Department for Environment Food & Rural Affairs

Plant Pest Factsheet

Tomato brown rugose fruit virus

Figure 1. Brown spotting caused by infection with tomato brown rugose fruit virus (Source EPPO/Camille Picard)

Background

Tomato brown rugose fruit virus (ToBRFV) is a member of the genus *Tobamovirus*, which was first described infecting tomato crops in Israel in 2014 and has subsequently spread to other tomato growing regions around the world.

As with other tobamoviruses, ToBRFV is readily spread via contact transmission, but is also seed transmissible and has been shown to be transmitted by bumblebees during pollination. The virus is environmentally stable, remaining active on various surfaces for months, and is also relatively heat tolerant making control of the pathogen challenging.

Geographical Distribution

ToBRFV was first observed in Israel in 2014, and in Jordan in the following year. Since then, the virus has been officially reported from other countries in Asia and has spread to countries in Africa, Europe, North America and South America. There has been some successful local eradication action, but there have been subsequent outbreaks in most of these countries. The distribution is rapidly changing and the virus is likely to be more widespread than currently reported. The latest records can be found on the EPPO Global Database which is updated regularly (https://gd.eppo.int/).

The virus was first found in the UK at a tomato production site in south-east England in the summer of 2019, and phytosanitary measures were taken, resulting in eradication of the virus. Since 2019 there have been a further eight outbreaks of ToBRFV in commercial tomato production sites in England, one in 2019, five in 2020, one in 2022 and two in 2023. The five outbreak sites from 2020 were declared eradicated in 2021 following surveillance. However, one of these outbreak sites was reinfected and the outbreak was redeclared in 2022, before eradication was achieved in 2023. A new outbreak was also declared at another tomato production site in 2022, and two were declared in 2023. Eradication measures are being applied at all three remaining sites.

ToBRFV has also been intercepted on imported tomato and pepper seed. Where the virus is confirmed in seed, official action is being taken by the Plant Health and Seeds Inspectorate (PHSI) to contain and eradicate the virus to prevent it from being used to produce an infected crop.

Host Plants

The major natural hosts are tomato and pepper. There has been a report of infection in aubergine, however this appears to be related to detection from a seed lot, and not from an infected plant.

The susceptibility of weed hosts is still relatively unknown, but solanaceous species (tomato family) such as *Solanum nigrum* (black nightshade), *S. elaegnifolium* (silverleaf nightshade) and *S. rostratum* (prickly nightshade) have all been shown to be susceptible to ToBRFV infection following experimental inoculation. Until recently ToBRFV had only been detected in these and other experimentally inoculated weeds, but recent studies have found weeds which have been naturally infected by the virus. These include common weeds such as *Beta vulgaris* subsp. *maritima* (sea beet), *Ipomoea purpurea* (morning glory), *Malva parviflora* (mallow), *Senecio jacobaea* (ragwort), *S. elaegnifolium, S. nigrum* and *Taraxacum officinale* (dandelion), suggesting it is likely that weeds could act as potential reservoirs of the pathogen.

Description & symptoms

The virus is named after the brown, wrinkled (rugose) patches which can develop on the fruit of infected plants. However, this distinct symptom is somewhat uncharacteristic of infection with the virus in hydroponic fruit production. Fruit generally suffers from discoloration (e.g. chlorotic marbling and dark spots), uneven ripening, deformation, reduced size, and necrotic patches or spotting.

Figure 2: Leaf deformation (Source Defra / Neil Giltrap)

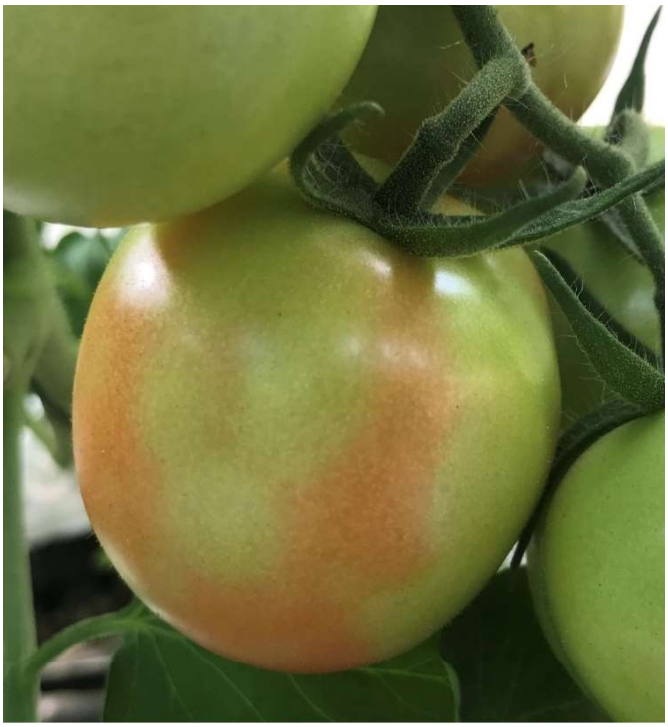

Figure 3: Tomato fruit discoloration (Source Defra / Neil Giltrap)

Figure 4: Tomato fruit discoloration (Source Defra / Neil Giltrap)

Foliar (leaf) symptoms include mosaic patterning which can range in severity from obvious to subtle. Leaf deformation may also occur such as puckering and narrowing, blistering, or reduction in leaflet size. Plants may also exhibit wilted leaves. Necrosis may develop on pedicels (stems), calyces, petioles and flowers.

Biology

ToBRFV infects plants through small wounds, entering cells and reproducing using the cells own replication mechanisms. The virus then moves from cell to cell or moves longer distances systemically within the plant via the phloem.

ToBRFV is transmissible through both sap transfer and contact, and as infection with the virus is systemic, all parts of an infected plant become a source of contamination enabling further spread. The virus is also seed transmissible, though it is thought to be limited to the seed coat and does not infect the embryo. However, the virus can survive on the seed coat for several years and whilst seed to seedling transmission is thought to be inefficient, and has not yet been experimentally demonstrated, this route of transmission is strongly suspected to occur.

Tobamoviruses are recognised to have robust virions (virus particles) which can withstand both raised temperatures and extended periods outside of a host cell and remain infectious. On both skin and disposable gloves exposed to contamination with ToBRFV, the virus remained active for over two hours. Handwashing has been shown to be of limited efficacy in removing viral contamination. The virus was also demonstrated to remain active on multiple surfaces (concrete, steel, aluminium, glass, hard plastic and polythene) for between one and three months, and in some cases up to six months.

Most commercial tomato varieties carry resistance genes to defend against infection with tobamoviruses such as tobacco mosaic virus and tomato mosaic virus (TMV and ToMV), known as Tm-2^2 genes. However, ToBRFV can overcome this genetic resistance, meaning tomato varieties which are resistant to TMV and ToMV will still be susceptible to infection with ToBRFV. Fortunately, pepper plants with the tobamovirus resistance genes L^1, L^3 and L^4 appear to retain resistance to ToBRFV.

Dispersal and Detection

Long distance dispersal of the virus is likely through movement of contaminated seed and the trade in propagation plants (plants for planting) coming from nurseries with established sources of infection. Another means of introduction may be through infected fruit moved in trade. Handling fruit from infected plants provides a source of contamination that could then be passed on to growing plants. Studies have found high incidence levels of infected fruits at retailers within the UK. The source of these infections could be due to fruit coming from infected plants, or the fruit itself being contaminated during packhouse processing. If infected fruits imported for packing are processed in packhouses at production sites, it will increase the risk of the virus being transferred to a growing crop via workers and

equipment such as trays and containers, particularly if the fruit becomes damaged and releases infectious sap. As such, stringent hygiene measures are important.

Once introduced to a production site, the virus can be spread over short distances through plant-to-plant contact or through human mediated spread (plant handling, grafting) on contaminated hands, gloves or clothing. Bumblebees have also been shown to be a potential dispersal route within a glasshouse during pollination. The virus will also be transferred on tools and equipment coming into contact with infected plants and fruit such as cutting knives, plastic trays and vehicles. Other items which can be inadvertently contaminated will also be potential sources for onward spread of the virus including mobile phones, watches and jewellery as well as contaminated fruit moving to other packing sites as part of trade or onto site by workers (e.g. in packed lunches).

Detection of the virus through symptom recognition is not considered to be a reliable method for identifying infections. The symptoms may appear to be similar to other virus infections or physiological conditions such as nutrient deficiency. Therefore, laboratory diagnosis is required to confirm the presence of the virus. This will rely on effective sampling, with levels of infection varying between parts of the plant depending on the age of the crop and timing of infection. The most reliable sections of plant to sample for detection are the sepals and young leaves. In young crops where the sepals have not developed, sampling should focus on the young leaves, whilst in a more mature crop sampling should focus on sepals and/or fruit.

Economic Impact

ToBRFV can infect up to 100% of a crop (reported in Jordan), and yield losses of between 25 and 70% have been reported, largely due to the fruit being unmarketable, and the loss of production period as plants reduce in vigour and die prematurely. Additional costs can be incurred through removal of infected crops and cleaning of the glasshouse.

It is possible for plants to show no obvious symptoms and yet still be infected, and the susceptibility of the crop is dependent on the variety, cultural practices and the climate, with glasshouse crops expected to be more susceptible than outdoor grown crops, as there is more handling and spread via mechanical transmission. Tomatoes are more likely to be susceptible than peppers, with pepper varieties with the L^1, L^3 and L^4 genes appearing to be resistant.

Pest Management and reporting

Since January 1st 2021, ToBRFV has been a GB quarantine pest with measures on import and movement of tomato (*Solanum lycopersicum*) and pepper (*Capsicum* spp.) seed and plants for planting to prevent the introduction and spread of ToBRFV.

There are no treatments available, and the only means of removing the virus from a crop is by destroying the plants and following good hygiene practice. This is particularly important at production sites and propagators associated with packhouses dealing with imported fruit, due to the high incidence levels of the virus associated with produce.

There are no treatments available, and the only means of removing the virus from a crop is by destroying the plants and following good hygiene practice. Following good hygiene practice is particularly important at production sites and propagators associated with packhouses dealing with imported fruit, due to the high incidence levels of the virus associated with produce. These sites will have an increased risk of infecting growing crops via mechanical transmission after handling infected produce. As such strict hygiene measures should be implemented, and moving packhouses to separate sites could be considered in order to reduce the risk of infecting the growing crop. Prior to destruction, infected crops at production sites may be permitted to be grown for harvest and the produced fruit to be sold, provided the harvested fruit is moved directly to retail or to a packhouse with suitable hygiene measures in place to prevent further infections of a growing crops. All infected sites will be subject to a post crop clean up using appropriate hygiene measures following harvest. All findings will be treated on a case-by-case basis. More detail on this can be found in the Defra pest specific contingency plan and the guidance published by the AHDB:

https://archive.ahdb.org.uk/knowledge-library/tomato-brown-rugose-fruit-virus

Suspected outbreaks of tomato brown rugose fruit virus or any other non-native plant pest should be reported to the relevant authority:

For **England and Wales**, contact your local **APHA Plant Health and Seeds Inspector** or the **PHSI Headquarters**, York.

Tel: 0300 1000 313

Email: planthealth.info@apha.gov.uk

For **Scotland**, contact the **Scottish Government's Horticulture and Marketing Unit:**

Email: hort.marketing@gov.scot

For **Northern Ireland**, contact the **DAERA Plant Health Inspection Branch:**

Tel: 0300 200 7847 Email: planthealth@daera-ni.gov.uk

Web: https://www.daera-ni.gov.uk/topics/plant-and-tree-health

For additional information on UK Plant Health please see:

https://planthealthportal.defra.gov.uk/pests-and-diseases/uk-plant-health-risk-register/

https://planthealthportal.defra.gov.uk/

https://www.gov.uk/plant-health-controls

http://www.gov.scot/Topics/farmingrural/Agriculture/plant/PlantHealth/PlantDiseases

https://www.daera-ni.gov.uk

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