

Resistance to Tobacco Mosaic Virus in Pepper Introductions

GROVER SOWELL, JR., Research Plant Pathologist, Agricultural Research Service, U.S. Department of Agriculture, Experiment, GA 30212

ABSTRACT

Sowell, G., Jr. 1982. Resistance to tobacco mosaic virus in pepper introductions. *Plant Disease* 66: 1062-1064.

Virus was not recovered from 53 of the 1,863 peppers (*Capsicum* spp.) in the national pepper collection evaluated for resistance to tobacco mosaic virus. Resistance was indicated by necrosis or no symptoms on inoculated leaves, followed by failure to recover the virus from uninoculated leaves.

Tobacco mosaic virus (TMV) is a very destructive pathogen on pepper, causing up to 80% loss when early infections occur (6). Resistance to TMV has been known in pepper since the work of Holmes (8). Cook (3) reported that 75% of the seed collections from South America produced some plants that were resistant to TMV as indicated by local

lesion production. A number of additional sources of resistance have been reported by Crossan and Rahn (4) and by Pound and Singh (10). Boukema (1) reported 25 *Capsicum chinense* accessions that were resistant to "pepper strain P8" in the Netherlands. She stated that P8 resembled the Samsun latent strain of tobacco mosaic virus (SLTMV) reported by Greenleaf et al (7). Van den Berkmortel (11) reported that two of 562 accessions screened were resistant to the "Dutch pepper strain" of TMV.

Although various reports have indicated some resistance to TMV among exotic peppers, the entire plant introduction (PI) collection has not been screened under uniform conditions. The purpose of this paper is to report the results of screening the entire collection of 1,863 pepper PIs maintained by the Southern Regional Plant Introduction Station for resistance to TMV.

MATERIALS AND METHODS

Approximately 28 seeds of each of the PIs were planted in single rows in flats of a soil, peat moss, vermiculite growing medium in the greenhouse. Plants were thinned to 20 per row soon after germination. Isolate PV 135 (common strain; American Type Culture Collection) was used in the first 13 preliminary tests; Isolate PV 1 (obtained from J. W. Demski, Georgia Experiment Station, Experiment, GA) was used in preliminary tests 14-28. Two rows of California Wonder 300 were included in all preliminary tests to check for level and uniformity of infection because the leaves of this cultivar become necrotic and abscise when infected by TMV. PV 135 and PV 1 were maintained in NC-95 and Samsun tobacco, respectively. Young, infected leaves were ground with a mortar and pestle, and the sap was filtered through cheesecloth and diluted at the rate of 1 g of infected tissue per 100 ml of 0.025 M phosphate buffer containing 1 g of 600-mesh Carborundum. Pepper plants were inoculated in the four- to six-leaf stage (4-5 wk old) with an atomizer at an air pressure of 3.5 kg/cm². Numbers of plants showing mottle in the younger leaves, local lesions as described by Holmes (8), or local necrotic areas were recorded 2 wk after inoculation. Five to

This research is a contribution of the Southern Regional Plant Introduction Station, Regional Project S-9.

Accepted for publication 27 February 1982.

The publication costs of this article were defrayed in part by page charge payment. This article must therefore be hereby marked "advertisement" in accordance with 18 U.S.C. § 1734 solely to indicate this fact.

This article is in the public domain and not copyrightable. It may be freely reprinted with customary crediting of the source. The American Phytopathological Society, 1982.

Table 1. Reaction of some pepper (*Capsicum* spp.) plant introductions (PIs) to two isolates of tobacco mosaic virus

| PI | Species ^a | Isolate PV 135 | | | Isolate PV 1 | | |
|-----------------------|----------------------|---------------------|----------------------------|-----------------------------|--------------|---------------|----------------|
| | | Mottle ^b | Local lesions ^c | Positive index ^d | Mottle | Local lesions | Positive index |
| 159233 | <i>frutescens</i> | 0/26 | 24/26 | 2/14 | 0/7 | 5/7 | 0/5 |
| 159234 | <i>frutescens</i> | 0/40 | 39/40 | 0/14 | 0/20 | 16/20 | 0/5 |
| 159236 | ? | 0/38 | 36/38 | 1/14 | 0/20 | 0/20 | 0/5 |
| 159261 | ? | 1/18 | 0/18 | 0/9 | 0/19 | 1/9 | 0/5 |
| 224418 | <i>annuum</i> | 3/36 | 11/36 | 4/15 | 0/20 | 18/20 | 0/5 |
| 224419 | <i>annuum</i> | 2/34 | 14/34 | 1/5 | 0/20 | 20/20 | 0/5 |
| 224421 | <i>annuum</i> | 0/37 | 25/37 | 0/15 | 0/19 | 19/19 | 0/5 |
| 224439 | <i>annuum</i> | 2/38 | 18/38 | 0/15 | 0/19 | 18/19 | 0/5 |
| 241650 | ? | 0/26 | 8/26 | 0/15 | 0/9 | 3/9 | 0/5 |
| 244668 | <i>annuum</i> | 5/25 | 10/25 | 2/10 | 0/9 | 7/9 | 3/5 |
| 246123 | <i>annuum</i> | 4/35 | 29/35 | 1/15 | 0/17 | 17/17 | 1/5 |
| 257047 | <i>annuum</i> | 0/37 | 28/37 | 0/5 | 0/19 | 19/19 | 0/5 |
| 257118 | <i>frutescens</i> | 0/39 | 35/39 | 0/15 | 0/18 | 15/18 | 0/5 |
| 281416 | <i>annuum</i> | 0/19 | 0/19 | 0/10 | 0/5 | 5/5 | 0/5 |
| 286419 | <i>annuum</i> | 4/36 | 0/36 | 2/15 | 0/20 | 20/20 | 0/5 |
| 288933 | <i>annuum</i> | 2/40 | 19/40 | 0/15 | 0/20 | 19/19 | 0/5 |
| 288941 | <i>annuum</i> | 2/40 | 0/40 | 1/10 | 0/17 | 17/17 | 1/5 |
| California wonder 300 | <i>annuum</i> | 1/20 | 20/20 | 3/5 | 0/20 | 19/19 | 1/5 |
| Greenleaf Tabasco | <i>frutescens</i> | 0/20 | 17/20 | 0/5 | 0/20 | 8/20 | 0/5 |
| Truhart Perfection | <i>annuum</i> | 7/20 | 0/20 | 5/5 | 4/20 | 0/20 | 5/5 |

^aSpecies based on flower characteristics.

^bNumber of plants showing mosaic/total number inoculated.

^cNumber of plants showing local lesions and/or necrotic areas on inoculated leaves/total number inoculated.

^dNumber of plants for which sap from newly formed, uninoculated leaves produced local lesions on *Nicotiana glutinosa*/total number indexed.

20 plants per row that showed little or no mottle were indexed for TMV by sap inoculation on a local lesion host, *Nicotiana glutinosa*.

PIs for which a low percentage of recovery of PV 135 was obtained were inoculated with isolate PV 1 in a repeat test. Those originally inoculated with isolate PV 1 were retested with the same virus. Flower characteristics and number of pods per node were determined to ascertain whether the PIs were properly identified in the first repeated test.

In the final test, susceptible cultivars Early California Wonder and Truhart Perfection were compared with three resistant cultivars and seven *C. annum* PIs that had high levels of resistance in previous tests.

RESULTS AND DISCUSSION

In the preliminary tests, 78 PIs were resistant to TMV as indicated by a low incidence of mottle, high or low incidence of local lesions, and failure to recover TMV from uninoculated leaves. All California Wonder 300 check plants showed symptoms in most experiments, indicating that infection was uniformly high. In repeated experiments, TMV could not be recovered from new leaves (developed after inoculation) in 53 of these PIs (Tables 1 and 2). PI 159236 did not develop local lesions or systemic symptoms when inoculated with PV 1 and only local lesions with isolate PV 135. PI 281416 did not develop systemic symptoms or local lesions with PV 135 but had local lesions with PV 1. Neither

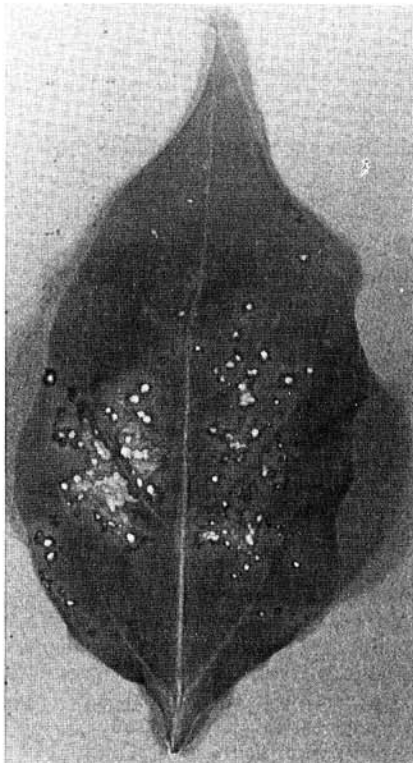


Fig. 1. *Capsicum annum*, PI 391563, showing local lesions following inoculation with strain PV 1 of tobacco mosaic virus.

isolate could be recovered from nine of the PIs listed in Table 1. Virus was recovered from all plants of Truhart Perfection tested. The small number of plants of this cultivar showing symptoms was caused, I believe, by the mildness of

the mottle symptom in the test. This is supported by the fact that 31 out of 34 plants of this cultivar showed mottle in the final test (Table 3), and the virus was recovered from all of the plants tested.

The type of resistance reported here (ie,

Table 2. Reaction of some pepper (*Capsicum* spp.) plant introductions (PIs) to isolate PV 1 of tobacco mosaic virus

| PI | Species ^a | Total plants | Mottle | Local lesions ^b | Positive index ^c |
|--------|----------------------|--------------|--------|----------------------------|-----------------------------|
| 390436 | <i>annuum</i> | 51 | 0 | 44 | 0/20 |
| 390437 | <i>annuum</i> | 60 | 0 | 56 | 0/15 |
| 391563 | <i>annuum</i> | 52 | 0 | 38 | 5/15 |
| 406725 | <i>annuum</i> | 54 | 0 | 20 | 0/15 |
| 370004 | <i>baccatum</i> | 60 | 0 | 59 | 0/15 |
| 413669 | <i>baccatum</i> | 59 | 0 | 54 | 4/15 |
| 260426 | <i>chacoense</i> | 56 | 0 | 16 | 0/20 |
| 260431 | <i>chacoense</i> | 57 | 0 | 18 | 1/10 |
| 260438 | <i>chacoense</i> | 56 | 0 | 35 | 0/20 |
| 215732 | <i>chinense</i> | 59 | 0 | 53 | 0/15 |
| 224447 | <i>chinense</i> | 60 | 0 | 36 | 0/20 |
| 238046 | <i>chinense</i> | 59 | 0 | 44 | 1/20 |
| 238050 | <i>chinense</i> | 59 | 0 | 51 | 0/15 |
| 257086 | <i>chinense</i> | 56 | 0 | 45 | 1/20 |
| 257110 | <i>chinense</i> | 57 | 0 | 48 | 0/15 |
| 257123 | <i>chinense</i> | 53 | 0 | 45 | 0/20 |
| 257124 | <i>chinense</i> | 49 | 0 | 42 | 0/15 |
| 257137 | <i>chinense</i> | 56 | 0 | 55 | 0/15 |
| 257162 | <i>chinense</i> | 48 | 23 | 47 | 1/20 |
| 257171 | <i>chinense</i> | 54 | 0 | 20 | 2/15 |
| 260492 | <i>chinense</i> | 54 | 0 | 50 | 0/20 |
| 260504 | <i>chinense</i> | 55 | 0 | 27 | 1/15 |
| 281319 | <i>chinense</i> | 22 | 0 | 0 | 4/13 |
| 281353 | <i>chinense</i> | 59 | 0 | 59 | 0/20 |
| 315021 | <i>chinense</i> | 58 | 0 | 24 | 0/20 |
| 360726 | <i>chinense</i> | 60 | 0 | 58 | 0/15 |
| 213918 | <i>frutescens</i> | 59 | 0 | 58 | 0/15 |
| 257062 | <i>frutescens</i> | 58 | 0 | 22 | 0/15 |
| 257069 | <i>frutescens</i> | 59 | 0 | 41 | 0/15 |
| 257070 | <i>frutescens</i> | 43 | 0 | 42 | 1/15 |
| 281419 | <i>frutescens</i> | 60 | 3 | 40 | 0/15 |
| 281422 | <i>frutescens</i> | 60 | 0 | 35 | 0/15 |
| 322717 | <i>frutescens</i> | 59 | 0 | 37 | 0/15 |
| 238061 | <i>microcarpum</i> | 57 | 0 | 51 | 0/10 |
| 159235 | <i>pendulum</i> | 55 | 4 | 44 | 3/15 |
| 159245 | <i>pendulum</i> | 60 | 0 | 18 | 0/15 |
| 241648 | <i>pendulum</i> | 51 | 0 | 49 | 0/15 |
| 241674 | <i>pendulum</i> | 36 | 0 | 36 | 0/13 |
| 257133 | <i>pendulum</i> | 60 | 2 | 58 | 0/10 |
| 257164 | <i>pendulum</i> | 35 | 1 | 26 | 0/10 |
| 257180 | <i>pendulum</i> | 47 | 0 | 43 | 2/15 |
| 260536 | <i>pendulum</i> | 42 | 2 | 27 | 0/10 |
| 260543 | <i>pendulum</i> | 57 | 0 | 37 | 0/10 |
| 260546 | <i>pendulum</i> | 57 | 0 | 39 | 0/10 |
| 260550 | <i>pendulum</i> | 58 | 4 | 24 | 3/10 |
| 260551 | <i>pendulum</i> | 59 | 3 | 6 | 9/10 |
| 260560 | <i>pendulum</i> | 59 | 0 | 41 | 0/10 |
| 260564 | <i>pendulum</i> | 60 | 0 | 32 | 0/10 |
| 260565 | <i>pendulum</i> | 58 | 1 | 43 | 2/10 |
| 260569 | <i>pendulum</i> | 59 | 0 | 37 | 0/10 |
| 260572 | <i>pendulum</i> | 51 | 0 | 24 | 0/10 |
| 260575 | <i>pendulum</i> | 59 | 0 | 30 | 0/10 |
| 260576 | <i>pendulum</i> | 60 | 0 | 37 | 0/10 |
| 260578 | <i>pendulum</i> | 31 | 1 | 19 | 3/10 |
| 260579 | <i>pendulum</i> | 40 | 0 | 25 | 2/10 |
| 260587 | <i>pendulum</i> | 60 | 0 | 58 | 0/15 |
| 281415 | <i>pendulum</i> | 44 | 0 | 39 | 0/15 |
| 315025 | <i>pendulum</i> | 60 | 0 | 49 | 0/15 |
| 337522 | <i>pendulum</i> | 55 | 0 | 41 | 0/15 |
| 260599 | <i>pubescens</i> | 60 | 0 | 13 | 0/15 |
| 385962 | unidentified | 54 | 0 | 15 | 0/15 |

^a As listed in 1977 catalog of seed available at the Southern Regional Plant Introduction Station, Experiment, GA.

^b Number of plants showing local lesions and/or necrotic areas on inoculated leaves.

^c Number of plants for which sap from newly formed, uninoculated leaves produced local lesions on *Nicotiana glutinosa*/total number indexed.

Table 3. Reaction of some pepper (*Capsicum* spp.) plant introductions (PIs) and cultivars to isolate PV 1 of tobacco mosaic virus

| Entry | Species | Total plants | Mottle | Local lesions | Positive index ^a |
|------------------|-------------------|--------------|--------|---------------|-----------------------------|
| Early California | | | | | |
| Wonder | <i>annuum</i> | 30 | 30 | 0 | 40/40 |
| Yolo Wonder L | <i>annuum</i> | 36 | 0 | 36 | |
| PI 159236 | <i>annuum</i> | 39 | 0 | 29 | 0/40 |
| PI 159261 | <i>annuum</i> | 13 | 0 | 11 | 0/12 |
| PI 281416 | <i>annuum</i> | 41 | 0 | 24 | |
| PI 390436 | <i>annuum</i> | 35 | 0 | 35 | |
| PI 390437 | <i>annuum</i> | 38 | 0 | 37 | |
| PI 391563 | <i>annuum</i> | 35 | 0 | 32 | |
| PI 406725 | <i>annuum</i> | 39 | 0 | 39 | |
| Greenleaf | | | | | |
| Tabasco | <i>frutescens</i> | 36 | 0 | 25 | |
| Tabasco | <i>frutescens</i> | 26 | 0 | 24 | |
| Truhart | | | | | |
| Perfection | <i>annuum</i> | 34 | 31 | 0 | 32/32 |

^a Number of plants for which sap from newly formed, uninoculated leaves produced local lesions on *Nicotiana glutinosa*/total number indexed.

necrotic local lesions on inoculated leaves) is identical to that reported by Holmes (8). All of the PIs in the final test had local lesions (Fig. 1), as did all the resistant cultivars. According to Demski (5), isolate PV 1 used in these tests resembles SLTMV as described by McKinney (9) and Greenleaf et al (7). This conclusion is supported by the facts that the isolate does not infect tomato, produces very mild symptoms in Samsun tobacco, and is seed transmitted in

pepper. PV 1 produced local lesions on Tabasco and Greenleaf Tabasco in my test (Table 3), indicating that it is not identical to SLTMV. PV 1 resembles pepper strain P11 reported by Boukema (2).

Plant breeders and plant pathologists who need additional sources of resistance to TMV can find them in the PI collection. Because there is such a large number of sources, it may be possible to find resistance to most strains of TMV.

ACKNOWLEDGMENT

I thank Larry E. Foley for technical assistance.

LITERATURE CITED

1. Boukema, I. W. 1977. Resistance in *Capsicum* to a pepper strain of TMV. (Abstr.) Pages 85-88 in: *Capsicum* 77. Congr. Eucarpia Piment.
2. Boukema, I. W. 1980. Allelism of genes controlling resistance to TMV in *Capsicum* L. *Euphytica* 29:433-439.
3. Cook, A. A. 1968. Virus disease resistance in some *Capsicum* species from South America. *Plant Dis. Rep.* 52:381-383.
4. Crossan, D. F., and Rahn, E. M. 1958. The development and evaluation of resistant pepper varieties and selections by means of artificial inoculation in the field with tobacco mosaic virus. *Plant Dis. Rep.* 42:48-50.
5. Demski, J. W. 1981. Tobacco mosaic virus is seedborne in pimiento peppers. *Plant Dis.* 65:723-724.
6. Feldman, J. M., Garcia, O., Pontis, R. E., and Boninsegna, J. 1969. Effect of pepper virus on pepper yield. *Plant Dis. Rep.* 53:541-543.
7. Greenleaf, W. H., Cook, A. A., and Heyn, A. N. J. 1964. Resistance to tobacco mosaic virus in *Capsicum*, with reference to the Samsun latent strain. *Phytopathology* 54:1367-1371.
8. Holmes, F. O. 1934. Inheritance of ability to localize tobacco mosaic virus. *Phytopathology* 24:984-1002.
9. McKinney, H. H. 1952. Two strains of tobacco mosaic virus, one of which is seed-borne in an etch-immune pungent pepper. *Plant Dis. Rep.* 36:184-187.
10. Pound, G. S., and Singh, G. P. 1960. The effect of air temperature on multiplication of tobacco mosaic virus in susceptible and resistant pepper. *Phytopathology* 50:803-807.
11. van den Berkmortel, L. G. 1977. Breeding pepper for resistance to a strain of TMV. (Abstr.) Pages 89-92 in: *Capsicum* 77. Congr. Eucarpia Piment.