Curly Top of Tomato

What You Should Know

Beet Curly Top Virus (BCTV) is taxonomically a Curtovirus in the Geminiviridae family of plant pathogenic viruses. It is vectored, or carried, by the beet leaf- hopper (BLH, *Circulifer tenellus*) insect. BCTV causes curly top of tomato, a common disease in Utah, and the western U.S. Multiple strains of BCTV have been identified, and molecular characterization of BCTV shows that there are three strains known as CFH, Worland, and California/ Logan. Some viral taxonomists disagree and so the taxonomy of this virus will undoubtedly change in the future based on ever-increasing molecular knowledge of the pathogen. Some strains may be more virulent than others and some hosts may be more, or less, susceptible. Both the virus and the BLH have a wide range of hosts so this disease affects a number of plant species. Although tomato plants are not desired hosts, the BLH will feed on tomato plants as other host plants become dried in the summer heat of Utah. The BLH has a piercing-sucking feeding habit; thus, the virus is spread, or injected from the insect's salivary gland into its new host as the insect pierces and feeds on non- infected plants. Virus infected plants cannot be treated and should be removed.

Introduction

BCTV causes the disease known as curly top of tomato. This virus can infect a wide range of host plants and usually occurs in semiarid areas in western North America, from Canada to Mexico. BLH can transmit the disease to a wide variety of plants, including more than 300 plant species of dicotyledonous plants. Monocotyle- donous hosts (typically grasses) have not been reported and there have also been no reports of the disease being transmitted in seed. Crop plants affected by this virus include beets, tomatoes, Swiss chard, spinach, beans and cucurbits such as watermelon, cucumbers and squash. The disease is not a serious problem in processing tomatoes but can cause extensive damage in staked tomatoes, which are more widely spaced. The BLH is the insect that vectors, or moves, the virus. This insect has been causing damage to crops in the West since the early 1900s and perhaps earlier. Rangeland host plants include both native and non-native species, the most frequently cited hosts are Kochia and other Chenopodiaceae plants. These include Lambsquarter, Halogeton, Russian thistle (Tumbleweed) Greasewood, and Atriplex (Four Wing Saltbush).

Due to disturbance from human-related activities, weed species have proliferated and many of these weed species serve as hosts to the BLH insect and BCTV. Many of these disturbance species serve as suitable habitat for the BLH and also serve as an alternative host for this viral disease.

Symptoms

Young plants that are infected with this disease are usually killed. Plants that are infected at a later stage of development may survive, but they will be yellow with stunted growth (Fig. 1). The leaves will become thicker and crisp and will roll upwards as the petioles of the leaf roll downwards, which gives the disease its name (Fig. 2). They will also turn a dull yellow color with purple-colored veins (Fig. 3). The fruit will ripen prematurely and will be dull and wrinkled, which is a characteristic symptom of curly top. Calyx tissues will often be abnormally large and thickened as well (Fig. 4). Both normal and affected fruit will be visible on the same stem if the plants are infected after fruit set. Infected plants are usually scattered in a field. Plants infected with the virus will not recover and will die or remain stunted without additional flowering and setting more fruit.

Fig. 1. Plants that were infected early in their development tend to be
stunted (see arrows). Many of the plants in this photograph are infected,
but were likely infected at different stages of development, thus the

different degrees of severity shown.

Fig. 2. Severely infected plants will be stunted, yellow, and will appear misshaped or deformed, giving a curled appearance. Leaves will often show cupping symptomsand petioleswill curl downward giving the curly top symptomology.

Disease Cycle

Fig. 3. CTV infected tomato plants will often exhibit purpling of veins, that are often enlarged. Young tender leaves at active growing points will often show strong purpling symptoms as well.

The BLH has a piercing-sucking feeding habit. As the BLHs pierce a plant and feed, they will inject and leave behind virus particles inside the plant. BLH insects carrying the virus need only to feed for one minute on an uninfected plant to transmit the virus. BLHs that have acquired BCTV can transmit the virus for the remainder of their life; however, the number of plants infected decreases when the insects are not continually or frequently feeding on infected plants. A tomato plant can begin to show symptoms about 7-14 days after infection. Transmission efficiency, a measure of how well the insect can move the virus, depends on how much virus is in the BLH, which is dependent on the number of virus in an infected plant it has fed on, and how many times it has fed on non-infected plants since last feeding on a BCTV infected plant.

The spread of BCTV into tomato fields depends on the seasonal cycle of the BLH. The BLH is adapted to desert conditions and can overwinter on limited vegetation in areas that have been uncultivated. There have been reports of long-distance spread of the virus from infected Russian thistle and other wild weeds. When the wild weed hosts dry up in the spring or early summer the BLH will move into the valleys and begin feeding on spring crops. Sugar beet is a common host and may serve as a virus reservoir. Tomato is not a desired host for the BLH, but the insects will remain in tomato fields long enough to transmit the virus while feeding. The edges of fields or isolated plants with a lot of soil around them are more susceptible to BLH feeding, which can result in high infection rates in these areas.

Diagnosis

Most of the diagnostic symptomology has already been introduced in previous sections of this fact sheet. However, if a person wishes, they can send samples of suspect plants to the Utah Plant Pest Diagnostic Laboratory (UPPDL). Directions for collecting and submitting samples of plant material to the UPPDL can be found online at http://utahpests.usu.edu/uppdl/htm/ forms. There are forms available for both insect and plant specimen submissions. Please follow the instructions to properly collect and submit samples for diagnoses.

Fig. 4. Floral structures of CTV infected tomato plants are usually very distinctive

and are a fairly reliable diagnostic feature of the disease. Note the normal calyx
structure of the uninfected plants fruit andthe enlarged and deformed calyx
structure of the infected plant.

Management

The sporadic nature of BCTV occurrence makes it very difficult to implement practical management strategies for this disease. Research findings, which rely on natural populations of BLH and BCTV in the field, have been very inconsistent (personal communications, Dr. John Damicone, Oklahoma State University). The use of chemicals to control BLH, where overwintering sites of the BLH could be identified, has been used in some locations in California (Dr. James Rudig, California Department of Food and Agriculture). However, this is not recommended in most situations. Locating the BLH overwintering areas to treat them is difficult and would be excessively costly. BLHs can also migrate long distances, making the use of chemicals for control in specific fields ineffective and thus, futile.

Control of BCTV should rely on an integrated pest management (IPM) approach. One of the most promising management practices to reduce the effects of BCTV in tomatoes would be to use resistant cultivars of tomatoes. The following four open-pollinated tomato cultivars have been reported to be resistant to BCTV: Columbian, Roza, Salad Master, and Row Pac. Utah State University Extension Agents in Washington and Iron Counties evaluated tomato cultivars during the 2006 and 2007 growing seasons for their reaction to the BCTV disease. They observed BCTV symptoms on Row Pac and Columbian.

There are at least three strains of BCTV, one that is mild, one that is intermediate for the severity of symptoms it causes, and one that is very severe for the symptoms it elicits (Koike et al.). It is quite possible that there are different strains of this virus in Utah, although that is not certain, and that these tomato cultivars may be resistant to some strains but not others. However, these resistant tomatoes grew and produced well in Southern Utah and deserve consideration in areas consistently impacted by BCTV.

Another possible management practice to try is shading. Some observations have shown that plants grown in the shade do not contract the virus. This may be due to the insect's preference to feed in areas where sunlight is abundant. Shade cloth placed over tomato plants may help prevent infection. Exclusion is accomplished when BLH feeding is prevented using some type of closure. The most practical closure is a "rowcover" made of a synthetic material such as "Reemay" (a very fine random mesh netting). The row cover is fairly inexpensive and should be placed over top of the plant row with the ends and sides buried in the soil. This should be effective until tomato vines become so large they can no longer be contained inside the cover. At this stage of development, plants can still be infected; however, they will likely have the ability to provide a suitable yield of tomatoes. It should be noted in windy areas it can be difficult to keep plants protected by these covers.

Double planting is the practice of planting twice as many plants in the space that normally one plant would occupy. The probability that the BLHs will feed on every plant is decreased. Infected plants would die out leaving virus-free tomatoes to fill out the remaining area. This tends to work better in larger commercial plantings. Indiscriminant feeding by BLH may in fact take out all the plants in one area, someone's garden tomatoes for example, whereas they may not feed on a neighbor's tomatoes. The feeding habit of BLH can be very intensive in a small area and that area can occur seemingly at random.

If a person could predict the emergence and severity of BLH in any given year, as can be done with other insect pests of fruits and vegetables, then one or more of the BCTV-management methods discussed here could be used with some efficacy. Spraying of adjacent range and pasture with pesticide may or may not lower BLH populations. The cost, however, would be prohibitive and BLHs could still migrate or be blown into vegetable growing areas from untreated fields. Also, indiscriminate use of pesticides is not environmentally sound and would likely be illegal. As mentioned before, the inconsistent nature of this disease and the migratory behavior of the BLH (which serves as a vector) make it very difficult to acquire consistent control.

References

- Damicone, J., Brandenberger L. (EPP-7626) Common Diseases of Tomato, Part 2 Diseases Caused by Bacteria, Viruses and Nematodes. Oklahoma Cooperative Extension Service.Retrieved March 21, 2008, http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-1327/EPP-7626web.pdf
- Damicone, J.,Grantham, R.(June 24, 2003) Tomato Problem Identified as Curly Top-A Virus Disease. Plant Disease and Insect Advisory. Retrieved April 2, 2008. \

- Jones, J. B., Jones, J. P., Stall, R. E., and Zitter, T. A. Eds. 2006. Compendium of Tomato Diseases. APS Press. St. Paul, MN. 73 pp.
- Koike, S. T., Gladders, P., and Paulus, A. O. 2007. Vegetable Diseases, A Color Handbook. Academic Press of Elsevier. Burlington, MA/San Diego, CA. 447 pp.
- Rudig, J., Curly Top Virus: Background. California Department of Food and Agriculture. Retrieved April 9, 2008.
- Swift, C., Harmon, B., (Tri-river Area) Tomato Curly Top Virus. Colorado State University Extension. Retrieved October 24, 2007.
- Thompson, S., Ockey, S., (Utah Plant Disease Control No. 29) Curly Top of Tomato. Utah State University Extension. Retrieved October 24, 2007.

Published May 2008
Utah State University Extension
Peer-reviewed fact sheet

Authors

Rick Heflebower, Extension Agent; **Chad Reid**, Extension Agent; **Erin Frank**, USU Plant Disease Diagnostician; **Kent Evans**, Extension Plant Pathology