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Tomato brown rugose fruit virus (ToBRFV)

Julius Kühn Institute, Federal Research Centre for Cultivated Plants

Impress

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Introduction

Tomato brown rugose fruit virus (ToBRFV) was detected in Germany for the first time in 2018 and was classified as quarantine pathogen. The virus is easily transmissible by mechanical means which can lead to rapid spread within greenhouses and/or production sites. Infected plant material should therefore be destroyed.

Taxonomy

ToBRFV belongs to the genus *Tobamovirus* and is therefore related to tobacco mosaic virus (TMV),tomato mosaic virus (ToMV), tomato mottle mosaic virus (ToMMV), cucumber green mottle mosaic virus (CGMMV) and odontoglossum ringspot virus (ORSV) (Adams et al. 2012).

Biology

Tobamoviruses have a single-stranded RNA molecule which is covered by a protein shell. The rod-shaped virus particles can only be visualised by electron microscopy (Figure 1). Tobamoviruses can be transmitted through infected seeds or by mechanical means. The virus particles can enter plant cells through small wounds. Within the host plant, the virus replicates using host cell factors and is reproduced. Tobamoviruses are very stable and can survive on surfaces such as clothing, plant debris, nutrient solutions, soil or transportation material without losing infectivity.

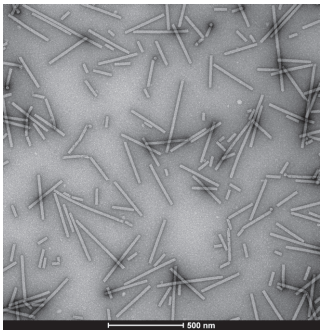

Figure 1. Electron microscopy image of purified ToBRRFV particles at 21.000x resolution. Intact particles are 300 nm in length, in this preparation, incomplete particles are also visible. Image courtesy Dr. Richert-Pöggeler, JKI.

Known Distribution

ToBRFV was firstly described for Jordan in 2016 (Salem et al. 2016). Subsequently, ToBRFV was discovered in Israel, Palestine, California and Mexico (Alkowni et al. 2019; Chitambar 2018; European and Mediterranean Plant Protection Organization 2019; Ling et al. 2019, 2019; Luria et al. 2017; North American Plant Protection Organization. Phytosanitary Alert System 2018). Within the EU, official reports exist for Germany and Sicily (European and Mediterranean Plant Protection Organization 2019; Menzel et al. 2019; Panno et al. 2019; Wilstermann and Ziebell 2019). Most recently, ToBRFV was reported in Turkey (Fidan et al. 2019).

Host Plants

Main host plants are cultivated tomatoes. ToBRFV can infect TMV or ToMV-resistant tomato varieties. ToBRFV can also infect tobamovirus-resistant pepper varieties (Luria et al. 2017). Other susceptible plant species can occur in nature in Germany, for example various goosefoot species (*Chenopodium murale*, *C. quinoa*, *C. amaranticolor*), petunia (*Petunia hybrida*; an important ornamental crop), and black nightshade (*Solanum nigra*). Experimental host plants include different *Nicotiana* species (Luria et al. 2017). Potato (*Solanum tuberosum*) and eggplant (*Solanum melongena*) appear to be not susceptible (Luria et al. 2017).

Symptoms

It is difficult to distinguish ToBRFV-induced symptoms from those caused by other plant viruses. Infected plants can display mild to strong mosaic symptoms of leaves. Leaves can be smaller in size or display blistering (Figures 2 and 3). Wilting and yellowing of whole plants with subsequent collapse could also be observed. Fruit symptoms are more prominent with brownish or yellowish discoloration of tomato fruits (title page and Figure 4). This makes the tomatoes unmarketable. Other tomato viruses such as tobamoviruses (TMV, ToMV) or physostegia chlorotic mottle virus can cause similar symptoms. Many tomato young plants in Europe are treated with mild pepino mosaic virus (PepMV) strains as part of a cross-protection strategy; therefore, PepMV symptoms may also be present in ToBRFV-infected plants.



Figures 2 to 4. ToBRFV symptoms on tomato. Leaves can have deformations and mosaic-type discoloration. These symptoms can also be induced by other plant viruses so that symptom-based diagnostics is not sufficient. Images courtesy Landwirtschaftskammer Nordrhein-Westfalen.

Dispersal and Spread

The virus can easily be transmitted by seeds or mechanical means. Tobamoviruses are extremely stable and can even be transmitted from cigarettes onto plants (Balique et al. 2012). Furthermore, tobamovirus particles can adhere to human skin, clothing, pots, packaging and transportation material as well as utensils (such as secateurs). Transmission by nutrient solutions is also possible. Bumble bees used for pollination in greenhouses can also transmit ToBRFV (Levitzky et al. 2019).

Detection and Identification

Only a few options are currently available for detection of ToBRFV. Virus particles can be visualised using electron microscopy but they cannot be differentiated from other tobamoviruses. Antibodies are available for serological tests; however, these antisera often cross-react with other tobamoviruses so that a positive test should be confirmed by other means. Different RT-PCR protocols for the broad detection of tobamoviruses are available but are not ToBRFV-specific (Dovas et al. 2004; Li et al. 2018; Luria et al. 2017; Maroon and Zavriev 2002). Positive tests should therefore be confirmed by sequencing the amplicons.

Prevention and Control

Strict hygiene protocols are the most important step in the prevention of tobamovirus infections. All plants need to be inspected regularly. If suspicious symptoms are observed, abiotic stress (nutrient deficiency, temperature) and pests should be ruled out. If a virus infection is suspected, the appropriate local plant protection organisation should be notified for virus testing. If ToBRFV infection is confirmed, all plant material should be destroyed (incineration) and not be composted as the virus particle can survive this process (Richter et al. 2019). There is currently no information available on the decontamination of greenhouse substrates. It is therefore recommended not to re-use contaminated substrates (such as rock wool or perlite) (Richter et al. 2019). There is a great danger of cross-contamination if the same crops or alternative hosts to ToBRFV are grown afterwards. Heat or steam treatment may reduce the risk of infection but do not guarantee that the materials are free from virus particles afterwards.

Floor space, boxes, containers, tools and utensils should be disinfected using licensed products. The use of licensed products guaranties proven efficacy whilst preventing negative effects on operators, plants and environment. In Germany, only Menno Florades ® is currently licensed as antiviral agent (Bundesamt für Verbraucherschutz und Lebensmittelsicherheit 2019). The manufacturer provides details on concentration and exposure time for successful inactivation of viruses. Unlicensed products are not recommended as they have not been tested for efficacy and harmlessness for humans, animals and the environment.

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