



Fig. 1. a) control tobacco plant; b) TMV negative immunotest result showing only one red band; c) TMV positive immunotest result showing two red bands; d) close up of symptoms on tobacco leaf showing the characteristic 'mosaic' – like mottling and discolouration; e) epidermal cell stained with 1% (w/v) Phloxine B showing the anamorphous inclusion body (i) and f) a crystalline inclusion body (i) in a hair cell. Images (e) and (f) were epidermal leaf peels from TMV infected tobacco plants observed with an Olympus BX51 microscope under differential interference contrast (DIF). Black arrows show the location of the nucleus.

Common Name: Tobacco Mosaic Virus (TMV)

Disease: Mosaic disease (MD)

Classification: Kingdom: Viruses and Viroids Phylum: N/A Class: N/A Order: N/A Family: Virgaviridae (N/A: Not Applicable)

In the realm of *Riboviria* and the genus *Tobamovirus*, TMV is a positive single strand RNA rod-shaped plant virus. It infects commercial tobacco belonging to the species *Nicotiana tabacum* L. It can be a serious problem when cultivating other solanaceous and ornamental plants using high density growth practices in greenhouses and nurseries.

Biology and Ecology:

Ranging from 300 nm by 15 nm in size, the virus can be transmitted via minor wounding by rubbing an infected leaf against a leaf of a healthy plant, by contaminated tools or handling healthy plants with contaminated hands. Once inside a tobacco plant cell cytoplasm, the virus particle disassembles and the exposed TMV ssRNA (+) serves as messenger RNA using the host ribosome to make replicase-associated proteins. This leads to the production of the negative sense RNA, subgenomic RNAs, the movement protein and coat protein respectively. New virions can be assembled using the coat proteins.

New plants can be infected by the new viral particles released from broken plant cells. Movement inside the infected plant, the complex of the positive sense RNA and the movement protein spread from cell-to-cell through the plasmodesmata and once they have reached the vascular system (veins in the leaf), they systemically spread through the phloem of growing plant. Auxin has been linked to TMV systemic movement and to enhance virus infection. Under the microscope, TMV infected cells form inclusion bodies. TMV can survive in seed coats, perennial weeds and almost 50 years in dead dried plant tissue.

In a susceptible host plant, symptoms can appear 7-14 days after infection. Depending on the plant host, symptoms are mosaic-like mottling, necrosis, leaf curling, yellowing of plant tissues, stunting, dwarfing and loss of apical dominance. Flowering may be delayed. Strains that infect tomatoes affect yield by delaying fruit ripening, distorting fruits and fruit colour. Factors such as plant age, virus strain and environmental conditions affect symptom development in the plant host.

Impact:

In 2017, more than 3.5 million hectares of land over 125 countries produced about 6.5 Mt of unmanufactured tobacco. Over a third of which is produced in China alone.

Distribution:

It has a worldwide distribution.

Host Range:

Apart from tobacco, tomatoes and other solanaceous plants such as potato, pepper, ornamental plants such as chrysanthemums, impatiens, petunias and orchids can be infected by TMV. It was recently found to infect sesame in China.

Management options:

Current practices involve the use of resistant cultivars which utilize the single gene N from the diploid wild relative *N. glutinosa* L. conferring resistance via a hypersensitive response. However it is not absolute as (a) the N gene mediated resistance is suppressed at temperatures of 28°C and above and, (b) the N gene is prone to deletion and/or point mutations thus increasing the susceptibility of cultivars to TMV infection. Workers need to wash their hands after handling tobacco products.

In a greenhouse or nursery setting, workers should ensure that seed stocks or plants used for grafting are virus-free and they should monitor their plants for TMV symptoms. If plants are suspected to be infected with TMV, plants should be quarantined and tested using ImmunoStrip® (Agdia, <http://www.agdia.com>) or samples sent to a diagnostic laboratory. If positive for TMV, infected plants including potting media should be destroyed and facilities and tools be disinfected using 0.6 % sodium hypochlorite or 20% (w/v) of non-fat milk powder solution.

Further Reading: Collum et al (2016) PNAS 113 (19) E2740-E2749; Lewandowski and Hayes (2010) Plant Dis. 94:542-550; Lewis and Rose (2010) Crop Sci. 50:1339-1347; Li et al (2015) Virol J 12:5 DOI 10.1186/s12985-014-0237-5; Madzokere ET (2017) Virol Mycol 6: 171. doi: 10.4172/2161-0517.1000171; McWhorter (1941) Stain Technol. 16. 143-148; Padmanabhan et al (2008) J Virol 82 (5):2477-2485; Scholthof et al (2011) Mol Plant Pathol 12: 938-954; see all sections in Philos Trans R Soc Lond B Biol Sci. 1999 Vol Volume 354 (1383).

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