

# Tomato Brown Rugose Fruit Virus (ToBRFV)

## At Risk

Tomato and pepper plants can be infected with tomato brown rugose fruit virus (ToBRFV). The disease is most severe in greenhouse and high tunnel production where plants are frequently handled for staking, tying, and pruning.

## Distribution

First observed in 2014 and 2015 in Jordan and Israel, ToBRFV was named as a new species of plant virus in 2016. It has since been detected in over 40 countries. Efforts to prevent its introduction and eradicate detections are in effect in many countries.

## Biology

Infected seeds or transplants can carry ToBRFV to a new area. Once infected plants are present, the virus spreads rapidly on hands and tools. ToBRFV is a long lived and durable virus. It has been shown to survive on workers hands for over 2 hours after touching an infected plant, and for 3 to 6 months on common greenhouse surfaces such as metal, glass, concrete, plastic pots and trays, and polyethylene sheeting. The virus can also survive in infected plant debris and soil from one season to the next and possibly longer. Viruses in the same family as ToBRFV are known to survive in plant debris for many years.

## Identification

### Leaves

- Symptoms are most easily observed on young leaves.
- Leaves have a mosaic or mottle of dark and light greens.
- Leaves may be puckered, have upward curling edges, or may be elongated and distorted.

### Fruit

- Fruit ripens irregularly with blotches of red, yellow, orange, or green.
- Raised, rough brown patches may appear on the fruit's skin.

Figure 1. Mosaic of dark and light greens make random patterns on ToBRFV infected leaf. MDA



Figure 2. Uneven ripening and brown discoloration of ToBRFV infected tomato fruit. MDA



## Look-Alikes

There are over 300 plant viruses known to infect tomato plants, many of which cause symptoms similar to ToBRFV. A lab test is required to determine which plant virus is causing symptoms.

## Regulatory Status

ToBRFV is federally regulated in transplants and seed. It is not regulated in tomatoes and peppers sold for human consumption. The Minnesota Department of Agriculture (MDA) regulates the disposal of infected plants and plant parts but allows for sale of fruit from infected plants.

## What Can Be Done?

### Prevent introduction of ToBRFV

- Purchase seed and transplants from a reputable supplier that tests for the presence of ToBRFV.
- Separate plants from different suppliers to prevent cross contamination.
- Disinfect hands and tools regularly when working with plants to prevent spread of disease.

The USDA allows sale of vegetables for human consumption from countries with ToBRFV. These vegetables are safe to eat but seeds and sap from the vegetables may contain ToBRFV.

- Do NOT plant seeds from tomatoes and peppers purchased in a grocery store.
- Greenhouse workers should wash hands vigorously with soap and water for 1 minute before work.

### Scout for disease

- Inspect plants regularly for symptoms of disease.
- Mark suspect plants with flagging tape or other marker, and do not touch suspect plants until the problem is identified. For seedlings, isolate any tray containing suspect plants from healthy plants.
- Send photos and a description to the [MDA Report a Pest](#) or submit plant samples to the University of Minnesota Plant Disease Clinic <http://pdc.umn.edu>.

**Figure 3. Leaves infected with ToBRFV curl upward, twist, and pucker. MDA**



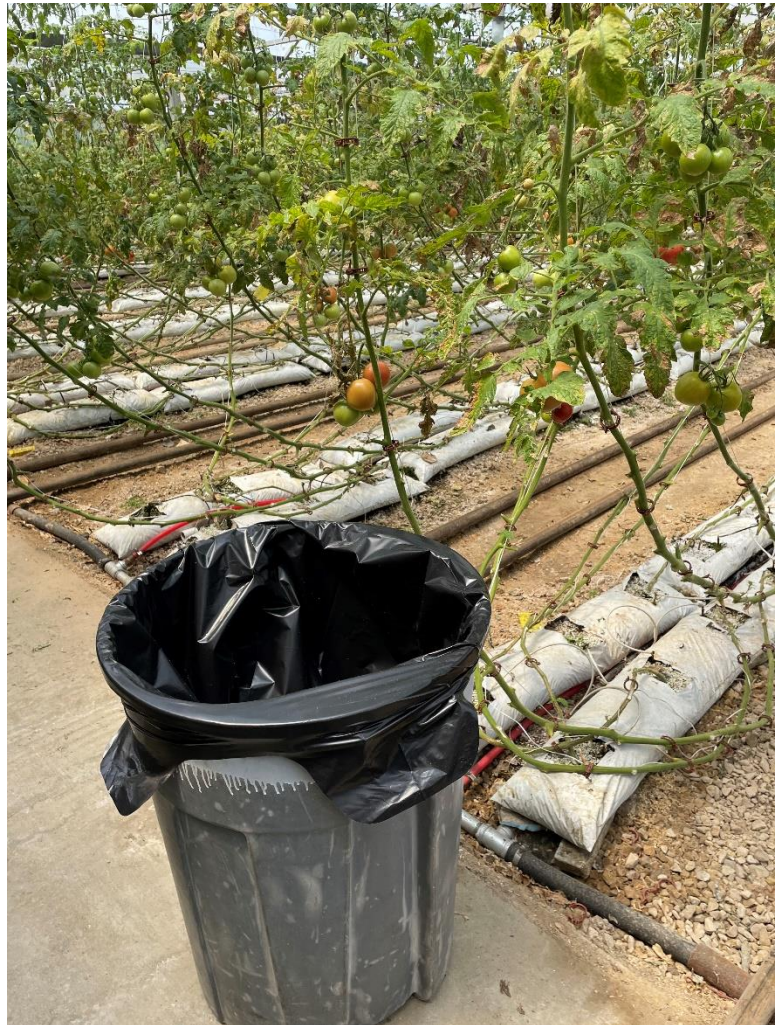
## Managing detections of ToBRFV

- Remove plants only if it's possible to do so without contacting nearby healthy plants.
- If infected plants cannot be removed or are too numerous to remove, clearly label infected plants and all entrances to the affected high tunnel. Only enter affected tunnels when necessary.
- Complete work in unaffected high tunnels first. Work with infected plants at the end of the day.
- Disinfect all tools with 10% bleach, Virkon, or Virocid after use on infected plants.
- Workers' outer clothes should be washed with hot water and detergent after work with infected plants, or disposable outer garments should be worn and discarded after one use.
- Workers should wear disposable gloves when working with infected plants or wash their hands vigorously with soap and water for 1 minute after working with infected plants.
  - ToBRFV can survive in sap on hands and gloves for 2 hours.
- Workers should clean shoes in a footbath or sanitizing mat filled with 10% bleach, Virkon, or Virocid after working with infected plants or use and discard disposable shoe covers.

## Harvesting infected plants

- Fruit from infected plants CAN be harvested and sold for food.
- Fruit from infected plants CANNOT be harvested for seed as ToBRFV will be present in seeds.
- Harvest fruit in high tunnels where infected plants are located at the end of the day, after all work in healthy plants is complete. Clean workers, clothes, hands, tools, and footwear after harvest, as described above.
- Avoid touching wounded or damaged fruit during harvest. ToBRFV can spread through sap from wounded fruit but will not spread from touching healthy, intact fruit.
- Clean all harvest totes and tools used with infected plants using 10% bleach, Virkon, or Virocid.

**Figure 4. Keeping a lined garbage can in the infected house makes it easy for workers to dispose of infected plant clippings and fruit in a safe way. MDA**



## Clean up and disposal of ToBRFV infected plant material and high tunnels

- All plant material, except fruit sold for food, **MUST** be disposed of on the farm property or taken to a commercial landfill.
- At the end of the season, complete all plant removal and other cleanup work in tunnels with healthy plants prior to working in tunnels with infected plant material.
- Cut off irrigation to infected plants several days prior to clean up and plant removal to allow plants to dry and reduce the amount of sap during removal.
- Plants can be burned, buried, or composted on site or sent to a commercial landfill.
  - ToBRFV may survive in soil where plants are buried or in compost that is not properly heated and broken down. It is best to bury plants or use compost in an area that will not be used for future production of tomatoes or peppers.
  - ToBRFV can spread in water. Do not bury or compost plants in an area where runoff could carry the virus into a future tomato or pepper crop or off farm.
- ToBRFV can survive in dried sap on:
  - Hands and disposable gloves for 2 hours.
  - Glass, hard plastic (like totes), and polyethylene plastic sheeting for at least 180 days (6 months).
  - Steel, concrete, and aluminum for up to 90 days (3 months).
- Disinfect all tools, equipment, and structures used with infected plants using 10% bleach, Virkon, or Virocid.
  - Remove any soil or debris prior to spraying a disinfectant. Dispose of these items with infected plants.
  - Soak small tools and equipment for 1 hour, then rinse prior to storage.
  - Use a wand or backpack sprayer to apply disinfectant to larger equipment or structures. Wait a minimum of 1 hour before rinsing.
  - Concrete was the most difficult surface to disinfect in research trials. Virocid was the most effective disinfectant for killing ToBRFV on concrete, while Virkon was not effective in disinfecting concrete.

- Recommended disinfectants for ToBRFV
  - Virkon S – Common greenhouse and farm disinfectant with the active ingredient potassium peroxymonosulfate. Available through many farm supply companies. Mix according to label instructions.
  - 10% bleach – Sold under various brand names by household or cleaning supply companies. The active ingredient is sodium hypochlorite. Mix one part bleach to nine parts water for a 10% solution. Use the mixture within 24 hours, as bleach will lose its effectiveness if left for longer.
  - Virocid – Available through veterinary or farm supply stores. Active ingredient of glutaraldehyde and quaternary ammonium compounds. Mix according to label instructions.

## Prevent disease the following growing season

- If possible, avoid planting tomatoes and peppers for 2 years in areas where ToBRFV has been detected.
- Promptly remove all weeds and volunteer tomato or pepper plants from areas where ToBRFV was detected, both during the current season and for the following 2 years. Dispose of these plants on the property, away from any current tomato or pepper crops.

## Reporting ToBRFV

If you suspect you have found ToBRFV, take pictures of the symptoms. Email pictures, your name, and location to [reportapest@state.mn.us](mailto:reportapest@state.mn.us) or report online at <https://www.mda.state.mn.us/reportapest>. The MDA may contact you to request a sample for laboratory testing to confirm the diagnosis.



[www.mda.state.mn.us/reportapest](https://www.mda.state.mn.us/reportapest)