



AGRONOMIC SPOTLIGHT



TOMATO BROWN RUGOSE FRUIT VIRUS

- » A new viral disease of tomatoes first observed in Israel in 2014 has since been detected in Europe, the Middle-East, and North America.
- » No tomato varieties are known to be resistant to the *Tomato brown rugose fruit virus*.
- » Preventing the spread of the virus is currently the best means of managing the disease.

HISTORY OF THE DISEASE

Virus-like symptoms were observed on tomato plants in Israel in 2014.¹ The symptoms were similar to those caused by tobamoviruses including *Tobacco mosaic virus* (TMV) and *Tomato mosaic virus* (ToMV), but the varieties showing symptoms contained the *Tm-2²* gene, which provides resistance to both of these viruses. Similar symptoms occurred on *Tm-2²* tomato varieties in Jordan in 2015.² Testing of these plants revealed the presence of a new virus, closely related to TMV and ToMV, in the tobamovirus group. The new virus was given the name *Tomato brown rugose fruit virus* (TBRFV) [also abbreviated ToBRFV in some articles].

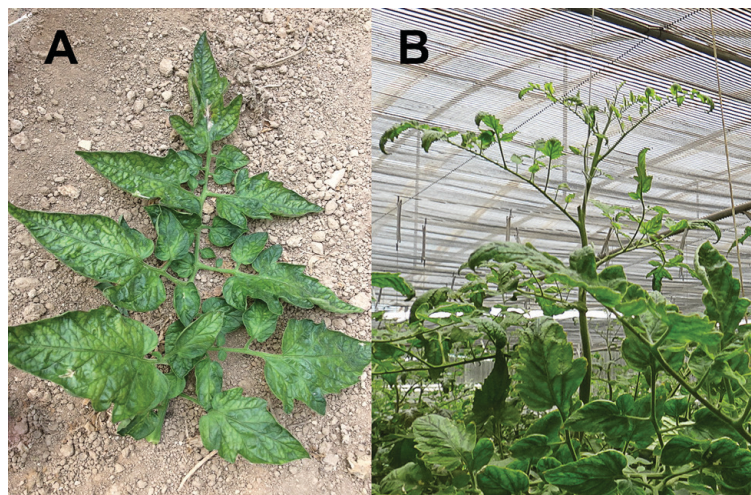


Figure 1. Foliar symptoms of TBRFV infection of tomato: (A) mosaic discoloration of leaves, (B) narrowing and distortion of leaf blades.

TBRFV was detected on tomatoes growing in Germany and southern Italy in 2018.³ The disease appears to have been eradicated in Germany, but the virus was detected in Italy again in early 2019. The virus was also detected in tomato plants in a greenhouse in California (USA) in 2018. All of the infected plants in the greenhouse were destroyed, and the disease is now considered to be eradicated in California. TBRFV also was detected in Mexico in 2018, and efforts to eradicate the virus there are currently underway.

SYMPTOMS

Mild to severe mosaic symptoms develop on the leaves of TBRFV infected plants (Figure 1). Yellowing of the leaf veins and narrowing of leaf blades occur occasionally. Symptoms develop most commonly on the upper leaves.¹ Yellow spots form on infected fruit, and brown rugose (wrinkled) patches develop on fruit surfaces (Figure 2).² Necrotic (brown, dead) lesions sometimes form on peduncles, pedicels, and the calyx of tomato fruit. The disease tends to be more severe during times of stress, such as during hot periods of the summer or cold periods of the winter.

The occurrence and severity of symptoms vary with the age of the plant at the time of infection; the most severe symptoms are seen on plants infected at a young age. Tomato variety and growing conditions (temperature and light) also affect the expression of symptoms, as do fruit load and nutritional status. Symptoms develop within 12 to 18 days of infection, and the disease can result in yield losses of 30 to 70%.^{1,2}

TOBAMOVIRUSES AND TBRFV

Tomato brown rugose fruit virus has been identified as a member of the *Tobamovirus* genus, which also contains *Tobacco mosaic virus* and *Tomato mosaic virus*.² These viruses are very stable outside of their plant hosts, which is unusual for plant viruses. Tobamovirus particles can survive in crop debris, in soil, and on implements, stakes, trellis wires, containers, greenhouse benches, and seedling trays for months to years. These viruses are mechanically transmitted in infected plant sap, meaning that anything that transfers infected plant sap from one plant to another can spread the disease. Therefore, TBRFV can be easily spread during commercial production operations including transplanting, pruning, staking, trellising, tying, spraying, and harvesting.^{4,5}

TBRFV can be spread by contaminated bumblebees. Bumblebees that collect pollen from TBRFV-infected tomato plants transmit the virus when they visit the flowers of healthy tomato plants. Bumblebees are important pollinators of

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tomato in protected culture systems, and they also visit tomato flowers in field plantings. Therefore, bees may be important in disease spread in both field and protected culture systems.⁴

The host range of TBRFV includes tomato and pepper (*Capsicum*) as major hosts, with documented infections under natural conditions. Inoculation experiments have also shown that TBRFV can infect tobacco, European black nightshade, several species of *Chenopodium* and *Chenopodium*, and petunia. Thus far, eggplant and potato have not been shown to be hosts of the virus.¹



Figure 2. Fruit symptoms: (A) brown necrotic lesions, (B) rugose fruit surface, brown streaking, and calyx necrosis.

MANAGEMENT

No commercial tomato varieties have been found to be resistant to TBRFV. Varieties do vary in the severity of symptom expression. However, even varieties that show only mild symptoms can contain high levels of TBRFV in their tissues and can serve as sources of inoculum for other tomato and pepper plants. The major resistance genes (*Tm1*, *Tm2*, *Tm2²*) in tomato that provide resistance to other tobamoviruses do not provide resistance to TBRFV.^{1,2,5}

Efforts to manage TBRFV currently focus on using strict sanitation practices. Because the virus is easily spread on hands and clothing, workers should be encouraged to wash their hands regularly during the day, to wear clean clothing every day, and to wash shoes before and after entering greenhouses or to wear clean, disposable shoe covers when entering greenhouses.⁵ The tools used in tomato transplant production and field operations should be regularly disinfected using solutions of household bleach (diluted to 0.5% NaOCl), Virkon® S, or non-fat (skimmed) milk.⁶ For transplant production, workers should be grouped to work in specific areas, and movement of workers between greenhouses should be minimized. Stakes, trays, and

greenhouse surfaces should be thoroughly cleaned and disinfected between plantings. Boxes, plants, and other material from external sources should not be brought into greenhouses when seedlings are being grown.

Growers should avoid direct seeding or transplanting into fields with root and crop debris of tomato or pepper, or planting into previously infected areas.⁵ Prompt destruction of crop debris after the final harvest is encouraged. To minimize symptom expression, growers can decrease plant stress and provide optimum growing conditions. Promoting a good balance of generative and vegetative growth by reducing fruit loads can help reduce plant stress, as can ensuring adequate levels of fertilization at critical growing stages.

Sources:

- ¹ Luria, N., Smith, E., Reingold, V., Bekelman, I., Lapidot, M., Levin, I., Elad, N., Tam, Y., Sela, N., Abu-Ras, A., Ezra, N., Haberman, A., Yitzhak, L., Lachman, O., and Dombrovsky, A. 2017. A New Israeli tobamovirus isolate infects tomato plants harboring Tm-2(2) resistance genes. *Plos One* 12.
- ² Salem, N., Mansour, A., Ciuffo, M., Falk, B., and Turina, M. 2016. A new tobamovirus infecting tomato crops in Jordan. *Archives of Virology* 161:503-506.
- ³ EPPO Global Database. <https://gd.eppo.int/taxon/TOBREV>
- ⁴ Levitzky, N., Smith, E., Lachman, O., Luria, N., Mizrahi, Y., Bakelman, H., Sela, N., Laskar, O., Milrot, E., and Dombrovsky, A. 2019. The bumblebee *Bombus terrestris* carries a primary inoculum of Tomato brown rugose fruit virus contributing to disease spread in tomatoes. *Plos One* 14.
- ⁵ Jones, J., Zitter, T., Momol, T., and Miller, S. 2014. Compendium of tomato diseases and pests, second edition. American Phytopathological Society, St. Paul, MN.
- ⁶ Li, R., Miller, S. A., Baysal-Gurel, F., Ling, K. S., and Kurowski, C. J. 2015. Evaluation of disinfectants to control mechanical transmission of tomato viruses and viroids in greenhouse tomatoes. IV International Symposium on Tomato Diseases 1069:221-227.

Websites verified 8-26-2019

For additional agronomic information, please contact your local seed representative.

Performance may vary from location to location and from year to year, as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on the grower's fields. The recommendations in this article are based upon information obtained from the cited sources and should be used as a quick reference for information about tomato diseases. The content of this article should not be substituted for the professional opinion of a producer, grower, agronomist, pathologist and similar professional dealing with this specific crop.

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