

Tomato mosaic virus in Tomatoes

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Plants *Tomato mosaic virus* has been shown to infect ^{2, 5, 6, 8, 15 * +}

Tomato mosaic virus (abbreviated ToMV) can infect a wide range of economically important plant species including: sweet, chilli, and hot peppers (*Capsicum annuum*, *C. frutescens*); quinoa (*Chenopodium quinoa*); tomato (*Solanum lycopersicon* L.); tobacco (*Nicotiana benthamiana*, *N. clevelandii*, *N. glutinosa*, *N. megalosiphon*, *N. rustica*, *N. tabacum*); tomatillo and cape gooseberry/ground cherry (*Physalis ixocarpa*, *P. peruviana*); eggplant (*Solanum melongena*); and potato (*S. tuberosum*).

Weedy plant species that have been identified with ToMV infection include: redroot pigweed (*Amaranthus retroflexus*); common lamb's quarters and nettle leaf goosefoot (*Chenopodium album* ssp. *amaranticolor*, *C. murale*); physalis (*P. floridana*); and black nightshade (*Solanum nigrum*).

Ornamental plants that can be infected with ToMV include: angel's trumpet (*Datura metel*); petunia (*Petunia x hybrida*); and red bitter berry (*Solanum giganteum*).

Fruits including cherry (*Prunus avium* and *P. cerasus*), pear (*Pyrus communis*), apple (*Malus sylvestris*), and grape (*Vitis vinifera*) can also be infected.

Plants *Tomato mosaic virus* has not been shown to infect ^{2, 5, 6, 8, 15 ** +}

ToMV has not been shown to infect muskmelon (*Cucumis melo*); squashes, pumpkins and zucchini (*Cucurbita pepo* spp.); green bean (*Phaseolus vulgaris*); and cowpea (*Vigna unguiculate*).

Symptoms in tomatoes ^{5, 6, 8, 15}

This virus causes a wide variety of symptoms dependent upon: plant variety, temperature, light intensity, plant age, virus strain, and more. It can also show no symptoms in many plants including tomatoes.

Leaf symptoms:

- thin, thread-like leaves
- leaf malformation
- mosaic (mottled areas of light green, dark green, yellow, or white)
- brown or yellow spots, stripes, or line patterns on leaves or stems
- stunting
- wilting
- complete plant death

Fruit symptoms:

- yellow spots or stripes that do not ripen
- internal browning
- yellow or brown rings
- brown circles or spots

Yield impact

Tomato mosaic virus can cause yield losses of 20-100% due to reduced fruit set or symptoms that make the fruit unsaleable.⁴ Infected plants should be pulled, attempting to get the majority of the roots, and burnt or otherwise removed from the growing area. ToMV can survive and be infectious in tomato root debris at 47 inches (120 cm) deep in fallow soil after 22 months and for over 2 years in soil under black plastic.⁴ It can also survive winter conditions in soil in Wisconsin.⁹ ToMV is a very stable virus, dried leaf tissue that was stored at room temperature was still infectious after 24 years.⁷ It is very important to test and identify ToMV infected plants so they can be removed promptly, reducing the amount of virus inoculum left in the growing area.

* ToMV has been inoculated into healthy plants of these species and infected them, field samples may have tested positive for ToMV. See citations for more details.

**ToMV has not been isolated from field samples or infected laboratory inoculated plants of these species. See citations for more details.

+ This does not exclude plant species not listed-these are the only species research has been completed and published on.

Spread

ToMV is easily spread by any contact that wounds plant leaves, stems, or roots including transplanting, pruning, trellising, harvesting, and bumble bee pollination.^{5, 13, 15} Chewing insects such as grasshoppers and locusts can also spread the virus from infected plants to other plants including weeds.¹⁶ Other insects such as aphids have been shown to spread ToMV by breaking leaf hairs.⁵ Water used in hydroponics can also spread ToMV so it must be sterilized if recirculated.⁵

ToMV can have up to a 94% seed transmission rate although less than a 1% seed transmission rate is enough to serve as inoculum for an epidemic due to the ease of mechanical transmission.^{5, 6}

Detection

ToMV can be tested for on the farm by using rapid immunochromatographic dipsticks obtained online from commercial sellers or infected plant tissue can be mailed or dropped off at a plant disease diagnostic clinic.

Tomato mosaic virus is closely related to *Tobacco mosaic virus*, *Tomato brown rugose fruit virus*, *Tomato mottle mosaic virus*, and others which have been reported causing disease in *Solanaceae* crops.^{14, 1} Antibody based tests for any of these viruses will react with other viruses in this family (*Tobamovirus*).¹ Sequencing of a portion of the virus genome is required to obtain a species level identification.¹ Sequencing can be completed by a plant disease diagnostic clinic.

Control

Seed treatment^{3, 5}

The major control method for ToMV is to use certified virus free seed or to disinfest seeds yourself. The hot water bath method does not reduce the amount of ToMV on tomato seeds.³

Seeds should be soaked with a 10% solution of trisodium phosphate=trisodium orthophosphate=sodium phosphate tribasic (Na_3PO_4) for 30 minutes and mixed several times, rinsed and dried. Note this solution should be made with warm water and the trisodium phosphate should be stored in an air tight container to prevent it from solidifying. After rinsing and drying, follow with a 1-2 minute soak in a 1:4 dilution of bleach, using 1 gallon of diluted bleach per pound of seed. Use bleach with 5.25-6% sodium hypochlorite concentration (NaOCl) and do not reuse. Pour seed into a fine mesh and rinse thoroughly with cool water. After air drying the seeds can be coated with fungicides following manufacturer's recommendations to control seed rot and damping-off.³ Trisodium phosphate and bleach will control anthracnose, bacterial spot, and will greatly reduce or eliminate seed coat carried ToMV.³ A trisodium phosphate soak alone will greatly reduce seed coat carried ToMV only.³

ToMV can also be transmitted inside of the seed, which is not destroyed by the soaking methods.⁵ Scouting of plants and testing to identify the biotic or abiotic issue causing symptoms is very important, even if using treated seeds.

Experiments are on-going to determine a protocol for using sonication, a non-chemical seed disinfesting method.

Tool sterilization^{10, 12}

Always sterilize tools and glove covered hands by dipping in a 10% solution of bleach with a 5.25-6% NaOCl concentration (change frequently, minimally every 2 hours) or 2% Virkon S between each plant.¹⁰ Disinfection is immediate, no tool soaking is required. It is recommended to dry tools and hands before handling plants as the chemicals may damage plant tissue. Sap residue must be removed from tools as it can harbor infectious virus, even after a dip. These treatments also prevent transmission of *Tobacco mosaic virus*, *Pepino mosaic virus*, and *Potato spindle tuber viroid*.¹⁰

String used for trellising tomatoes should not be reused. If wire must be used again, sterilize it by completely submerging in a 5% solution of trisodium phosphate (Na_3PO_4) for 10 minutes, or 0.1% caustic soda (also called lye and sodium hydroxide with a chemical formula of NaOH) for 10 minutes, or use dry heat of 266° F (130° C) for 15 minutes.¹²

Resistance¹¹

Resistant tomato varieties could be selected for use in the following years if ToMV has been diagnosed-however there have been resistant breaking ToMV strains identified that can cause symptoms in tomatoes containing resistance genes.¹¹ ToMV and *Tobacco mosaic virus* (TMV) have different resistance genes so it is best to obtain a diagnosis to the species level to make choosing resistant tomato varieties effective. There have been no large trials to test the resistance claims that are made for tomato varieties but Cornell University has one of the most complete disease resistance charts for varieties currently on the market that can be used to choose resistant varieties (link at bottom of page).

Resistant tomato varieties in many cases can still be infected by and allow the reproduction of (and an increase in concentration) of both ToMV and TMV but do not show symptoms.

Look-alikes

Herbicide damage can also resemble virus symptoms but some diagnostic laboratories can test for common herbicides-consult them for specific details. Other viruses and viroids can also cause similar symptoms to ToMV but have different management methods. Testing and identification of the agent causing symptoms will allow for effective management solutions to be taken to reduce damage in the current growing season and the following ones as well.

Reference to commercial products or trade names is made with the understanding that no discrimination is intended of those not mentioned and no endorsement is implied for those mentioned.

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Tomato fruit symptoms from plants infected with Tomato Mosaic Virus



Tomato leaf symptoms from plants infected with Tomato Mosaic Virus

