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TOMATO BROWN RUGOSE FRUIT VIRUS

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WHAT IS TOMATO BROWN RUGOSE FRUIT VIRUS (ToBRFV)?

ToBRFV is an economically damaging viral pathogen of tomatoes and peppers and is a new global threat to the tomato and pepper industry. The virus was first discovered in 2014. Its occurrence has since then been reported in China, Greece, Israel, Italy, Jordan, Mexico, The Netherlands, Saudi Arabia, Spain, Turkey, the United Kingdom, and a few other countries in Asia, Europe, and the Mediterranean region, according to the European and Mediterranean Plant Protection Organization (EPPO). ToBRFV was also detected in isolated outbreaks in greenhouse tomato crops in California and Germany, for which the virus has been eradicated in both cases.

WHY SHOULD I CARE?

Over the years, scientists have developed improved varieties of tomatoes and peppers with genetic resistance (e.g., *Tm-2*^{2}) to tobamoviruses such as the tobacco mosaic virus (TMV). Unfortunately, these improved varieties are susceptible to infection by ToBRFV, indicating that the virus can overcome (i.e., break) the resistance. Though ToBRFV does not pose a health risk to people or animals, symptomatic tomato and pepper fruits are rendered unmarketable, resulting in severe economic losses. The virus is also a quarantine pest in the U.S. and some other countries, hence infection can impact movement of seeds, transplants, and fruit produce.

HOW CAN I RECOGNIZE AN INFECTED PLANT?

Like its other tobamovirus relatives, such as TMV and tomato mosaic virus (ToMV), leaf symptoms of ToBRFV on tomatoes include chlorosis, mosaic, and mottling with occasional leaf narrowing (Fig. 1). The leaf petiole, fruit peduncles, and calyx may also show necrotic (i.e., dead) spots. ToBRFV symptoms on fruits include yellow and/or brown spots (or blotchiness), uneven ripening, and rugosity (e.g., deformed or corrugated surface) (Fig. 2). Disease symptoms on peppers include leaf deformation, yellowing, and mosaic. Affected pepper fruits may also become deformed, with yellow or brown areas or green stripes.

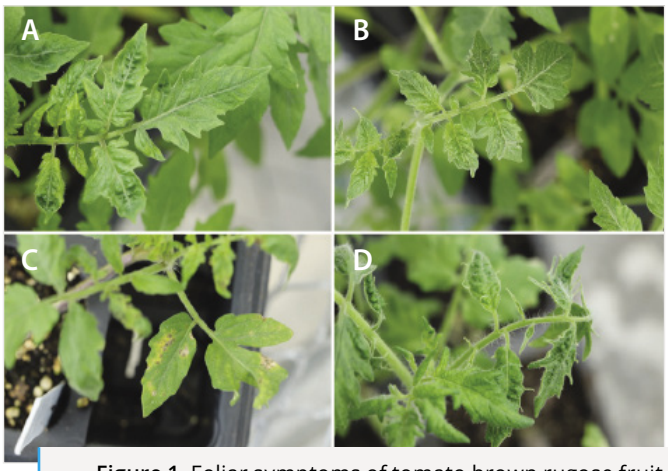

Figure 1. Foliar symptoms of tomato brown rugose fruit virus infection on different tomato cultivars. They include mosaic and mottling on cv. Brioso (A), mild mosaic on cv. Idolini (B), necrotic lesions on cv. Endeavour (C), and severe mosaic and mottling on cv. Moneymaker (D). *(Photo credit: Dr. Kai-Shu Ling (USDA-ARS); https://doi.org/10.1094/PDIS-05-20-1070-RE)*

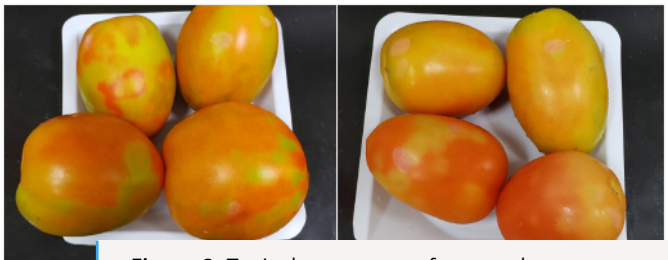

Figure 2. Typical symptoms of tomato brown rugose fruit virus infection on tomato fruits, including yellow and/or brown spots (or blotchiness), uneven ripening, and rugosity (e.g., deformed, or corrugated surface). *(Photo credit: Dr. Olufemi J. Alabi)*

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HOW IS IT TRANSMITTED?

ToBRFV and other tobamoviruses are mechanically transmitted, which means that they can be transmitted through contact, including contaminated tools, hands, clothing, and direct plant-to-plant contact. The virus can also be transmitted through grafting or spread through movement of infected plant materials, such as transplants and through fruits from infected plants. Contaminated seeds are also primary means through which the spread of tobamoviruses occur. Thus, movement of infected plant materials (i.e., transplants and seeds) by humans constitutes a major pathway for the spread of tobamoviruses across local, national, and international boundaries. Though not vectored by an insect, insects such as pollinators may facilitate mechanical spread of ToBRFV as they forage between infected and healthy plants. The virus can remain viable in seeds, plants' debris, and contaminated soil for months.

HOW CAN THE VIRUS BE DETECTED?

It is difficult to distinguish between foliar and fruit symptoms due to ToBRFV infection and those due to other tobamoviruses based on visual observation. With seeds, it is impracticable to determine their health status based on visual inspection. In addition, asymptomatic virus infections are not unusual, with the infected but symptomless plants serving as a continuous source of virus spread. Consequently, accurate and reliable detection of the virus can only be performed by trained personnel using approved antibody or DNA-based techniques. There are antibody-based tests, such as enzyme-linked immunosorbent assay (ELISA) and ImmunoStrips, which is able to detect tobamoviruses in infected plant samples (Fig. 3). Unfortunately, these tests often detect multiple tobamovirus species and are inconclusive for specific virus identification due to antibody cross-reactions. The definitive identification of ToBRFV relies on molecular tests such as reverse transcription polymerase chain reaction using virus specific primers (Fig. 4), which can only be performed in a well-equipped diagnostic laboratory—such as the Texas Plant Virus Diagnostic Laboratory in Weslaco, Texas and the Texas Plant Disease Diagnostic Lab in College Station, Texas.

Figure 3. Testing of symptomatic tomato fruits for the presence of tomato brown rugose fruit virus using commercially available lateral flow test strips (immunostrips). The samples gave positive reactions to both tobacco mosaic virus and ToBRFV immunostrips. *(Photo credit: Dr. Olufemi J. Alabi)*

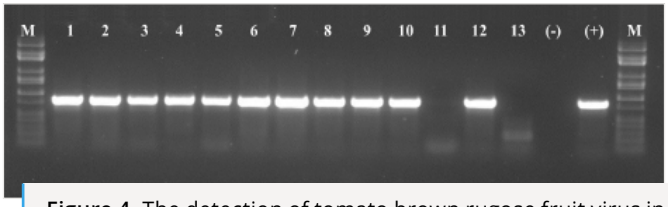

Figure 4. The detection of tomato brown rugose fruit virus in infected tomato fruits by reverse transcription polymerase chain reaction using virus-specific primers. Samples 1 through 10 and 12 tested positive for ToBRFV, while samples 11 and 13 tested negative. (-) = negative control; (+) = positive control; M = DNA Ladder. *(Photo credit: Dr. Olufemi J. Alabi)*

WHAT IS BEING DONE TO PREVENT ToBRFV SPREAD IN THE U.S.

Due to its economically damaging nature, and to safeguard the U.S. against the introduction of this virus while facilitating the safe trade of healthy tomatoes, the U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service has put in place a ToBRFV Federal Import Order effective November 22, 2019. The Federal Import Order applies to imports of tomato (*Solanum lycopersicum*) and pepper (*Capsicum* spp.) seed lots and transplants from all countries and imports of tomato and pepper fruit entering the U.S. from Mexico, Canada, Israel, and the Netherlands. The Import Order requires that all tomato and pepper seed lots and transplants imported from countries where the virus exists should be officially tested and certified free of the disease. Also, that all tomato and pepper fruit imported from Mexico, Israel, and the Netherlands should be inspected at the point of origin to ensure it is free of disease symptoms; and that Canada should inspect all tomato and pepper fruit prior to export to the U.S. to ensure it is free of disease symptoms. Obscured seeds (i.e., seeds coated, pelleted, or embedded in tape or another substrate that obscures visibility) and small seed lots are also subject to the Federal Import Order. In addition, U.S. Customs and Border Protection (CBP) will increase inspections of tomato and pepper seed, plant, and fruit imports from countries where the virus is known to occur—and will take action to keep any infected products out of the U.S. For most up-to-date information about the Federal import order please visit *https://www.aphis.usda.gov/aphis/ourfocus/planthealth/import-information/federal-import-orders/tobrfv/tomato-brown-rugose-fruit-virus.*

IS THERE A CURE FOR ToBRFV?

There is no chemical cure for ToBRFV. Also, there are no currently known tomato and pepper varieties with resistance to the virus. However, there are steps that can be implemented to prevent spread of ToBRFV. In addition to complying with federal and state regulations on the safe movement of plants and plant materials, ToBRFV spread can be limited through proper sanitation, such as the use of disinfectants to sanitize surfaces and implements. It is recommended that farm workers should wash their hands regularly during the day, ensure their clothing is disinfected daily, and wear disposable shoe covers when entering greenhouses where the risk of contact spread is extremely high. Farm tools and implements should also be disinfected regularly. Some of the recommended disinfectants include household bleach (10 percent Clorox), Virkon® S (2 percent), and non-fat (skimmed) milk (3.5 percent protein). Direct seeding or transplanting of plants into soils with debris from previous tomato and pepper crops should be avoided. In general, crop rotation with non-host crops in-between season is good practice.

WHAT CAN I DO TO AVOID ToBRFV SPREAD?

It is important to ensure compliance with federal and state regulations on the safe movement of plants and plant materials, including transplants, seeds, and fruits. These measures are meant to safeguard U.S. agriculture, because once an infected plant material is introduced into an area, it could serve as source of virus spread. If there is a plant that is suspected to be infected, based on its appearance, check to see if the symptoms match those described for tobamoviruses earlier in this publication. Immediately isolate the suspect plant from others, taking precautions to mechanically avoid contact between it and other host plants. Although inconclusive for diagnosis, the observation of the described symptoms on tomato or pepper varieties that carry known tobamovirus resistance genes heightens the likelihood of ToBRFV infection. While keeping the suspect plant isolated, contact the nearest diagnostic laboratory for guidance on how to send a sample for testing and confirmation of ToBRFV infection. The lab would also provide guidance on how to notify the relevant agencies to contain further spread of ToBRFV. In the event of positive ToBRFV detection, affected plants and plant parts should be destroyed by burying or incineration.

REFERENCES

Chanda, B., Gilliard, A., Jaiswal, N., & Ling, K.-S. 2021. Comparative analysis of host range, ability to infect tomato cultivars with *Tm-2*^{2} gene, and real-time reverse transcription PCR detection of *Tomato brown rugose fruit virus.* Plant Dis. 105:3643-3652. doi:10.1094/PDIS-05-20-1070-RE.

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., & Dombrovsky, A. 2017. A new Israeli *Tobamovirus* isolate infects tomato plants harboring *Tm-2*^{2} resistance genes. PLOS One 12:e0170429. doi:10.1371/journal.pone.0170429.

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