

A Destructive Disease of Garden Balsam Caused by a Strain of Turnip Mosaic Virus

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ABSTRACT

Provvidenti, R. 1982. A destructive disease of garden balsam caused by a strain of turnip mosaic virus. *Plant Disease* 66:1076-1077.

A striking and lethal disease of garden balsam (*Impatiens balsamina*) was caused by a strain of turnip mosaic virus (TuMV). Naturally and experimentally infected plants developed foliage chlorosis and necrosis, prominent stem streak, and stunting. Plants withered and died prematurely. Plants of five balsam cultivars inoculated with three strains of TuMV reacted similarly and died prematurely. Type, sequence, and intensity of symptoms varied with the strain, however. One strain of TuMV was not infectious to balsam plants.

In the last 2 yr, plants of garden balsam or lady's slipper (*Impatiens balsamina* L.) grown in a garden in Geneva, NY, showed stem necrosis and foliage chlorosis with necrotic veins and spots. Few plants reached full maturity; most collapsed and died prematurely. Initially, infection by fungi or bacteria was suspected, but isolations of such organisms were inconclusive. Inoculations with leaf extracts from affected plants to healthy greenhouse-grown balsam plants, however, resulted in symptoms closely resembling those occurring on naturally infected plants. Electron microscopy of negatively stained preparations of affected leaves revealed virus particles similar in shape and size to those of the potyvirus group (2). Turnip mosaic virus (TuMV) was suspected as the causal agent because it had been recovered previously from dame's violet (*Hesperis matronalis* L.) plants abundant in the same garden (unpublished).

This paper reports the characterization of a newly recognized disease of garden balsam caused by a strain of TuMV.

MATERIALS AND METHODS

Leaves were collected from 10 plants of the balsam cultivar Tall Camellia Flowered with varying degrees of stem necrosis and foliage chlorosis and from five dame's violet plants with prominent leaf mosaic and distortion. Individual specimens were ground with 0.01 M phosphate buffer (K⁺) (pH 7.4), and extracts were rubbed on leaves of diagnostic species, including the Tall Camellia Flowered balsam. Subse-

quently, each virus isolate was passed through three single-lesion transfers on *Chenopodium quinoa*, then used to inoculate six accessions of Chinese cabbage (*Brassica campestris* subsp. *pekinensis*) for identification of TuMV strains (7). For comparative studies, plants of the balsam cultivars Tom Thumb, Royal, Dwarf Double Flowered, Double Camellia Flowered, and Tall Camellia Flowered were inoculated at the four- to six-leaf stage with four recognized strains of TuMV (C1, C2, C3, and C4) and one virus isolate from a naturally infected balsam plant.

Immunodiffusion tests were performed in sodium dodecyl sulfate (SDS) agar plates (0.8% Ionagar, 1% NaN₃, and 0.5% SDS) as reported by Purcifull and Batchelor (8). Antigens were derived from plants of the turnip cultivar Presto infected with field isolates of the virus. Antiserum to TuMV was obtained from D. E. Purcifull (University of Florida).

Aphid transmission was attempted with an insectary colony of *Myzus persicae*. Young adult apterous aphids were starved for 2 hr, then allowed 1-min acquisition access on TuMV-infected dame's violet plants. Viruliferous aphids were transferred to young balsam plants for 1-hr inoculation access. All work was conducted in a greenhouse maintained at 25 C.

RESULTS

Identification of the causal agent. Each of the 15 specimens yielded virus isolates that caused the following symptoms on diagnostic species: local chlorotic and necrotic spots, systemic foliar mottle and necrosis, distortion, and stunting of *B. campestris* subsp. *rapifera* 'Presto'; chlorotic local lesions and limited systemic mottle on *C. quinoa*; prominent local and systemic chlorotic spots on *Cichorium endivia* 'Salad King'; a few scattered local chlorotic spots without systemic infection of *Cichorium intybus* 'Catalogna'; small systemic chlorotic

specks limited to a few leaves on *Cucurbita pepo* 'Seneca Zucchini'; conspicuous systemic chlorotic mottle and malformation of *H. matronalis*; necrotic local lesions, systemic vein chlorosis and necrotic spotting, leaf distortion, stem necrosis, stunting, and premature death of *I. balsamina* 'Tall Camellia Flowered'; prominent chlorotic mottle, distortion, and necrosis of *Nicotiana glutinosa*; local chlorotic spots turning necrotic but no systemic infection of *N. tabacum* 'Havana 423'; and no infection of *Phaseolus vulgaris* 'Red Kidney.' PI 418957, PI 391560-1, Takii WR-65 Days, and Tropical Delight Chinese cabbage plants were not infected with any of the virus isolates, whereas Champion and Crusader plants developed prominent local and systemic symptoms consisting of foliar mosaic, distortion, necrosis, and severe stunting.

In immunodiffusion tests, antigens of the 15 virus isolates from infected turnip plants reacted with a TuMV antiserum. Precipitin bands coalesced among themselves and with that of TuMV-C1, in a continued pattern of identity. No reaction was visible with sap of healthy turnip plants used as controls.

On the basis of host range (9), resistance in Chinese cabbage (6) and Catalogna chicory (7), and serological tests, it was concluded that the virus infecting balsam plants was TuMV. In addition, all isolates from balsam and dame's violet plants were identical to TuMV-C1, a strain previously found in cabbage in New York State (6).

Reaction of balsam cultivars to strains of TuMV. Plants of five commercial cultivars responded similarly to each of four recognized strains of TuMV. Those inoculated with TuMV-C1 or a field isolate from balsam incited identical symptoms that appeared to be the most striking and severe. Local necrotic lesions were followed by systemic chlorotic spots with necrotic centers and veinal chlorosis. Concurrently, plant growth was retarded and the younger leaves remained small, became chlorotic and distorted, and curled downward (Fig. 1). Black streaks appeared on the thick fleshy stems within 2 wk after inoculation. The necrosis then spread to the entire stem, lateral branches, petioles, and veins of the older leaves, which became yellow and abscised (Fig. 2). Within 1 mo, affected plants withered and died. In contrast, plants inoculated with strain TuMV-C2 did not develop symptoms, and assays of inoculated and uninoculated leaves

Accepted for publication 9 June 1982.

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0191-2917/82/11107602/\$03.00/0
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Fig. 1. Tom Thumb garden balsam infected with turnip mosaic virus (left) compared with healthy plant.

showed them to be free from virus. Plants inoculated with strain TuMV-C3 or TuMV-C4 reacted similarly, but symptoms incited by TuMV-C3 were much milder initially. Local chlorotic lesions were followed by systemic veinal chlorosis, which was very prominent in plants infected with TuMV-C4. Newly developed leaves remained small and curled upward. Plant growth was retarded and black stem streaks became visible 3-5 wk after inoculation. The necrosis spread to the entire stem, lateral branches, petioles, and some of the veins of mature leaves. Plants eventually collapsed and died. The plants that produced a few flowers showed color break. Thus, with the exception of strain TuMV-C2, which failed to infect any of the five balsam cultivars, the strains caused a disease that resulted in plants dying prematurely. Type, sequence, and intensity of symptoms varied with the strain, however.

Aphid transmission. The green peach aphid readily transmitted TuMV from dame's violet plants to Tall Camellia Flowered and Tom Thumb balsam plants. In a trial using six aphids per plant, all six plants of each cultivar developed symptoms identical to those noted under field conditions.

DISCUSSION

This apparently is the first report of TuMV in *I. balsamina*, although this virus was reported to infect plants of two related species, *I. parviflora* D.C. in Czechoslovakia (4) and *I. walleriana* Hook. in Germany (1). Garden balsam was also reported to be a host of a few other viruses, including those of alfalfa mosaic (3,5), cucumber mosaic (4,5), and tobacco ringspot (5), but the disease caused by some strains of TuMV is unquestionably the most destructive. At least one strain of this virus, however, did not infect any of the five balsam cultivars tested.

Stem necrosis is the most notable feature of the disease. It causes the thick fleshy stem to collapse, which suggests some fungal or bacterial infection. The uniform susceptibility of five balsam cultivars to virulent TuMV strains suggests a restricted genetic base, which would provide little chance of locating resistance or tolerance within the species.

Balsam was a recent introduction to the garden in which it was found to be diseased. The high incidence of infection among the few hundred plants could be attributed to the local presence of TuMV in dame's violet plants and an abundance of aphids. Apparently, no measures to

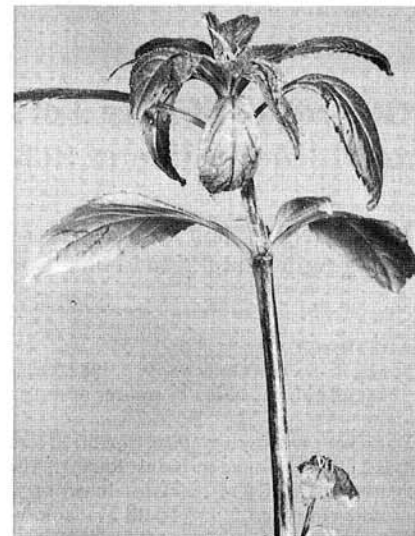


Fig. 2. Black stem streak and veinal necrosis caused by turnip mosaic virus in Tall Camellia Flowered garden balsam.

control pests had been taken.

Garden balsam appears to be a useful indicator host for TuMV and may be of some value for differentiating strains of this virus.

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