in 1888. It has since spread extensively in the USA and is reported to cause significant losses in commercial crops.

BCTV is currently absent from the UK but has the potential to cause significant damage to both outdoor crops of sugar beet (*Beta vulgaris*) and protected crops such as tomato (*Solanum lycopersicum*) and peppers (*Capsicum annuum*) should it be introduced.

Infection with BCTV results in curly top disease which gives hosts severely stunted growth with crinkled, rolled and chlorotic foliage, and blistered and swelled veins on the underside of leaves. Younger plants and seedlings often die when infected. Symptoms in the main two hosts of concern to the UK (sugar beet and tomato) are broadly similar with leaf rolling leading to leaves becoming thick, crisp, and brittle. Sugar beet tubers can have excessively hairy roots and black longitudinal concentric rings when cut, whilst tomato plants become rigid, stunted and fruits can prematurely ripen.

Geographical Distribution

BCTV has been reported from Africa: Cote d'Ivoire and Egypt; North America: Canada, Costa Rica, Mexico and USA; South America: Argentina, Bolivia and Uruguay; Asia: India, Iran, Japan, Republic of Korea; and Europe: Cyprus, Italy, and Türkiye.

The distribution of the only known vector, the beet leafhopper (*Circulifer tenellus* (Baker)) is broadly similar to that of the virus. It is not reported in all the countries in which the virus is known to occur, but this may be due to the distribution not being fully known rather than it being absent.

Neither the vector nor the virus are known to be present in the UK.

Host Plants

BCTV can infect a wide range of hosts, with it being known to infect over 300 species in 44 plant families. Many of these hosts do not show signs of disease, but the virus can infect several hosts of concern to the UK including beans (*Phaseolus vulgaris*), cucurbits (*Cucurbitaceae*), pepper, potato (*Solanum tuberosum*), sugar beet and tomato. It can also infect common weeds such as pigweed (*Amaranthus* spp.) and fat hen (*Chenopodium album*). *Circulifer tenellus* is also able to feed on a wide range of herbaceous plants and shrubs.

Description

Beet curly top virus is the type species of the *Curtovirus* genus in the Geminiviridae family. The Geminiviridae family is split by looking at differences in the insect vectors, host range, symptom phenotype, coat proteins and genomics. Curtoviruses are vectored by leaf hoppers, infect a variety of vegetable crops, and usually have seven genes within their genomes.

Recent revisions of the Curtoviruses have meant that several formerly distinct species, such as *Beet severe curly top virus* and *Beet mild curly top virus* have been reassigned as strains of BCTV. Another species, *Beet curly top Iran virus* causes a similar leaf curl disease of sugar beet in Iran but the virus belongs to a different genus – the *Becurtovirus* within the Geminiviridae, and is distinguished from BCTV via diagnostic tests.

Circulifer tenellus is the only known vector of BCTV (Fig 2), although a second species, *C. opacipennis*, is suspected to be a vector. *Circulifer tenellus* is a leafhopper in the family Cicadellidae, sub-family Deltocephalinae. Insects from this group are typically phloem sap feeders and are responsible for vectoring a number of plant pathogenic bacteria and viruses.



Figure 2. *Circulifer tenellus* adults. © Paul Langlois, Museum Collections: Cicadas, Planthoppers, & Allies, USDA APHIS PPQ, Bugwood.org

Biology

Whilst the virus can be mechanically transmitted, the primary means of spread is via insect vectors. No other modes of transmission are currently known for BCTV.

The vectors can spread the virus both via contaminated mouthparts and by circulative transmission. This is when the vector ingests the virus whilst feeding allowing the virus to

move internally within the vector from the guts to the salivary glands, where they are rereleased during feeding. The vector only needs to feed for a short time to acquire BCTV and can quickly transmit the virus to new host plants. The virus does not replicate within the vector, but BCTV is a persistent virus and can survive within the vector for up to 30 days, although its transmission efficiency declines over this time.

The *C. tenellus* life cycle consists of an egg, five nymphal instars and a winged adult stage. It can complete between one and six generations per year, depending on climatic conditions. In the spring, overwintering females lay up to 200 eggs into leaf veins and petioles with developmental time varying between 19 to 119 days to reach the adult stage. The adults can survive for up to five months feeding on various herbaceous plants and shrubs, although the average survival time for an adult is around two months.

Following crop harvest *C. tenellus* adults, primarily mated females, migrate to weeds where they overwinter until spring.

Dispersal and Detection

BCTV can be moved locally by *C. tenellus* and over long distances as infected host material or within the vector. The virus is not known to be seed or tuber borne and therefore infected plants for planting are considered the main potential pathway for the virus into the UK.

Plants for planting may also contain eggs of *C. tenellus* which are inserted into the leaves. Due to this, there are special requirements for plants for planting, other than seeds of sugar beet coming from areas where BCTV is known to occur, and thus some mitigation is in place against the introduction of BCTV into the UK. However, given the wide host range there is potential for BCTV to be introduced on other hosts.

In terms of the dispersal of the vector, reports from the USA suggest that movements of *C. tenellus* adults are seasonal, dispersing in spring and returning in autumn. They can travel relatively long distances (tens of miles), although dispersal of up to 300 km has been observed and the insect is reported to be capable of flying over hundreds of miles although this is debated. *Circulifer tenellus* has been observed on cars so there is also capacity for the pest to hitchhike. However, given the distance from the UK of areas where the distribution of the vector and virus overlap, this is an unlikely pathway into the UK.

Detection of the disease is primarily based on visual inspection for the symptoms described in the background section, whilst detection of the vector can be done using yellow sticky traps or sweep netting. Samples can be taken of symptomatic material for molecular testing to determine the presence of the virus.

Economic Impact

The majority of economic impacts are from the USA and are mostly from crops of sugar beet and tomato, although a range of other crops are also affected such as chilli

(*Capsicum* spp.) and basil (*Ocimum basilicum*), with the former having reported losses of up to 50% in New Mexico, USA.

Losses in sugar beet crops due to BCTV can be severe, with seedlings killed off and infections in mature plants reducing the vitality, sugar content and effectively the marketable yield. In semi-arid regions such as the western USA, it is considered a serious yield-limiting disease, with BCTV almost eliminating sugar beet production in this region in the 1920s-1930s. Subsequently, emphasis was placed on domestic seed production to increase yield and resistance to the virus which has provided adequate control of the pathogen and saved the sugar beet industry.

Tomato crop losses can also be severe with losses of \$100 million reported in the USA in 2013.



Figure 3. Tomato plant infected with beet curly top virus © Bob Hammon, Colorado State University, Bugwood.org

Pest Management and Reporting

There are no biological or chemical management controls for BCTV, and management relies on the use of resistant cultivars and good cultural and sanitation measures. These measures can include:

- the quick removal and destruction of infected material; and
- the removal of volunteers and weeds which could provide natural reservoirs for the vector and pathogen.

A control strategy should also monitor for the presence of the vector using yellow sticky traps. If found, *C. tenellus* can be treated with foliar insecticide treatments to reduce the population level and decrease the potential spread of the disease.

Suspected outbreaks of BCTV, *Circulifer tenellus* or any other non-native plant pest should be reported to the relevant authority:

For **England and Wales**, contact your local **APHA Plant Health and Seeds Inspector** or the **PHSI Headquarters**, York.

Tel: 0300 1000 313 (please select option 3 when calling)

Email: planthealth.info@apha.gov.uk

For Scotland, contact the Scottish Government's Horticulture and Marketing Unit:

Email: <u>hort.marketing@gov.scot</u>

For agricultural crops in **Scotland**, contact your local **RPID officer**: Web site: <u>http://www.gov.scot/Topics/farmingrural/Agriculture/AOcontacts/contacts</u>

For Northern Ireland, contact the DAERA Plant Health Inspection Branch:

Tel: 0300 200 7847 Email: planthealth@daera-ni.gov.uk

Web: https://www.daera-ni.gov.uk/topics/plant-and-tree-health

For additional information on UK Plant Health please see:

https://planthealthportal.defra.gov.uk/pests-and-diseases/uk-plant-health-risk-register/

https://planthealthportal.defra.gov.uk/

https://www.gov.uk/plant-health-controls

http://www.gov.scot/Topics/farmingrural/Agriculture/plant/PlantHealth/PlantDiseases

https://www.daera-ni.gov.uk

Authors

Simon Honey (Defra)

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