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Technical Bulletin No. 20

Sources of resistance to viruses of pepper (*Capsicum* spp.): a catalog

S.K. Green and J.S. Kim



Asian Vegetable Research and Development Center

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of pepper (*Capsicum* spp.):
a catalog

S.K. Green and J.S. Kim

*Asian Vegetable Research and Development Center
Taiwan, ROC*

*Agricultural Sciences Institute, Rural Development Administration
Republic of Korea*

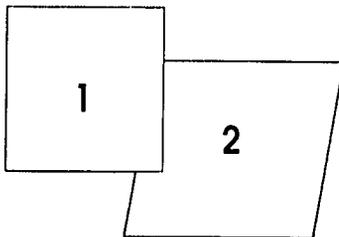


Asian Vegetable Research and Development Center

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About the cover: 1 — virus-infected pepper plant
2 — healthy pepper plant
(Photos by Chen Ming-che, AVRDC)

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Introduction

Some 35 viruses have been reported to infect peppers (*Capsicum* spp.) (Appendix 1). Many of these occur worldwide and cause considerable economic losses in terms of reduced quality and marketable yield. For detailed information concerning viruses of peppers the reader is referred to the AVRDC Technical Bulletin No. 18, Characteristics and control of viruses infecting peppers: a literature review. Control of these viruses by chemicals or cultural management practices has not been very effective. The planting of resistant cultivars offers the best way to control these viruses. A number of sources of virus resistance have been reported in wild and cultivated lines and several virus-resistant lines have already been released. Among these are lines with resistance to potato virus Y (PVY), tobacco etch virus (TEV), pepper mottle virus (PeMV), and certain tobamoviruses. However, other viruses, particularly cucumber mosaic virus (CMV) and the leaf curl virus complex, continue to pose a challenge to breeding programs.

Information on sources of resistance to many viruses of peppers is scattered and is often contained in progress reports or similar publications with a limited circulation. Furthermore, some reports are written in languages not widely understood.

The primary purpose of this publication is to provide a practical reference for breeders, pathologists, and agricultural specialists working on virus diseases of peppers and to encourage the evaluation and use of germplasm reported to carry virus resistance or tolerance. Sufficient progress has been attained in the development of germplasm resistant to viruses to make this tactic a very promising approach to control. Yet there is evidence that breeders in developing countries are not using the available resistant cultivars and that many are not sufficiently aware that these lines exist.

Information presented here may not be complete. The literature search tried to cover as much of the available published information as possible. We also contacted researchers of national programs with active pepper breeding programs to obtain additional information on sources of resistance. We hope that important omissions as well as results of future research will be brought to our attention.

Commercially available sources of resistance are generally not included as they should be easily accessible from the various seed catalogs. The information presented here is grouped alphabetically by individual viruses. Within each virus section the references are listed in chronological order. We have attempted to include additional information on the type of resistance wherever it was available since some of the resistant lines have been identified and studied by various researchers under different conditions. We avoided grouping these together but, instead, listed these separately to provide as much information as possible. The terminology for resistance, immunity, and tolerance is indicated verbatim from the cited reference. Similarly, the nomenclature for the various *Capsicum* species is mostly that used by the original authors.

Some of the virus-resistant germplasm have been assembled by AVRDC and can be freely obtained from the center. Virus-resistant germplasm can also be obtained from the International Plant Genetic Resources Institute (IPGRI)-designated global pepper germplasm collection at the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Costa Rica. For each resistance source the original authors are listed and, thus, they may also be contacted.

We thank the many people who furnished information for inclusion in this list, and we hope to obtain feedback from the readers on resistance sources we may have omitted as well as new sources of resistance to update this catalog in the future.

S.K. Green and J.S. Kim

Chilli Veinal Mottle Virus (CVMV)

References

- | Chilli Veinal Mottle Virus (CVMV) | References |
|---|-------------------|
| 1. <i>Capsicum annuum</i> HDA 832, HDA 248 | AVRDC 1990a |
| 2. <i>C. annuum</i> HDA 832, Serrano Huasteco | AVRDC 1990b |
| 3. <i>C. annuum</i> VC 33a, VC 37a, VC 58, BG1, Chili Piquin, Erectar, Serrano San Luis, Taiwan 1, Tiwari, Thailand Varieties FCM 2, FCM 3, FCB 1, FCB 3, DCM 4, DC, DCB 1

<i>C. annuum</i> VC 17a, VC 40a, VC 41a, Lorai, Mexico, Perennial, Punjab Lal, Serrano Tampiqueño, Szechuan
— also resistant to CMV | Chew and Ong 1990 |
| 4. <i>C. annuum</i> HDA 210bis, HDA 230, HDA 252, HDA 295

<i>C. annuum</i> HDA 248, HDA 249
<i>C. frutescens</i> PSP-11
— also resistant to PVMV

<i>C. annuum</i> HDA 273
— also resistant to PVY

<i>C. annuum</i> Perennial HDV, HDA 832
— also resistant to PVMV and PVY | AVRDC 1991 |
| 5. <i>C. annuum</i> Lorai
— also resistant to TMV, CMV, PVY, and leaf curl virus

<i>C. annuum</i> Punjab Lal
— also resistant to TMV, CMV, and leaf curl virus | Singh 1992 |
| 6. <i>C. annuum</i> Cili Padi No. 6
— resistance to CVMV is controlled by a pair of recessive genes (possibly a number of independent resistance genes are involved)

<i>C. annuum</i> Serrano Huasteco
— resistance to CVMV is controlled by a pair of recessive genes (possibly a number of independent resistance genes are involved)
— also resistant to CMV | Chew 1993 |

Chilli Veinal Mottle Virus

References

7. *C. annuum* Avelar, AVRDC Acc. C 01175H (Criollo de Morelos 334), C 01664, PBC 37, BG-1, Lorai, Osir (F₁), Pant C-1, Serrano Huasteco, Serrano Tampiqueño, Tiwari II
- C. annuum* Perennial
- resistant to CVMV isolates from Taiwan, Malaysia, and Thailand
 - also resistant to a Malaysian CMV isolate
- C. annuum* Perennial HDV
- resistant to CVMV isolates from Malaysia, Taiwan, and Thailand
 - also resistant to CMV isolates from Malaysia and Thailand
- C. annuum* HDA 230, HDA 248, HDA 249, HDA 252, Seagochu
- resistant to CVMV isolates from Thailand and Malaysia
- C. annuum* HDA 295
- resistant to CVMV isolates from Thailand, Malaysia, and Taiwan
 - also resistant to an isolate of CMV in Malaysia
- C. annuum* HDA 210 bis
- resistant to CVMV isolates from Malaysia and Taiwan
 - also resistant to a Thailand isolate of CMV
- C. annuum* HDA 832, Serrano Huasteco
- resistant to CVMV isolates from Taiwan and Malaysia
 - also resistant to PVMV
- C. frutescens* PSP-11
- resistant to CVMV isolates from Taiwan and Malaysia
- C. annuum* HDA 273
- resistant to CVMV isolates from Malaysia and Taiwan
 - also resistant to CMV isolates from Malaysia, Taiwan, and Thailand

Chilli Veinal Mottle Virus

References

8. *C. annuum* PBC 092, PBC 180, PBC 349, PBC 370,
PBC 495, PBC 522, PBC 523, PBC 545, PBC 549,
PBC 569, PBC 691, PBC 787,
AVRDC Acc. C 00563, C 01315

AVRDC 1994

C. annuum AVRDC Acc. C 01664
— also resistant to PVY

Cucumber Mosaic Virus (CMV)

References

- | | |
|---|--|
| <p>1. <i>C. frutescens</i> LP-1</p> <ul style="list-style-type: none"> — tendency to escape infection; — less concentration of CMV within plant — CMV resistance controlled by a single recessive gene — also resistant to TEV (resistance to TEV is dominant) | <p>Barrios et al. 1971</p> |
| <p>2. <i>C. annuum</i> Antibois, Piment Sucette</p> <ul style="list-style-type: none"> — CMV-tolerant; tolerance associated with small fruit size — white fruit-type peppers have some tolerance to CMV | <p>Pochard and Chambonnet 1972
 Lovisolo and Conti 1976
 Zatyko 1978</p> |
| <p>3. <i>C. baccatum</i> var. <i>pendulum</i> 3-4</p> <ul style="list-style-type: none"> — resistant to virus migration — the virus is localized in lateral shoots, the invaded tissue becoming necrotic (a form of hypersensitivity); inhibitors may also be present — also resistant to PVY <p><i>C. annuum</i> A6 (derived from Val x Babas), Babas (derived from <i>C. annuum</i> Bastidon x <i>C. baccatum</i> x Val), Val</p> <p><i>C. frutescens</i> LP 1</p> <ul style="list-style-type: none"> — has tendency to escape infection <p><i>C. annuum</i> Avelar, Ikeda, Moura</p> <ul style="list-style-type: none"> — low level of infection in the field | <p>Pochard and Chambonnet 1972
 Pochard 1977b
 Palloix et al. 1989</p> |
| <p>4. <i>C. annuum</i> (8 lines)</p> <ul style="list-style-type: none"> — resistant to CMV <p><i>C. annuum</i> (13 lines)</p> <ul style="list-style-type: none"> — tolerant to CMV <p><i>C. baccatum</i> var. <i>microcarpum</i> (1 line)</p> <ul style="list-style-type: none"> — resistant to CMV <p><i>C. baccatum</i> var. <i>pendulum</i> (1 line)</p> <ul style="list-style-type: none"> — resistant to CMV | <p>Saccardo 1973</p> |

Cucumber Mosaic Virus (CMV)	References
<p><i>C. chinense</i> (1 line) — resistant to CMV</p>	
<p><i>C. frutescens</i> (10 lines) — resistant to CMV</p>	
<p>5. <i>C. annuum</i> (8 wild lines) <i>C. baccatum</i> var. <i>pendulum</i> (1 line) <i>C. baccatum</i> var. <i>microcarpum</i> (1 line) <i>C. chinense</i> (1 line) <i>C. frutescens</i> (10 lines)</p>	Saccardo 1974
<p>6. <i>C. annuum</i> Perennial, S 5-4, S 20-1, S 41-1, S 118-2 — single recessive gene (<i>cm</i>) for resistance to CMV — also possess single recessive gene (<i>lc</i>) for TLCV — also possess single recessive gene (<i>l</i>) for TMV (strain 1); (According to Pochard et al. 1983, there is no resistance to TMV pathotype 0, 1-2, and 1-2-3 in Perennial) — the 3 separate genes are linked (crossover value 38–40%)</p>	Singh and Thakur 1977
<p>7. <i>C. annuum</i> Kalocsai V1 (derived from a cross between a half wild hypersensitive Chinese variety and the susceptible old variety Szegedi 91-95) — CMV-tolerant — also TMV-resistant</p>	Szirmai 1978
<p>8. <i>C. annuum</i> EC 4095II, S 4-5, S 5-3, S 5-4, S 6-3, S 6-6, S 6-8, S 11-1, S 11-4, S 20-1, S 34-7, S 41-1, S 41-2, S 72-4, S 118-2, S 118-4, Perennial <i>C. annuum</i> Bangla Green, HS-1, Jamni, Laichi, Longi, Lorai, Pant C-1, Perennial, Tiwari, S 20-1, S 118-2 — also resistant to TMV — also field resistant to leaf curl virus</p>	Singh and Thakur 1979
<p>9. <i>C. annuum</i> Góliát (Magician) — CMV-tolerant <i>C. annuum</i> Táltos — CMV-tolerant — CMV tolerance derived from <i>C. annuum</i> Antibois</p>	Zatyko et al. 1979

Cucumber Mosaic Virus (CMV)

References

- | | |
|---|---|
| <p>10. Unidentified local Indian variety
 — immune to CMV and PVX
 — tolerant to TMV and leaf curl virus</p> <p><i>C. annuum</i> Pant C-1, Pant C-2
 — tolerant to CMV, PVX, TMV, and leaf curl virus</p> <p><i>C. annuum</i> NP 46-0, X-196</p> <p><i>C. frutescens</i> EC 31352
 — tolerant to CMV and PVX</p> <p><i>C. annuum</i> var. <i>angulosum</i>
 — tolerant to CMV
 — also tolerant to PVX</p> | <p>Konai and Nariani 1980</p> |
| <p>11. <i>C. annuum</i> Ikeda, Moura
 — resistant to aphid transmission</p> | <p>Cohen 1982</p> |
| <p>12. Some species (among 48 plants tested)</p> | <p>Pasco et al. 1982</p> |
| <p>13. <i>C. annuum</i> var. <i>minimum</i> Rama
 — dominant gene (<i>Riv</i>) for reduced accessibility of the leaves to CMV by mechanical inoculation</p> <p><i>C. annuum</i> Perennial
 — recessive genes for reduced accessibility of the leaves to CMV by mechanical inoculation</p> <p><i>C. annuum</i> PM 642, PM 660, PM 662
 — partly resistant to CMV</p> | <p>Pochard 1982</p> |
| <p>14. <i>C. annuum</i> S 38-2-1, S 94-4-9-3, S 101-2-33
 — tolerant to CMV
 — also tolerant to PVX, TMV, PVY, and leaf curl virus</p> | <p>Tewari and Viswanath 1982</p> |
| <p>15. <i>C. annuum</i> X-196, X-197
 — tolerant to PVX</p> | <p>Konai and Nariani 1983</p> |
| <p>16. <i>C. annuum</i> Delhi Local
 — immune to CMV and PVX
 — tolerant to TMV and leaf curl virus</p> <p><i>C. annuum</i> Pant C-1, Pant C-2
 — tolerant to CMV, PVX, leaf curl virus, and TMV</p> | <p>Konai and Nariani 1983
 Tewari and Viswanath 1986
 Tewari 1986</p> |

Cucumber Mosaic Virus (CMV)

References

- C. annuum* X-196, X-197
— tolerant to CMV
17. *C. annuum* Philomèle 1
(derived from *C. baccatum* var. *pendulum* 3-4)
— field resistant to CMV
18. *C. annuum* HDA 249, HDA 260, HDA 268, HDA 293
(androgenetic doubled haploids from the cross
Perennial x Yolo Wonder)
— highly tolerant to CMV under field conditions
and by artificial inoculation
- C. annuum* HDA 206, HDA 211, HDA 227, HDA 230,
HDA 232, HDA 234, HDA 242, HDA 248, HDA 252,
HDA 255, HDA 258, HDA 265, HDA 267, HDA 283,
HDA 294, HDA 295
— CMV-tolerant
19. *C. annuum* Lorai, Longi, Pant C-1, Perennial, S 118-2
— resistant/tolerant to CMV and TMV under
field conditions, showing very mild to
moderate symptoms
— also resistant/tolerant to leaf curl virus
20. *C. annuum* PI 286419
— virus localized in inoculated leaves
— resistant only to Massachusetts CMV isolates
not to California isolates
21. *C. pubescens*
— also resistant to PVY and ToMV
22. *C. baccatum* var. *microcarpum*
C. chacoense
C. frutescens var. *cerasiforme*
C. frutescens Tabasco
— also resistant to TMV
- C. baccatum* var. *pendulum*
— also resistant to TMV and ToMV
23. *C. baccatum* var. *pendulum* 3-4
— partial resistance to CMV

Marchoux et al. 1983

Pochard et al. 1983

Sharma et al. 1983
Sharma and Singh 1985
Singh 1992

Cuevas and Nicklow 1985

Horvath 1986a

Horvath 1986b

Miladinovic et al. 1986

Cucumber Mosaic Virus (CMV)

References

- Lines 12/84, 14/84
 — reaction to CMV similar to
C. baccatum var. *pendulum* 3-4
24. *C. annuum* Perennial
 — resistant to virus multiplication
 (polygenic recessive inheritance) Pochard et al. 1986
 Pochard and Daubèze 1989
25. *C. annuum* var. *minimum* Rama
 (wild type from Nicaragua) Pochard et al. 1986
 — resistant to infection
 — 1 single dominant gene
- C. annuum* PM 815 (Er-Fu-Tou),
 PM 819 (Chao-Tian-Jiao) (both of Chinese origin)
 — resistant to virus multiplication
26. *C. annuum* Jangsu (F₁ hybrid) RDA 1986
 (CMV resistance derived from a Thailand local
 variety Taigukgochu)
 — also resistant to TMV
- C. annuum* Wongkyo 306
 (CMV resistance derived from Taigukgochu)
 — also resistant to TMV
27. *C. annuum* Bangla Green, HS-1, Jamni, Laichi,
 Longi, Lorai, Pant C-1, Perennial, S 20-1, S 118-2
 (released as Punjab Lal in 1985), Tiwari Singh and Kaur 1986
 Singh 1992
 — also field resistant to leaf curl virus
 — resistant to CMV and TMV
28. *C. annuum* S 38-2-1, S 96-4-9-3, S 101-2-33
 — tolerant to CMV
 — also tolerant to TMV, PVX, and leaf curl virus
 Tewari and Viswanath 1986
- C. annuum* S 38-3-19, S 42-2-4
 — tolerant to CMV
 — also tolerant to PVX and leaf curl virus
- C. annuum* S 52-1-6, S 96-4-8
 — tolerant to CMV
 — also tolerant to leaf curl virus

Cucumber Mosaic Virus (CMV)

References

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|---|---|
| <p>29. <i>C. annuum</i> Sel 52-18
(derived from a cross of Pusa Jwala and Delhi Local)
— tolerant to CMV
— also tolerant to leaf curl virus and potato virus X</p> <p>30. <i>C. pubescens</i> LS 1659
— plants of this line show only very mild symptoms and are not damaged</p> <p>31. <i>C. annuum</i> MRCH
— tolerant to CMV
— resistance is polygenic and linked to small fruit size</p> <p>32. <i>C. annuum</i> Bhivapur 1, Pantnagar-1,
Pantnagar-2, PKV-2, Sabouragar, Surjamani</p> <p><i>C. annuum</i> Perennial
— immune to CMV
— also immune to ToMV</p> <p><i>C. annuum</i> G5, KI, CA 1068, PKV 1
— moderately resistant to CMV
— also moderately resistant to TMV</p> <p><i>C. frutescens</i> Lawangi
— moderately resistant to CMV
— also resistant to TMV</p> | <p>Tewari 1986</p> <p>Narikawa et al. 1987</p> <p>Shifriss and Cohen 1987</p> <p>Peshney and Moghe 1988</p> <p>Pochard 1988
(personal communication)
Pochard and Daubèze 1989</p> |
| <p>33. <i>C. annuum</i> Perennial
— partially resistant to CMV
(reduced virus multiplication)
— highly tolerant to CMV under field conditions
— delayed symptom appearance, mild symptoms
— also partly resistant to PVY (pathotypes 0, 1, 1.2)</p> <p><i>C. annuum</i> HDA 201, HDA 210 bis, HDA 230,
HDA 248, HDA 249, HDA 252, HDA 260, HDA 268,
HDA 273, HDA 295
— field tolerant to CMV
— also resistant to PVY (0, 1, 1.2)
— tolerant to TYLCV under field conditions</p> | |

Cucumber Mosaic Virus (CMV)

References

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|--|---|
| <p>34. <i>C. baccatum</i> PEN 3-4</p> <ul style="list-style-type: none"> — partially resistant (resistant to migration) — only necrotic reaction of the invaded tissues; — virus does not move to axillary shoots in 5-leaf stage plants inoculated on the 3rd leaf and then decapitated above the 3rd leaf; however, when inoculated at the cotyledon stage, some plants become invaded by CMV <p>35. <i>C. baccatum</i> var. <i>pendulum</i> LS 390</p> <ul style="list-style-type: none"> — tolerant to CMV in Japan <p><i>C. annuum</i> 505</p> <ul style="list-style-type: none"> — limited virus migration within the plant <p>36. <i>C. annuum</i> Milord</p> <ul style="list-style-type: none"> — partially resistant (reduced virus migration; CMV is localized in tissues on the side of the inoculated leaf) — resistance is suppressed at low temperatures (12–25°C) <p><i>C. annuum</i> Ivan</p> <ul style="list-style-type: none"> — resistant to CMV — virus remains localized in the inoculated leaf <p><i>C. annuum</i> PM 815 (Er-Fu-Tou)</p> <ul style="list-style-type: none"> — tendency to recover from viral infection <p>37. <i>C. frutescens</i>
(several wild accessions from Latin America)</p> <p>38. <i>C. annuum</i> Punjab Lal</p> <ul style="list-style-type: none"> — also resistant to PVY, TMV, and leaf curl virus <p>39. <i>C. annuum</i> Bangla-Green 1 (BG-1), Punjab Lal (PL)</p> <ul style="list-style-type: none"> — reduced CMV multiplication — resistance accompanied by increase in total and orthodihydroxy phenols and high levels of quinones after virus infection <p>40. <i>C. baccatum</i>
<i>C. pubescens</i></p> <ul style="list-style-type: none"> — more resistant than commercial cultivars | <p>Dufour et al. 1989</p> <p>Palloix et al. 1989</p> <p>Chaine et al. 1992</p>
<p>Cited by Kostova et al. 1989</p>
<p>Pochard and Daubèze 1989</p> <p>Palloix et al. 1989</p> <p>Nono-Womdim et al. 1991</p>
<p>Provvidenti and Gonsalves 1989</p>
<p>Singh and Cheema 1989</p>
<p>Singh and Singh 1989</p>
<p>Narikawa et al. 1989</p> |
|--|---|

Cucumber Mosaic Virus (CMV)	References
41. <i>C. annuum</i> Bangla Green (BG-1), CH-1, Indonesian selection, Laichi 1, Laichi 2, Lorai, LS-I, MF41-1, MS-13, Pant C-1, Perennial, Punjab Lal, S 20-1, Surjamani, Tiwari — field resistant to CMV — field resistant to leaf curl virus	Singh and Kaur 1990
42. <i>C. baccatum</i> LS1621/1, LS1621/2, LS1631/1 <i>C. annuum</i> VC17a, VC40a, VC41a, Lorai, Mexico, Perennial, Punjab Lal, Serrano Tampiqueño, Szechuan — also resistant to CVMV	Chew and Ong 1990
43. <i>C. frutescens</i> Pusa Sada Bahar — also resistant to TMV and leaf curl virus	Tewari 1991
44. <i>C. annuum</i> Vania — resistant to CMV migration	Nono-Womdim et al. 1991
45. <i>C. annuum</i> AVRDC Acc. C 00266, PBC 199, Extra Long Selection, Punjab Lal	AVRDC 1991
46. <i>C. annuum</i> IHR 243 (Attapadi Lokal), IHR 328-9 (Anekal Local), IHR 384 (Perennial), IHR 990 (LICB), IHR 1049 (Puri Red), Pant C-1 — resistance stable at temperatures from 26.1 to 37.6°C — also resistant to PVY	George et al. 1992
<i>C. chinense</i> IHR 1252 (EC 218682) <i>C. frutescens</i> IHR 1274 (EC 218704) — also resistant to PVY	
47. <i>C. frutescens</i> (several landraces from Latin America) — involvement of complementary recessive genes	Loaiza-Figueros et al. 1992
48. <i>C. annuum</i> Perennial — resistant to 3 California isolates V 27, causing severe mosaic and stunting, and V 226 and 28, causing mild symptoms — susceptible to CMV-FNY, a severe isolate from New York	Lackney et al. 1992

Cucumber Mosaic Virus (CMV)

References

- C. frutescens* BG 2814 (14-6), BG 2816 (16-1)
 — resistant to mild isolates from California (V 26, V 28) and New York (CMV-Ca, CMV-NY) but not to the FNY isolate
49. *C. annuum* Indonesian selection, MS-13, Perennial, Punjab Lal
 — resistant (symptomless) to CMV by artificial inoculation; no local lesions produced after back inoculation to *Chenopodium amaranticolor*
 — also resistant under field conditions
- C. annuum* 851201, CA 586, ELS-1, ELS-2, Jawahar-218, JCS-1, KCI-152, Laichi 4-4, MF 41-1-2, Ornamental Berry, Ornamental Long, Pant C-1, Surjamani, TC-2
 — moderately resistant to CMV (disease incidence ranging from 4 to 24%)
50. *C. annuum* S 20-1, Laichi 2
 — also resistant to PVY, TMV, and leaf curl virus
- C. annuum* Tiwari
 — also resistant to TMV and leaf curl virus
 — also resistant to TMV, PVY, PVMV, and leaf curl virus
- C. annuum* Lorai
 — also resistant to TMV, PVY, leaf curl virus, and CVMV
- C. annuum* Perennial
 — also resistant to TMV, PVY, PVMV, and leaf curl virus
- C. annuum* Punjab Lal
 — also resistant to TMV, CVMV, and leaf curl virus
- C. annuum* Bangla Green (BG-1)
 — also resistant to TMV and leaf curl virus
 — partially resistant to PVY
- C. annuum* Ch-1, LS III
 — also moderately resistant to leaf curl virus
51. *C. annuum* TAM Veracruz
 (derived from *C. annuum*, AC 2207, Avelar, PI 264281, PI 342947, Jalapeño 1158, Jalapeño100, and Jalapeño L.)
 — also resistant to PeMV, PVY, TMV, and TRSV
- Bansal et al. 1992
- Singh 1992
- Villalón et al. 1992

Cucumber Mosaic Virus (CMV)**References**

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52. *C. annuum* HDA 210 bis
— resistant to an isolate from Thailand
— also resistant to CVMV isolates from Malaysia and Taiwan
- C. annuum* HDA 273
— resistant to CMV isolates from Taiwan, Malaysia, and Thailand
— also resistant to CVMV isolates from Taiwan and Malaysia
- C. annuum* HDA 295
— resistant to an isolate of CMV from Malaysia
— also resistant to CVMV from Malaysia, Taiwan, and Thailand
- C. annuum* Perennial
— resistant to a CMV isolate from Malaysia
— also resistant to CVMV isolates from Malaysia and Taiwan
- C. annuum* Perennial HDV
— resistant to CMV isolates from Malaysia and Thailand
— also resistant to CVMV isolates from Malaysia, Taiwan, and Thailand
53. *C. annuum* Serrano Huasteco
— also resistant to CVMV
- AVRDC 1993
- Chew 1993

Curly Top Virus**References**

- | | |
|---|------------------------|
| 1. <i>C. annuum</i> PI 257053, PI 281297, PI 288938, PI 357522
— apparently resistant when exposed to infectious leafhoppers | Ungs et al. 1977 |
| 2. A hybrid from the cross Jerusalem x Sweet Bell
— resistance controlled by two recessive genes | Konai and Nariani 1980 |

Leaf Curl Virus Complex ¹	References
1. <i>C. annuum</i> Puri Red, Puri Orange	Mishra et al. 1963 Dhanraj and Seth 1968 Singh 1973
2. <i>C. annuum</i> EC 4020, EC 6589, EC 7299, ED 7338, EC 9293, Puri Red, Puri Orange — field resistant to leaf curl virus	Singh 1973
3. <i>C. annuum</i> Jwala	Tewari and Ramanujam 1974
4. <i>C. annuum</i> Surjamani, Perennial — also resistant to chilli mosaic	Sooch et al. 1976
<i>C. annuum</i> S 118, S 114 (derived from Perennial × Long Red)	
5. <i>C. annuum</i> Jwala (derived from Puri Red and N.P. 46A) — also resistant to mosaic	Tewari 1977, 1982
6. <i>C. annuum</i> Perennial, S 5-4, S 20-1, S 41-1, S 118-2 — also resistant to TMV and CMV — 3 weakly linked recessive genes control resistance	Singh and Thakur 1977
7. <i>C. annuum</i> Perennial	Singh and Brar 1978 Singh 1992
8. <i>C. annuum</i> Bangla Green, HS-1, Jamni, Laichi, Longi, Lorai, Pant C-1, Perennial, S 20-1, S 118-2, Tiwari — field resistant to leaf curl virus — also resistant to TMV	Singh and Thakur 1979

¹The leaf curl virus complex refers to nonmechanically but whitefly-transmitted geminiviruses that usually cause yellowing, leaf curling, and stunting of plants. The viruses causing these symptoms are referred to as leaf curl virus (LCV), tobacco leaf curl virus (TLCV), and chili leaf curl virus in the literature reviewed. Most of these have not been exactly characterized. Resistance listed under 23 refers to tomato yellow leaf curl virus (TYLCV), a well characterized geminivirus which affects mainly tomatoes and only rarely peppers in the Near East. For more detailed information on leaf curl and yellowing viruses of peppers, the reader is referred to the AVRDC Technical Bulletin No. 21: Leaf curl and yellowing viruses of pepper and tomato: an overview.

Leaf Curl Virus Complex

References

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|---|---|
| <p>9. Unidentified local Indian variety</p> <ul style="list-style-type: none"> — tolerant to leaf curl virus — also tolerant to TMV — immune to CMV and PVX <p><i>C. annuum</i> Pant C-1, Pant C-2</p> <ul style="list-style-type: none"> — tolerant to leaf curl virus — also tolerant to CMV, TMV, and PVX <p><i>C. annuum</i> var. <i>angulosum</i></p> <ul style="list-style-type: none"> — tolerant to leaf curl virus — also tolerant to CMV | <p>Konai and Nariani 1980</p> |
| <p>10. <i>C. annuum</i> Pusa Jwala</p> <ul style="list-style-type: none"> — also resistant to TMV — susceptible to CMV | <p>Tewari 1982
Singh and Singh 1989</p> |
| <p>11. <i>C. annuum</i> Delhi Local</p> <ul style="list-style-type: none"> — tolerant to leaf curl virus — also tolerant to TMV — immune to CMV and PVX | <p>Konai and Nariani 1983
Tewari and Viswanath 1986
Tewari 1986</p> |
| <p>12. <i>C. annuum</i> Cross 218, EC 121490, IC 18253, IC 18885, JCA 196, Karanja, Pant C-1</p> <ul style="list-style-type: none"> — less than 30% leaf curl incidence in the field | <p>Bhalla et al. 1983</p> |
| <p>13. <i>C. annuum</i> CA-960, G-4, Jwala</p> | <p>Dhanju 1983</p> |
| <p>14. <i>C. annuum</i> Lorai, Longi, Pant C-1, Perennial, S 118-2</p> <ul style="list-style-type: none"> — resistant/tolerant to leaf curl virus — also resistant/tolerant to CMV and TMV <p><i>C. annuum</i> H-6, Longi, No. 76, No. 289-1-3-1-1, S 20-1, S 41-1-5, X-200</p> <ul style="list-style-type: none"> — field resistant/tolerant to leaf curl virus (disease severity mild to moderate) | <p>Sharma et al. 1983
Sharma and Singh 1985
Singh 1992</p> |
| <p>15. <i>C. annuum</i> Lorai, Longi, Pant C-1, Perennial, S 118-2</p> | <p>Sharma and Singh 1985</p> |
| <p>16. <i>C. annuum</i> S 38-3-19, S 42-2-4</p> <ul style="list-style-type: none"> — tolerant to leaf curl virus — also tolerant to PVX and CMV <p><i>C. annuum</i> S 52-1-6, S 96-4-8</p> <ul style="list-style-type: none"> — tolerant to leaf curl virus — also tolerant to CMV | <p>Tewari and Viswanath 1986</p> |

Leaf Curl Virus Complex

References

- C. annuum* S 38-2-1, S 38-3-19, S 42-2-4, S 52-1-6, S 96-4-8,
S 96-4-9-3, S 101-2-33
— tolerant to leaf curl virus
— also tolerant to CMV, TMV, and PVX
- C. annuum* S 81-1-1, S 96-4-9
(selected from Pusa Jwala x Delhi Local)
— tolerant to leaf curl virus
— also tolerant to PVX
17. *C. annuum* Sel 52-18
(derived from a cross of Pusa Jwala and Delhi Local)
— tolerant to leaf curl virus
— also tolerant to CMV and PVX
- C. annuum* Puri Red
- C. annuum* Pusa Jwala
(derived from the cross N.P.46-A and Puri Red)
18. *C. annuum* Pant C-1, Lic-45, N-66-A
— moderately resistant (40–46% disease incidence)
to leaf curl virus under field conditions
19. *C. annuum* Bangla Green, HS-1, Jamni, Longi,
Lorai, Pant C-1, Perennial, S 20-1, S 118-2
(released as Laichi, Punjab Lal in 1985), Tiwari
— field resistant to leaf curl virus
— also resistant to CMV and TMV
20. *C. annuum* Ci 1, Lic-45, N-146
21. *C. annuum* Laichi-2
— highly resistant to leaf curl virus
22. *C. annuum* JCA 196, JCA 218, JCA 248, NP-46-A,
Pant C-1, Pusa Jwala
23. *C. annuum* HDA 201, HDA 210 bis, HDA 230, HDA 248,
HDA 249, HDA 252, HDA 260, HDA 268, HDA 273, HDA 295
— all lines have *C. annuum* Perennial as a parent
— also tolerant to CMV under field conditions
— also resistant to PVY (strains 1 and 1.2)
24. *C. annuum* Jawahar 218
— tolerant to leaf curl virus
- Tewari 1986
- Sawant et al. 1986
- Singh and Kaur 1986
Singh 1992
- Memane et al. 1987
- Singh and Kaur 1987
- Sangar et al. 1988
- Pochard 1988
(personal communication)
- Singh and Cheema 1989

Leaf Curl Virus Complex

References

- C. annuum* Punjab Lal
 — resistant to leaf curl virus
 — also resistant to TMV, CMV, and PVY
25. *C. annuum* Bangla Green (BG-1), CH-1, Indonesian Selection, Laichi-1, Laichi-2, Lorai, LS-I, MF41-1, MS-13, Pant C-1, Perennial, Punjab Lal, S 20-1, Surjamani, Tiwari-1
 — field resistant to leaf curl virus
 — also field resistant to CMV
26. *C. frutescens* Pusa Sada Bahar
 — also resistant to CMV and TMV
27. *C. annuum* HS III, LS I, LS IV
 Hundel 1992
 (personal communication)
28. *C. annuum* Lorai
 — also resistant to TMV, CMV, PVY, and CVMV
- C. annuum* S20-1, Laichi 2
 — also resistant to TMV, CMV, and PVY
- C. annuum* Tiwari
 — also resistant to TMV and CMV
- C. annuum* Perennial
 — also resistant to TMV, CMV, PVY, and PVMV
- C. annuum* Punjab Lal
 — also resistant to TMV, CMV, and CVMV
- C. annuum* Bangla Green (BG-1)
 — also resistant to TMV and CMV
 — also partially resistant to PVY
- C. annuum* Indonesian Selection
 — also resistant to CMV and PVY
- C. annuum* CH-1, LS III
 — moderately resistant to leaf curl virus
 — also resistant to CMV
- C. annuum* LS III
 — moderately resistant to leaf curl virus
- Singh and Kaur 1990
- Tewari 1991
- Singh 1992

Pepper Mottle Virus (PeMV)	References
1. <i>C. frutescens</i> Greenleaf Tabasco (derived from <i>C. frutescens</i> x <i>C. chinense</i>) — also resistant to TEV	Zitter 1972 Greenleaf 1986
2. <i>C. annuum</i> PI 159236 — resistant to PeMV (multiplication and movement of virus prevented in homozygous condition) — also resistant to TMV	Zitter 1972 Boukema 1977 Subramanya 1982 Greenleaf 1986
3. <i>C. annuum</i> Delray Bell — tolerant to PeMV (resistance controlled by a single recessive gene) — also tolerant to TEV and PVY	Zitter and Cook 1973 Cook et al. 1977 Cook 1984a
4. <i>C. annuum</i> Avelar — tolerant to PeMV (single recessive gene) — also resistant to TEV and PVY	Zitter and Cook 1973 Zitter and Ozaki 1973
5. <i>C. annuum</i> Florida VR-4 — also resistant to PVY and TMV	Cook 1982, 1984a Abdalla and Desjardins 1985
6. <i>C. annuum</i> FLBG-1 (derived from Cubanelle and Agronomico-8) — tolerant to PeMV — also resistant to TEV and PVY	Subramanya et al. 1983
<i>C. annuum</i> Florida VR-4 — also resistant to TEV, PVY, and TMV	
7. <i>C. annuum</i> Tam Mild Jalapeño-1 (derived from <i>C. annuum</i> PI 342947, Avelar, and Jalapeño L) — also resistant to TEV, TMV, and PVY	Villalón 1983
8. <i>C. annuum</i> Tambel-2, Tam Mild Chile-2 — also resistant to TEV, PVY, and TMV	Abdalla and Desjardins 1985
9. <i>C. annuum</i> PI 152225, PI 159236, Greenleaf Tabasco	Greenleaf 1986
10. <i>C. annuum</i> Tambel-2 — also resistant to TEV, TMV, and PVY	Villalón 1986a

Pepper Mottle Virus (PeMV)

References

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|---|---|
| 11. <i>C. annuum</i> Tam Mild Chile-2 (TMC-2)
(derived from <i>C. annuum</i> Agronomico-8, Avelar
[both resistant to TEV, PVY, TMV], Cal-Compack 528,
and Anaheim TMR-23)
— also resistant to PVY, TEV, and TMV | Villalón et al. 1986 |
| 12. <i>C. chinense</i> | Horvath 1986b |
| 13. <i>C. annuum</i> Hidalgo
— also resistant to TEV, TMV, and PVY | Villalón 1986b |
| 14. <i>C. annuum</i> Hidalgo, Tambel-1, Tambel-2,
Tam Mild Chile-1, Tam Mild Chile-2,
Tam Mild Jalapeño-1
— also resistant to TEV, TMV, and PVY | Villalón 1986c |
| 15. <i>C. annuum</i> Tam Rio Grande Gold-Sweet
— also resistant to TMV, PVY, and TEV | Villalón 1987 |
| 16. <i>C. annuum</i> Criollo de Morelos (CM) 334
— also resistant to PVY | Palloix et al. 1991
Chaine Dogiment 1993
Palloix 1993
(personal communication) |
| 17. <i>C. annuum</i> Tam Veracruz
(derived from <i>C. annuum</i> , AC 2207, Avelar, PI 264281,
PI 342947, Jalapeño 1158, Jalapeño 100, and Jalapeño L.)
— also resistant to CMV, PVY, TMV, TEV, and TRSV | Villalón et al. 1992 |

Pepper Veinal Mottle Virus (PVMV)	References
1. <i>C. annuum</i> DH 2-4, DH 11-15	Rao et al. 1980
2. <i>C. annuum</i> HDA 818, HDA 832 (androgenetic doubled haploids resulting from the cross Perennial x Florida VR-2 (both susceptible parents) — resistance to PVMV is a case of complementary gene action	Gebré Selassie et al. 1986
3. <i>C. annuum</i> Perennial	AVRDC 1988
4. <i>C. annuum</i> HDA 832, Perennial HDV	AVRDC 1990a
5. <i>C. annuum</i> HDA 248	AVRDC 1990b
6. <i>C. annuum</i> HDA 248, HDA 249 <i>C. frutescens</i> PSP-11 — also resistant to CVMV	AVRDC 1991
<i>C. annuum</i> Perennial HDV, HDA 832 — also resistant to CVMV and PVY	
7. <i>C. annuum</i> Perennial — also resistant to TMV, CMV, PVY, and leaf curl virus	Singh 1992

Pepper Vein Banding Virus (PVBV)**References**

1. *C. annuum* DH 2-#4, DH 11-15
— also resistant to TRSV and PVMV

Rao et al. 1980

Potato Virus X (PVX)
References

1. Unidentified Indian local variety Konai and Nariani 1980
 - immune to PVX
 - also immune to CMV
 - also tolerant to TMV and TLCV

C. annuum Pant C-1, Pant C-2

 - tolerant to PVX
 - also tolerant to TMV, CMV, and TLCV

C. annuum NP 46-A

C. frutescens EC 31352

 - tolerant to PVX
 - also tolerant to CMV

2. *C. frutescens* 75#208 Singh and Chenulu 1980

C. praetermissum EC 108633

 - high degree of resistance; only necrotic local lesions on inoculated leaves, without systemic infection

C. angulosum EC 97758

C. pendulum

C. microcarpum

 - high degree of resistance to PVX (only necrotic local lesions on inoculated leaves, without systemic infection)
 - also resistant to PVY

C. annuum var. Kalyan-Sel.

C. frutescens 76#231

 - moderately resistant to PVX (no visible symptoms, but virus recovered)

3. *C. annuum* Pant C-1, Pant C-2 Konai and Nariani 1983
 - tolerant to PVX, CMV, TMV, and leaf curl virus

C. annuum NP 46-0

 - tolerant to PVX
 - also tolerant to CMV

Potato Virus X (PVX)
References

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|--|---|
| <p>4. <i>C. annuum</i> Delhi Local</p> <ul style="list-style-type: none"> — immune to PVX — also immune to CMV — tolerant to leaf curl virus and TMV | <p>Konai and Nariani 1983
Tewari and Viswanath 1986
Tewari 1986</p> |
| <p>5. <i>C. annuum</i> S 38-2-1, S 94-4-9-3, S 101-2-33</p> <ul style="list-style-type: none"> — tolerant to PVX — also tolerant to CMV, leaf curl virus, and TMV <p><i>C. annuum</i> S 38-3-19, S 42-2-4</p> <ul style="list-style-type: none"> — tolerant to PVX — also tolerant to CMV and leaf curl virus <p><i>C. annuum</i> S 81-1-1, S 96-4-9</p> <ul style="list-style-type: none"> — tolerant to PVX — also tolerant to leaf curl virus | <p>Tewari and Viswanath 1986</p> |
| <p>6. <i>C. annuum</i> Sel. 52-18
(derived from a cross of Pusa Jwala and Delhi Local)</p> <ul style="list-style-type: none"> — tolerant to PVX — also tolerant to leaf curl virus and CMV | <p>Tewari 1986</p> |
| <p>7. <i>C. angulosum</i> EC97758
<i>C. praetermissum</i> EC108633
<i>C. frutescens</i> 76 ≠ 208</p> <ul style="list-style-type: none"> — resistance governed by a pair of dominant genes | <p>Singh and Chenulu 1984</p> |

Potato Virus Y (PVY)

References

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|---|---|
| <p>1. <i>C. annuum</i> P 11 (PI 264281)</p> <ul style="list-style-type: none"> — unaffected by PVY (several strains) — reacts in hypersensitive manner to most strains of TMV — tolerant to most strains of TEV | <p>Cook and Anderson 1959
Nagai 1983</p> |
| <p>2. <i>C. annuum</i> Florida VR-2
(derived from PI 163192, PI 264281, and Cayenne SC 46252)</p> <ul style="list-style-type: none"> — also resistant to TEV — <i>et^h</i> gene for resistance (homozygous) confers resistance to mild and severe strains of PVY and to mild strains of TEV — also resistant to TMV — homozygous for <i>L¹</i> (determines imperfect localization response to infection with common TMV) | <p>Cook 1960, 1963b, 1977
Cook et al. 1976
Greenleaf 1986
Sooch et al. 1976</p> |
| <p>3. <i>C. annuum</i> PI 264281</p> <ul style="list-style-type: none"> — resistant to PVY-N, PVY-N^{hr}, but not to PVY-N^{hr} which occurs in Puerto Rico — resistance derived from this introduction is inherited as a single recessive factor; 3 loci associated with resistance. Inheritance is monofactorial with the respective dominant alleles conferring susceptibility and the (homozygous) recessive alleles conferring resistance — also resistant to TEV and TMV | <p>Cook 1960, 1963b
IVT 1984
Nagai 1984</p> |
| <p>4. <i>C. annuum</i> IHR-1049 (Puri Red)</p> | <p>Anand et al. 1961</p> |
| <p>5. <i>C. annuum</i> Italian EL</p> | <p>Simmons 1966</p> |
| <p>6. <i>C. annuum</i> Yolo Y
(derived from a single mutant plant of Yolo Wonder)</p> <ul style="list-style-type: none"> — a single recessive gene <i>y¹</i> confers resistance to mild strains of PVY — also carries <i>L¹</i> gene for TMV resistance (imperfect localization response to infection with common TMV) | <p>Cook 1966
Morales et al. 1976
Greenleaf 1986
Pochard 1977</p> |

Potato Virus Y (PVY)	References
7. <i>C. annuum</i> Casca Dura, Mogi-das-Cruzes — immune to some PVY strains tested in Brazil	Nagai 1968
8. <i>C. pubescens</i> I-30771, I-30772, SA 112, <i>C. annuum</i> P 11 (PI 264281) — genes <i>y'y'</i> for resistance — immune to PVY strains tested in Brazil	Nagai 1968
9. <i>C. annuum</i> PI 264281 (P11), Agronomico-8, Acc. 2120	Nagai and Smith 1968 Pochard 1987
10. <i>C. annuum</i> Agronomico-4, Agronomico-7, Agronomico-8, Agronomico-9, Agronomico-10, Agronomico-11, and Agronomico-12 — resistant to most strains of PVY	Nagai 1968, 1971, 1973, 1980, 1983, 1984 Nagai and Costa 1972
11. <i>C. annuum</i> P 11 (PI 264281) — immune to all PVY strains tested in Brazil	Nagai 1968, 1984
12. <i>C. annuum</i> PI 264281, Agronomico-10, and Agronomico 11	Nagai 1971
13. <i>C. annuum</i> Agronomico-9 and Agronomico-10 (obtained by multiple crossing between <i>C. annuum</i> Casca Dura, Mogi-das-Cruzes, Puerto Rico Wonder)	Nagai 1971, 1980
14. <i>C. baccatum</i> var. <i>pendulum</i> 3-4 — also resistant to CMV	Pochard and Chambonnet 1972 Pochard 1977b Palloix et al. 1988
15. <i>C. annuum</i> Agronomico-4 — also resistant to TMV	Nagai 1973
16. <i>C. annuum</i> Serrano, Gigante — resistant to all PVY strains tested in Brazil	Pahlen and Nagai 1973
17. <i>C. annuum</i> Avelar — tolerance due to a single recessive gene — also resistant to TEV — also tolerant to PeMV	Zitter and Cook 1973 Zitter and Ozaki 1973
18. <i>C. annuum</i> Delray Bell — tolerant to PVY — also tolerant to TEV and PeMV	Zitter and Cook 1973 Cook et al. 1977 Cook 1984a

Potato Virus Y (PVY)	References
19. <i>C. annuum</i> Italian EL, Agronomico, Mogi-das-Cruzes	Lovisololo and Conti 1976
20. <i>C. annuum</i> cv 136 — also resistant to TMV and TEV	Morales et al. 1976
21. <i>C. annuum</i> Florida VR-2 — <i>yy</i> gene for resistance <i>C. baccatum</i> var. <i>pendulum</i> P-7 — virus titer in F ₁ is intermediate between that of the resistant and susceptible parents	Sooch et al. 1976
22. <i>C. annuum</i> Agronomico-8, Avelar, Doux d'Alger, Ikeda, Jalapeño, LP 1, L 136, PI 264281, P 11, Puerto Rico Wonder, Serrano Vera Cruz <i>C. baccatum</i> var. <i>pendulum</i> 3-4 — recessive gene for resistance (allelic to Yolo Y resistance) — probably there is a single locus with many different alleles <i>C. annuum</i> Rama, Turrialba — hypersensitive reaction (local lesions followed by generalized necrosis) with certain strains of PVY	Pochard 1977a
23. <i>C. annuum</i> Delray Bell — also resistant to TEV (<i>et^r</i> resistance gene for TEV) — also tolerant to PeMV (<i>et^{tr}</i> resistance gene for PeMV) — develops mild mottle symptoms on leaves, but no fruit symptoms	Cook et al. 1977 Abdalla and Desjardins 1985
24. DH 16-4, DH 30-4	Rao et al. 1980
25. <i>C. annuum</i> Pant C-1 <i>C. angulosum</i> EC 97758	Konai et Nariani 1980
26. <i>C. annuum</i> Chanchal, CM 511, CM 517, CM 526, CM 550, EC 31349, G 2, G 3, G 4, G 5, IC 2345, IC 10435, IC 18205, KA 22, K. No. 2, NP 23, NP 37, NP 42, X 196, X 197, X 198 <i>C. frutescens</i> 76 ≠ 55, 76 = 252	Singh and Chenulu 1980

Potato Virus Y (PVY)

References

- C. angulosum* EC 97758
C. microcarpum
C. pendulum
 — resistant to PVY
- C. annuum* NP 36, IC 3430
C. frutescens 76 ≠ 201, 76 ≠ 208
C. pubescens
 — moderately resistant to PVY
27. *C. annuum* Florida XVR 3-25, USAJI-5
 — also resistant to TEV
 Cook 1982
28. *C. annuum* Florida XVR 3-25
 (derived from *C. chacoense* PI 260435 x *C. annuum* VR-2)
 — carries *et^a* and *L¹* resistance genes
 — also resistant to TMV
 Cook 1982, 1984c
29. *C. annuum* Florida VR-4
 (derived from VR-2 x Delray Bell)
 — also resistant to TEV and PeMV
 — susceptible to common TMV
 — carries resistance genes *et^a* and *et^{an}*
 Cook 1982, 1984a
30. *C. annuum* Todo Ano
 Ferreira et al. 1982
31. *C. annuum* Serrano Vera Cruz
 — resistant to PVY strains 0, 1, 1.2
 Gebré Selassie et al. 1983
32. *C. annuum* FLBG-1
 (derived from Cubanelle and Agronomico-8)
 — also resistant to TEV
 — also tolerant to PeMV
 Subramanya et al. 1983
- C. annuum* Florida VR-4
 — also resistant to TEV and TMV
 Subramanya et al. 1983
33. *C. annuum* Agronomico-10G, Agronomico-13,
 Agronomico-14, Agronomico-15,
 Agronomico-16, Magda, Margareth
 Nagai 1983
34. *C. annuum* Tam Mild Jalapeño-1
 [derived from *C. annuum* PI 342947 (resistant to
 TEV, PVY, and TMV), Avelar (resistant to TEV
 and PVY), and Jalapeno L]
 — also resistant to TEV, TMV, and PeMV
 Villalón 1983

Potato Virus Y (PVY)	References
35. <i>C. annuum</i> Florida VR 2-34 — also resistant to TEV and TMV — carries resistance genes <i>et¹</i> and <i>L¹</i>	Cook 1984b Greenleaf 1986
36. <i>C. annuum</i> USAJI 5 (derived from PI 265281, resistant to TEV and PVY [<i>et¹</i>] and a selection from ECUAJI, resistant to PVY) — also resistant to TEV	Cook 1984d Greenleaf 1986
37. <i>C. annuum</i> ECUAJI (from Ecuador)	Cook 1984d
38. <i>C. baccatum</i> var. <i>pendulum</i> <i>C. chinense</i> <i>C. eximium</i> <i>C. flexuosum</i> — resistant to PVY by hypersensitive type of reaction	Horvath 1984
39. <i>C. annuum</i> Tambel-2, Tam Mild Chile-2 (TMC-2) — also resistant to TEV, PeMV, and TMV	Abdalla and Desjardins 1985
40. <i>C. annuum</i> Tam Mild Chile-2 (TMC-2) (derived from Agronomico-8 and Avelar [both resistant to TEV, PVY, and TMV], Cal-Compact 528 and Anaheim TMR-23) — also resistant to PeMV, TMV, and TEV	Villalón et al. 1986a
41. <i>C. annuum</i> Florida VR-2, Lamuyo, Early Prolific, California Wonder 300	Apablaza and Jorquera 1985
42. <i>C. annuum</i> var. <i>angulosum</i> EC 97758 <i>C. baccatum</i> var. <i>microcarpum</i> — single pair of identical recessive genes <i>C. annuum</i> cv. NP 36 <i>C. frutescens</i> 76 = 208 <i>C. pubescens</i> — moderately resistant (monogenic recessive)	Singh and Chenulu 1985
43. <i>C. annuum</i> Long Green Chile 76042, Tam Mild Jalapeño 1, Texas Bell 17004, — also resistant to TEV, PeMV, and TMV	Greenleaf 1986
44. <i>C. annuum</i> Agronomico-8, Agronomico-10, Avelar, Casca Dura, Ikeda, Moura, PI 264281 (P11), Puerto Rico Wonder	Greenleaf 1986

Potato Virus Y (PVY)

References

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| <p>45. <i>C. chinense</i>
 <i>C. baccatum</i> var. <i>pendulum</i>
 <i>C. eximium</i>
 <i>C. flexuosum</i>
 — all show local lesions and leaf drop</p> <p><i>C. pubescens</i>
 — shows local lesions and leaf drop
 — also resistant to ToMV and CMV</p> | <p>Horvath 1986a</p> |
| <p>46. <i>C. cardenasii</i>
 <i>C. frutescens</i></p> | <p>Horvath 1986b</p> |
| <p>47. <i>C. annuum</i> S 38-2-1, S 38-3-19, S 42-2-4,
 S 52-1-6, S 96-4-9-3, S 96-4-8, S 101-2-33
 — tolerant to PVX
 — also tolerant to TMV, CMV, and TLCV</p> <p><i>C. annuum</i> S 81-1-1, S 96-4-9
 — also tolerant to PVX and leaf curl virus</p> | <p>Tewari and Viswanath 1986</p> |
| <p>48. <i>C. annuum</i> Tambel-2
 — also resistant to TMV, TEV, and PeMV</p> | <p>Villalón 1986a</p> |
| <p>49. <i>C. annuum</i> Tam Mild Chile-2 (TMC-2)
 (derived from Agronomico-8 and Avelar [both
 resistant to TEV, PVY, and TMV], Cal-Compack 528
 and Anaheim TMR 23)
 — also resistant to TEV, TMV, and PeMV</p> | <p>Villalón et al. 1986</p> |
| <p>50. <i>C. annuum</i> Hidalgo
 (derived from PI 342947 [resistant to TEV, PVY,
 and TMV] × Avelar [resistant to TEV and PVY])
 — also resistant to TEV, TMV, and PeMV</p> | <p>Villalón 1986b</p> |
| <p>51. <i>C. annuum</i> Hidalgo, Tambel-1, Tambel-2,
 Tam Mild Chile-1, Tam Mild Chile-2,
 Tam Mild Jalapeno 1
 — also resistant to TEV, TMV, and PeMV</p> | <p>Villalón 1986c</p> |
| <p>52. <i>C. annuum</i> Tam Rio Grande Gold-Sweet
 — also resistant to TEV, TMV, and PeMV</p> | <p>Villalón 1987</p> |

Potato Virus Y (PVY)	References
53. <i>C. annuum</i> PM 4 (F ₁ hybrid, Northrup Seed Co.) — single dominant gene for resistance to all PVY strains tested in Brazil, including a new strain, Y ^m	Nagai 1987
54. <i>C. annuum</i> Redlands Sweet Sue (derived from Yolo Y x Hungarian Yellow Wax) — resistant to Australian strain 1 (but not to strains 2 or 3)	Hibberd et al. 1988, 1989 Thomas et al. 1989
55. <i>C. annuum</i> Perennial — partly resistant (highly tolerant) to several PVY strains — also resistant to virus strain EP 11, which is serologically distinct from other PVY strains and virulent on most of the resistant lines — also tolerant to CMV under field conditions	Pochard 1988, 1989 (personal communication) Pochard and Daubèze 1989
<i>C. annuum</i> HDA 201, HDA 210bis, HDA 230, HDA 248, HDA 249, HDA 252, HDA 260, HDA 268, HDA 273, HDA 295 (all lines have Perennial as a parent) — resistant to PVY strains 0, 1, and 1.2 — also tolerant to CMV and tomato yellow leaf curl virus (TYLCV) under field conditions	
56. <i>C. annuum</i> YoloY, Maor, Redlands Sweet Sue — resistant to PVY strain 1 in Australia	Thomas et al. 1989 Hibberd et al. 1989
<i>C. annuum</i> Bell Tower — resistant to PVY strain 1 in Australia — partially resistant to PVY strain 2 in Australia	
<i>C. annuum</i> Delray Bell, Florida VR-4 — resistant to PVY strain 1, 2, and 3 in Australia	
<i>C. annuum</i> Acc. 1534 (piquin type chilli) — highly resistant to PVY strains 1, 2, and 3 in Australia	
57. <i>C. annuum</i> Agronomico 10G, Magda, Margareth	Nagai 1989
58. <i>C. annuum</i> Punjab Lal — also resistant to TMV, CMV, and leaf curl virus	Singh and Cheema 1989

Potato Virus Y (PVY)

References

59. *C. annuum* Hidalgo, Rio Grande Gold
C. baccatum PEN 3-1
 Unknown species AVRDC Acc. C 00006, C 00574
- C. annuum* HDA 273
 — also resistant to CVMV
- C. annuum* HDA 832, Perennial HDV
 — also resistant to CVMV and PVMV
60. *C. annuum* Criollo de Morelos (CM) 334
 -- rapid blockage of virus infection, associated
 with local necrotic lesions
 — dominant gene (*Cy-2*) controls resistance to
 pathotypes PVY 0, 1, and 1-2
 — also resistant to PeMV
 — also carries *cy-1* gene that confers recessive
 resistance to PVY
61. *C. annuum* AVRDC Acc. C 01175
 (Criollo de Morelos 334)
 — also resistant to CVMV
62. *C. annuum* AVRDC Acc. C 00229-1, C 00753,
 C 01511, C 05116; Thailand lines Kee Noo Chinda
 No. 1, Chinda No. 23, Chinda No. 24, Hua Rua No. 1,
 Hua Rua No. 2, Hua Rua No. 3, Sri Saket
 Unknown species AVRDC Acc. C 00352, C 00373,
 C 00574, C 00595, C 01176, C 05078
- C. chinense* AVRDC Acc. C 00304
 — also resistant to ToMV, TMV, and PMMV
- C. baccatum* var. *pendulum* AVRDC Acc. C 00803
 Unknown species AVRDC Acc. C 01173
 — also resistant to ToMV
- C. baccatum* var. *pendulum* AVRDC Acc. C 00753-1,
 C 01172
- C. chinense* AVRDC Acc. C 00940
- C. frutescens* AVRDC Acc. C 00848
 Unknown species AVRDC Acc. C 01090, C 01175
 — also resistant to TMV and ToMV
- AVRDC 1991
- Palloix et al. 1991
 Palloix 1993
 (personal communication)
 Chaîne-Dogiment 1993
- Green 1991
 (unpublished)
- AVRDC 1992

Potato Virus Y (PVY)

References

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|---|---------------------------|
| <p>63. <i>C. annuum</i> Lorai, Perennial, S 20-1
(selection from a cross of Perennial x Long Red)
— also resistant to CMV, TMV, and leaf curl virus</p> <p><i>C. annuum</i> Punjab Lal
— partially resistant to PVY
— also resistant to CMV, TMV, and leaf curl virus</p> <p><i>C. annuum</i> Indonesian Selection
— also resistant to CMV and leaf curl virus</p> | <p>Singh 1992</p> |
| <p>64. <i>C. annuum</i> IHR 993 (EC 171502), IHR 994 (IAC-8)
<i>C. frutescens</i> IHR 1243 (EC 218673)
<i>C. pubescens</i> IHR 1267 (EC 218692)</p> <p><i>C. annuum</i> IHR 243 (Attapadi Lokal),
IHR 328-9 (Anekal Lokal), IHR 384 (Perennial),
IHR 990 (LIC B), IHR 1049 (Puri Red), Pant C-1
<i>C. chinense</i> IHR 1252 (EC 218682)
<i>C. frutescens</i> IHR 1274 (EC 218704)
— also resistant to CMV</p> | <p>George et al. 1992</p> |
| <p>65. <i>C. annuum</i> Laichi 2, S 20-1
— also resistant to TMV, CMV, and leaf curl virus</p> <p><i>C. annuum</i> Perennial
— also resistant to TMV, CMV, PVMV, and leaf curl virus</p> <p><i>C. annuum</i> Lorai
— also resistant to TMV, CMV, CVM, and leaf curl virus</p> <p><i>C. annuum</i> Indonesian Selection
— also resistant to CMV and leaf curl virus</p> <p><i>C. annuum</i> Bangla Green (BG-1)
— partially resistant to PVY
— also resistant to TMV, CMV, and leaf curl virus</p> | <p>Singh 1992</p> |
| <p>66. <i>C. annuum</i> Yolo Y
— resistant to PVY 0 but not to PVY 1
— carries gene <i>vy</i> for resistance</p> <p><i>C. annuum</i> Italian EL
— resistant to PVY-0, but not PVY-1
— resistance is recessive and monogenic
— resistance gene(s) the same or allelic to
Yolo Y resistance genes</p> | <p>Ortega et al. 1992</p> |

Potato Virus Y (PVY)

References

- C. annuum* Florida VR-2
— resistant to PVY-1 but not PVY 1-2
- C. annuum* Serrano Vera Cruz
— resistant to PVY-0, 1, and 1-2
67. *C. annuum* Tani Veracruz
(derived from *C. annuum*, AC 2207, Avelar, PI 264281, PI 342947, Jalapeño 1158, Jalapeño 100, and Jalapeño L.)
— also resistant to CMV, PeMV, TEV, TMV, and TRSV
Villalón et al. 1992
- C. annuum* Avelar, PI 342947
— also resistant to Texas isolates of TEV and TMV
68. *C. annuum* AVRDC Acc. C 01175 (Criollo de Morelos 334), C 01276, PBC 392, Serrano Tampiqueño, Thailand Lines Chinda No 1, Hua Rua, Lueng 1, Lueng 2, Lueng 3, Lueng 4, Lueng 7, Lueng 8, Lueng 9, Lueng 10, Tupang
AVRDC 1993
- C. frutescens* AVRDC Acc. C 05459, C 05550, C 05560, C 05570, C 05571, C 05572
- C. annuum* AVRDC Acc. C 05342
C. frutescens AVRDC Acc. C 05473
— also resistant to ToMV
69. *C. annuum* PBC 349, PBC 365, PBC 370, PBC 450, PBC 454, PBC 458, PBC 483, PBC 495, PBC 521, PBC 524, PBC 534, PBC 535, PBC 545, PBC 580, PBC 581, PBC 582, PBC 596, PBC 622, PBC 710, PBC 729, PBC 730, PBC 731, PBC 787, PBC 830
AVRDC 1994
- C. annuum* AVRDC Acc. C 01664
— also resistant to CVMV

Tobacco Etch Virus (TEV)	References
1. <i>C. chinense</i> PI 152223	Greenleaf 1953
2. <i>C. annuum</i> SC 46252 — resistant, but not immune to TEV — single recessive gene for resistance	Greenleaf 1953, 1956 Cook 1960
3. <i>C. chinense</i> PI 152225 (from Peru) — resistant, but not immune to TEV	Greenleaf 1953, 1959
4. <i>C. annuum</i> PI 264281 — single recessive gene for resistance — also resistant to PVY and TMV	Greenleaf 1956 Cook 1960
5. <i>C. frutescens</i> Tabasco-G (Greenleaf Tabasco) (derived from <i>C. frutescens</i> Tabasco, <i>C. chinense</i> PI 152225 and PI 159236) — monogenic resistance — also resistant to PeMV	Greenleaf 1956, 1975 Zitter 1972
6. <i>C. annuum</i> P 11 — tolerant to most strains of TEV — unaffected by PVY (several strains) — also resistant to TMV (hypersensitive resistance to most strains of TMV)	Cook and Anderson 1959
7. <i>C. annuum</i> Acc. 2120, Agronomico-8 (a derivative of PI 264281 [P 11]) <i>C. frutescens</i> PI 152225, PI 159236	Nagai and Smith 1968
8. <i>C. frutescens</i> LP-1 — resistance to TEV dominant — also resistant to CMV (recessive)	Barrios et al. 1971
9. <i>C. frutescens</i> Greenleaf Tabasco — also resistant to PeMV	Zitter 1972 Greenleaf 1986
10. <i>C. annuum</i> Delray Bell — also resistant to PeMV and PVY	Zitter and Cook 1973 Cook et al. 1977 Cook 1984a

Tobacco Etch Virus (TEV)

References

- | Tobacco Etch Virus (TEV) | References |
|--|---|
| 11. <i>C. annuum</i> PI 264281 (P 11)
— immune to TEV | Weinbaum and Milbrath 1976 |
| 12. <i>C. annuum</i> cv. 136
— also resistant to TMV and PVY | Morales et al. 1976 |
| 13. <i>C. annuum</i> Avelar
— TEV tolerance due to a single recessive gene
— also resistant to PVY and PeMV | Zitter and Cook 1973
Zitter and Ozaki 1973 |
| 14. <i>C. annuum</i> VR-2, Delray Bell
— also resistant to TMV and PVY | Cook 1977 |
| 15. <i>C. annuum</i> : Florida VR-2, VR-4, Delray Bell
— also resistant to PVY and PeMV | Cook et al. 1977
Cook 1984a |
| 16. <i>C. annuum</i> PI 342947 (Acc. 2120), PI 410407 (Avelar),
PI 432946 (Agronomico-8)
<i>C. chinense</i> PI 152225
— highly resistant to TEV

<i>C. annuum</i> PI 264281 (P 11), PI 432948
— moderately resistant to TEV

<i>C. annuum</i> PI 342949 (Casca Dura)
— resistant in the greenhouse but not in the field | Sowell and Demski 1977 |
| 17. <i>C. annuum</i> Florida XVR 3-25, USAJI-5
— also resistant to PVY

<i>C. annuum</i> Florida VR-4
— also resistant to PeMV, PVY, and TMV | Cook 1982 |
| 18. <i>C. annuum</i> FLBG-1
(derived from Cubanelle and Agronomico-8)
— also resistant to PVY
— also tolerant to PeMV

<i>C. annuum</i> Florida VR 4
— also resistant to TMV and PVY | Subramanya et al. 1983 |
| 19. <i>C. annuum</i> Tam Mild Jalapeño-1
(derived from <i>C. annuum</i> PI 342947, Avelar, and
Jalapeño L)
— also resistant to TMV, PVY, and PeMV | Villalón 1983 |

Tobacco Etch Virus

References

- C. annuum* Long Green Chile 76042, Texas Bell
— also resistant to Texas strains of SL-TMV, PVY, and PeMV
20. *C. annuum* Florida VR 2-34
— also resistant to PVY and TMV
21. *C. annuum* USAJI 5
(derived from PI 265281, resistant to TEV and PVY [*et^r*] and a selection from ECUAJI, resistant to PVY)
— also resistant to PVY
22. *C. annuum* California Wonder 300, Early Prolific, Florida VR-2, Lamuyo
— resistant to PVY common strain (PVY^o) in Chile
23. *C. annuum* Tambel-2, Tam Mild Chile-2 (TMC-2)
— also resistant to PVY, PeMV, and TMV
24. *C. chinense* AC 2176 TEV
— also resistant to TMV
25. *C. annuum* Cayenne SC 46252, Pimsan 3
— resistant to TEV (*et^r* gene for resistance)
- C. annuum* Cayenne 16, Cayenne 17, Cayenne 18, Cayenne 19, Cayenne 20
— also resistant to PeMV
26. *C. annuum* Tam Mild Chile-2 (TMC-2)
(derived from Agronomico 8, Avelar [both resistant to TEV, PVY, and TMV], Cal Compact 528, and Anaheim TMR-23)
— also resistant to PVY, PeMV, and TMV
27. *C. annuum* Tambel-2
— intermediate resistance
— also resistant to TMV, PVY, and PeMV
- C. annuum* Agronomico-8
— moderately resistant
28. *C. annuum* Hildalgo, Tambel-1, Tambel-2, Tam Mild Chile-1, Tam Mild Chile-2, Tam Mild Jalapeño-1
— also resistant to PeMV, TMV, and PVY

Tobacco Etch Virus

References

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| 29. <i>C. chinense</i> | Horvath 1986b |
| 30. <i>C. annuum</i> Hidalgo
(derived from PI 342947 [resistant to TEV, PVY,
and TMV] x Avelar [resistant to TEV and PVY])
— also resistant to PVY, PeMV, and TMV | Villalón 1986b |
| 31. <i>C. annuum</i> Tam Rio Grande Gold-Sweet
— also resistant to PeMV, PVY, and TMV | Villalón 1987 |
| 32. <i>C. annuum</i> Georgia C 44NV, Georgia C 44CA
— highly resistant under greenhouse conditions
but mild mottle in 10% of the plants in the field | Kuhn et al. 1987 |
| 33. <i>C. chinense</i> PI 159241 | Padgett et al. 1987 |
| 34. <i>C. annuum</i> GA-C44-V22
— highly resistant under greenhouse conditions
(no symptoms; no virus detected by ELISA)
— highly tolerant under field conditions
(mild mottle observed in the field in 15%
of the plants, but virus was not detected) | Kuhn et al. 1987, 1989 |
| <i>C. annuum</i> Florida XVR-3-25
— difficult to infect mechanically
— highly resistant under greenhouse conditions
(no symptoms; no virus detected by ELISA)
— mild disease in the field (50–85% of plants
developed mild symptoms in the field.
Virus could be detected in less than 15%
of the plants with symptoms) | |
| <i>C. annuum</i> Tambel-2, Asgrow-XPB-5021
— moderate resistance (low to medium virus
titer for 2–3 weeks after inoculation) | |
| 35. <i>C. annuum</i> Tam Veracruz
— also resistant to CMV, PVY, PeMV, TMV, and TRSV | Villalón et al. 1992 |
| <i>C. annuum</i> Avelar, PI 342947
— also resistant to Texas isolates of PVY and TMV | |

Tobacco Ring Spot Virus (TRSV)**References**

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| 1. <i>C. annuum</i> Tam Veracruz
(derived from <i>C. annuum</i> , AC 2207, Avelar, PI 264281,
PI 342947, Jalapeño 1158, Jalapeño 100, and Jalapeño L.)
— also resistant to CMV, PeMV, PVY, TEV, and TMV | Villalón et al. 1992 |
| 2. <i>C. annuum</i> DH 2-4, DH 11-15
— also resistant to PVBV and PVMV | Rao et al. 1980 |

Tobamoviruses¹

References

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|--|---|
| 1. <i>C. baccatum</i> PI 152234
<i>C. chinense</i> PI 152222, PI 152225
Unlisted species PI 152221, PI 152235, PI 152453
— local lesions | Greenleaf 1953 |
| 2. <i>C. chinense</i> PI 152225, PI 159236,
PI 159241, PI 257284, PI 315008, PI 315024,
PI 315023 | Greenleaf 1956
Boukema 1977 |
| 3. <i>C. annuum</i> P11 (PI 264281)
— reacts in a hypersensitive manner to most strains
of TMV
— tolerant to most strains of TEV
— unaffected by PVY (several strains) | Cook and Anderson 1959 |
| 4. <i>C. annuum</i> Florida VR-2
— resistant to TMV
— also resistant to strains of PVY and TEV | Cook 1960, 1963b, 1977
Cook et al. 1976
Greenleaf 1986
Sooch et al. 1976 |
| 5. <i>C. annuum</i> PI 264281
— also resistant to PVY and TEV | Cook 1960, 1963b
IVT 1984
Nagai 1984 |
| 6. <i>C. annuum</i> PI 163201
— necrotic local lesions on inoculated leaves
— no systemic infection | Pound and Singh 1960 |
| 7. <i>C. annuum</i> PI 183441
— a plant of this introduction remained
symptomless after repeated inoculations | Sowell 1960
Cook 1963a |
| 8. <i>C. annuum</i> cv. 136
— also resistant to TEV and PVY | Cook 1966
Morales et al. 1976 |

¹Several tobamoviruses are known to infect peppers (see Appendix 1), the most common of which are tobacco mosaic virus (TMV), tomato mosaic virus (ToMV), and pepper mild mottle virus (PMMV). Some literature references, particularly the early ones, do not distinguish between the different tobamoviruses but refer only to TMV, while they may actually be dealing with ToMV or PMMV. For information on the different strains and pathotypes of the tobamoviruses, the reader is referred to the AVRDC Technical Bulletin No. 18: **Characteristics and control of viruses infecting peppers: a literature review.**

Tobamoviruses	References
9. <i>C. annuum</i> Yolo Y — also resistant to PVY	Cook 1966 Morales et al. 1976 Greenleaf 1986 Pochard 1977
10. <i>C. frutescens</i> Tabasco	Ramakrishnan et al. 1966
<i>C. microcarpum</i> — immune to TMV	
<i>C. annuum</i> Birdeye, 971 — hypersensitive reaction with TMV	
11. <i>C. annuum</i> Agronomico-9, Agronomico-10, Agronomico-11, Agronomico-12 — highly resistant to TMV — also resistant to PVY	Nagai and Costa 1972 Nagai 1973
12. <i>C. chinense</i> PI 159236 — also resistant to PeMV	Zitter 1972 Boukema 1977 Subramanya 1982
13. <i>C. annuum</i> Agronomico-4	Nagai 1973
14. <i>C. annuum</i> A ₂₇ , C1, IC 3425, IC 3440, IC 3588, IC 3779, Konidiverum G2, Puri Orange, Puri Red, Surjamukhi — field resistant to TMV	Singh 1973
15. <i>C. annuum</i> S 5-4, S 20-1, S 41-1, S 41-2, S 41-3, S 69-1, S 72-3, S 72-4	Kaul 1975
16. <i>C. annuum</i> INRA Bird's Eye, Lamuyo, Yolo Wonder, Yolo Y, Toledo F ₁	Lovisolo and Conti 1976
17. <i>C. annuum</i> Yolo Wonder, Yolo Y — genotype L'/L' — also resistant to PVY	Greenleaf 1986 Morales et al. 1976
<i>C. annuum</i> cv. 136 — also resistant to TEV and PVY	
18. <i>C. annuum</i> Fusini, Kimjang gochu, Sae gochu, Sandia, 2520, Taekuk, Wheonggeri 128-2-1, Wheonggeri 128-3-3, Yolo Y	Kang and Choi 1976

Tobamoviruses

References

- C. frutescens* Tabasco 131-4
 — local lesions only in inoculated leaves
 — possibly carries the *L* gene for resistance
19. *C. chinense* PI 152225
 — 1 dominant gene
 van den Berkmortel 1977
20. *C. annuum* Florida VR-2
 — also resistant to TEV and PVY
 Cook 1977;
 Greenleaf 1986
21. *C. baccatum*
 — resistant to strains P 0 and P 1
 — susceptible to strain P 1.2
 Rast 1977
22. *C. annuum* Perennial
 — also resistant to CMV and leaf curl virus
 — 3 weakly recessive genes control resistance to CMV, TMV, and leaf curl virus
 Singh and Thakur 1977
23. *C. annuum* Kalocsai V1
 (derived from a cross between a half wild hypersensitive Chinese variety and the susceptible variety Szeged 91-95)
 — also tolerant to CMV
 Szirmai 1978
24. *C. annuum* Keystone Resistant Giant
 — *L*¹ gene for resistance
 Zatyko 1978
25. *C. chinense* (10 lines)
 — *L*³ gene for resistance
 Boukema 1978, 1980
- C. chinense* PI 152225, PI 159233, PI 159236,
 PI 213917, PI 215024, PI 224424, PI 257284,
 PI 315008, PI 315023
 — local necrotic lesions with P 8 strain
26. *C. annuum* Bangla Green, HS-1, Jamni, Laichi, Longi, Lorai, Pant C-1, Perennial, S 20-1, S 118-2, Tiwari
 — also resistant to CMV
 — also field resistant to leaf curl virus
 Singh and Thakur 1979
27. *C. annuum* Kremovyi 20 (Cream 20), Yolo Wonder, Adygei, Konservnyi, Krasnyi, Red Canning
C. baccatum var. *pendulum*
C. chinense
C. frutescens
 Timina and Balashova 1979

Tobamoviruses	References
28. <i>C. annuum</i> Fehérözön — L^1 gene for resistance	Zatyko et al. 1979 Tobias and Csillery 1982
29. <i>C. chinense</i> PI 159236, PI 213917, PI 224424, PI 257117, PI 257284, PI 281428, PI 315008 (Miscucho), PI 315023 (Mishme), PI 315024, PI 159233 (listed <i>C. annuum</i>), PI 15362, PI 5380, PI 5393, PI 5395, PI 5397, PI 5401, PI 5416, PI 5431, PI 5451, PI 5490, PI 7204, PI 7208, W10, D8 — genotype L^1L^1 — resistant to tomato strain P 0 and “pepper strains” P 1 and P 1.2, but not to P 1.2.3.	Boukema et al. 1980
<i>C. chinense</i> Ru 72-292 — resistant to tomato strain P 0 — genotype L^1L^1	
<i>C. frutescens</i> Tabasco — L^2L^2 genotype — resistant to P 0 and P 1	
<i>C. chinense</i> PI 152225 — segregates 1 susceptible, 8 resistant	
<i>C. chinense</i> PI 159241 — segregates 2 susceptible, 7 resistant — 1 dominant gene	
30. <i>C. annuum</i> Pant C-1, Pant C-2 — also resistant to CMV, PVX, and leaf curl virus	Konai and Nariani 1980
Unidentified local Indian variety — tolerant to TMV — also immune to CMV and PVX	
31. <i>C. annuum</i> Gypsy (F_1 hybrid)	Tigchelaar 1980
32. <i>C. chinense</i> PI 152225, PI 159230, PI 315008, PI 315023 — resistant by hypersensitivity to a new strain isolated from <i>C. annuum</i> Lamuyo	Gebré Selassie et al. 1981
33. <i>C. chinense</i> (7 accessions) — resistant to a strain of TMV; isolated from <i>C. frutescens</i> Tabasco	Boukema 1982

Tobamoviruses

References

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|---|---|
| <p>34. <i>C. chacoense</i> PI 260429, SA 185
— <i>L'</i> gene for resistance</p> <p>35. <i>C. annuum</i> Florida XVR 3-25
— also resistant to PVY and TEV</p> <p>36. <i>C. annuum</i> Florida VR 4
— also resistant to PVY, TEV, and PeMV</p> <p>37. <i>C. annuum</i> Yolo Wonder, Florida VR-2
— resistant to pathotype TMV-P0</p> <p>38. <i>C. annuum</i> Keystone
— resistant to a Cuban strain of TMV</p> <p>39. <i>C. chacoense</i> SA 185
— resistant to TMV strain P 1.2.3
— resistance is based on 1 incompletely dominant gene</p> <p>40. <i>C. annuum</i> KKG-W3, Gunzulina, Poivron, Titan
— resistant to TMV-T</p> <p>41. <i>C. annuum</i> Garden Sunshine
(derived from Yolo Wonder x Aconcaqua)</p> <p>42. <i>C. annuum</i> Pusa Jwala
— also resistant to leaf curl virus and CMV</p> <p>43. <i>C. baccatum</i> PI 260549</p> <p><i>C. chinense</i> PI 159233 (USA), PI 159236 (USA), PI 257284 (Spain), PI 315008 (Miscucho), PI 315024 (Peru)
— resistant to tomato and pepper strains</p> <p><i>C. annuum</i> Rama, Turrialba
— resistant to pepper strain P 11</p> <p>58 species
— resistant to TMV-T and TMV-Tm</p> <p>31 species
— resistant to TMV-P 11 (pepper strain)</p> <p>5 species
— resistant to TMV-P 8 (pepper strain)</p> | <p>Boukema 1982, 1984
Tobias and Csillery 1982</p> <p>Cook 1982</p> <p>Cook 1982, 1984</p> <p>Dumas de Vaulx et al. 1982</p> <p>Cordero and Gaborjanyi 1982</p> <p>IVT 1982</p> <p>Kostova 1982</p> <p>Millet and Jones 1982</p> <p>Tewari 1982
Singh and Singh 1989</p> <p>Rast 1982</p> |
|---|---|

Tobamoviruses	References
44. <i>C. annuum</i> S 38-2-1, S 94-4-9-3, S 101-2-33 — tolerant to TMV — also tolerant to CMV, PVX, and leaf curl virus	Tewari and Viswanath 1982
45. <i>C. frutescens</i> 33/5 — dominant oligo gene Line L 938 — single recessive gene	Balashova et al. 1983
46. <i>C. annuum</i> (54 lines) — resistant by hypersensitive reaction	Marte 1983
47. <i>C. annuum</i> Lorai, Longi, Pant C-1, Perennial, S 118-2 — resistant/tolerant to TMV — also resistant/tolerant to CMV and leaf curl virus	Sharma et al. 1983 Sharma and Singh 1985
48. <i>C. annuum</i> Pant C-1, Pant C-2 — tolerant to TMV — also tolerant to CMV, PVX, and leaf curl virus <i>C. annuum</i> Delhi Local — tolerant to TMV — also tolerant to leaf curl virus — immune to CMV and PVX	Konai and Nariani 1983
49. <i>C. annuum</i> Tam Mild Jalapeno-1 (derived from <i>C. annuum</i> PI 342947, Avelar, and Jalapeño L) — also resistant to TEV, PVY, and PeMV	Villalón 1983
50. <i>C. annuum</i> Florida VR 2-34 — also resistant to PVY and TEV	Cook 1984b Greenleaf 1986
51. <i>C. annuum</i> Florida XVR 3-25 (derived from <i>C. chacoense</i> PI 260435 x <i>C. annuum</i> Florida VR-2) — also resistant to PVY	Cook 1984c
52. <i>C. baccatum</i> var. <i>baccatum</i> <i>C. baccatum</i> var. <i>pendulum</i> <i>C. frutescens</i> var. <i>minimum</i> <i>C. frutescens</i> Tabasco <i>C. praetermissum</i> <i>C. pubescens</i>	Horvath 1984

Tobamoviruses

References

- | Tobamoviruses | References |
|---|--|
| 53. <i>C. chacoense</i> PI 260429
— resistant to TMV strain P1.2.3
— resistance is based on 1 single incompletely dominant gene L^1 | IVT 1984 |
| 54. <i>C. annuum</i> Torito
— resistant to TMV-0 | Stolk 1984 |
| 55. <i>C. annuum</i> L 290, L 305, L 323 | Jilaveanu et al. 1984 |
| 56. <i>C. annuum</i> Tam Mild Chile-2 (TMC-2) | Abdalla and Desjardins 1985
Villalón 1986a, c |
| 57. <i>C. annuum</i> Tambel-2
— also resistant to PVY, PeMV, and TEV | Abdalla and Desjardins 1985
Villalón 1986a, c |
| 58. F_1 generation
(Almapaprika and Paradicsomalaku Zold Szentesi x Florida VR-2) | Barta et al. 1985 |
| 59. <i>C. annuum</i> Wongkyo 306 | Choi and Pae 1985 |
| 60. F_1 generation
(<i>C. annuum</i> Albena ns8 x <i>C. chinense</i> AC 2176) | Kounovasky et al. 1985 |
| 61. <i>C. chacoense</i> | Yildiz et al. 1985 |
| 62. <i>C. annuum</i> Bighart, Pimsan 1, Pimsan 2
— L gene for TMV resistance

<i>C. annuum</i> Florida VR-2, Florida VR 2-34,
Florida XVR 3-25, Keystone Resistant Giant,
Verbeterde Glas, Yolo Wonder, Yolo Y
— L^1/L^1 genotype
— resistant to strains of TMV (P0)

<i>C. frutescens</i> Tabasco | Greenleaf 1986 |
| 63. <i>C. baccatum</i> var. <i>microcarpum</i>
<i>C. chacoense</i>
<i>C. frutescens</i> var. <i>cerasiforme</i>
<i>C. frutescens</i> Tabasco
— also resistant to CMV | Horvath 1986b |

Tobamoviruses

References

- C. baccatum* var. *pendulum*
- resistant to TMV and ToMV
 - also resistant to CMV
- C. pubescens*
- resistant to ToMV
 - also resistant to CMV and PVY
64. *C. annuum* Jangsu (F₁ hybrid), Wongkyo 306 RDA 1986
- also resistant to CMV
 - TMV and CMV resistance derived from Taigukgochu, a local variety from Thailand
65. *C. annuum* Agronomico-8 Villalón 1986a
- C. annuum* Tambel-2
- also resistant to PVY, TEV, and PeMV
66. *C. annuum* Hidalgo Villalón 1986b
- (derived from PI 342947 [resistant to TEV, PVY, and TMV] × Avelar [resistant to TEV and PVY])
- also resistant to PVY, TEV, and PeMV
67. *C. annuum* Hidalgo, Tambel-1, Tambel-2, Tam Mild Villalón 1986c
Chile-1, Tam Mild Chile-2, Tam Mild Jalapeño-1
— also resistant to PeMV, PVY, and TEV
68. *C. annuum* Bangla Green, HS-1, Jamni, Laichi, Longi, Singh and Kaur 1986
Lorai, Pant C-1, Perennial, S 118-2, S 20-1, Tiwari
- also resistant to CMV and field resistant to leaf curl virus
69. *C. annuum* Catalan, Fado (F₁), Helder, Jericho, Betti et al. 1986
Lamuyo, Melody (F₁), Pacific, Rinascita, Shamrock, Yolo Wonder B
70. *C. annuum* S 38-2-1, S 38-3-19, S 42-2-4, S 52-1-6, Tewari and Viswanath 1986
S 96-4-9-3, S 96-4-8, S 101-2-33
- tolerant to TMV
 - also tolerant to CMV, PVX, and TLCV
71. *C. annuum* Tam Mild Chile-2 (TMC-2) Villalón et al. 1986
- (derived from Agronomico 8, Avelar [both resistant to TEV, PVY, TMV], Cal Compack 528 and Anaheim TMR-23)
- also resistant to PVY, PeMV, and TEV

Tobamoviruses	References
72. <i>C. annuum</i> Novi (F ₁), Delgado (F ₁) — <i>L'L</i> ³ alleles for resistance	Tanzi et al. 1986
73. <i>C. annuum</i> Tam Rio Grande Gold-Sweet — also resistant to PeMV, PVY, and TEV	Villalón 1987
74. <i>C. chacoense</i> PI 260429 line Chaton 2-2 — resistant to TMV strains 0, 1, 1.2, 1.2.3 <i>C. baccatum</i> var. <i>pendulum</i> 152234, 159235 — only local lesions with TMV	Pochard 1988 (personal communication)
75. <i>C. chinense</i> PI 315008 (Miscucho) — resistant to P0, P1, P1.2, but not P1.2.3	Pochard 1988
76. <i>C. annuum</i> Perennial — immune to TMV and CMV	Peshney and Moghe 1988
<i>C. annuum</i> CA 1068, G 5, K I, PKV 1 — moderately resistant to TMV and CMV	
<i>C. annuum</i> Bhivapur 1, Pantnagar 1, Pantnagar 2, PKV 21, Sabouragar, Surjamani — moderately resistant to TMV — also resistant to CMV	
<i>C. frutescens</i> Lawangi — moderately resistant to CMV	
<i>C. microcarpum</i> — hypersensitive resistance to TMV	
77. <i>C. annuum</i> Punjab Lal — also resistant to PVY and CMV	Singh and Cheema 1989
78. <i>C. annuum</i> PI 152225, PI 159236, PI 315008, Smith SA 411 — resistant to TMV-P (pepper strain)	Narikawa et al. 1989
79. <i>C. frutescens</i> Greenleaf Tabasco — resistant to TMV and ToMV	AVRDC 1991
<i>C. chinense</i> PI 152225, PI 159236, <i>C. frutescens</i> Tabasco McIlhenny — resistant to TMV, ToMV, and PMMV	

Tobamoviruses	References
80. <i>C. frutescens</i> Pusa Sada Bahar — also tolerant to CMV and leaf curl virus	Tewari 1991
81. <i>C. annuum</i> Indonesia line LV 2411, Thailand line Kee Noo Kao <i>C. baccatum</i> AVRDC Acc. C 00948 <i>C. baccatum</i> var. <i>pendulum</i> AVRDC Acc. C 00755, C 00773, C 01178 <i>C. chinense</i> AVRDC Acc. C 00967, C 01177 <i>C. frutescens</i> AVRDC Acc. C 00897, C 00966, C 01610 — resistant to ToMV and TMV	AVRDC 1992
<i>C. chinense</i> AVRDC Acc. C 06917, C 01174 — resistant to ToMV, TMV, and PMMV	
<i>C. chinense</i> AVRDC Acc. C 00304 — resistant to ToMV, TMV, and PMMV — also resistant to PVY	
<i>C. baccatum</i> var. <i>pendulum</i> AVRDC Acc. C 00753-1, C 01172 <i>C. frutescens</i> AVRDC Acc. C 00848 Unknown species AVRDC Acc. C 01090, C 01175 — resistant to TMV and ToMV — also resistant to PVY	
<i>C. chinense</i> AVRDC Acc. C 00940 — resistant to ToMV and PMMV — also resistant to PVY	
<i>C. baccatum</i> var. <i>pendulum</i> AVRDC Acc. C 00803 Unknown species AVRDC Acc. C 01173 — resistant to ToMV — also resistant to PVY	
82. <i>C. annuum</i> S 20-1, Laichi 2 — also resistant to CMV, PVY, and leaf curl virus	Singh 1992
<i>C. annuum</i> Tiwari — also resistant to CMV and leaf curl virus	
<i>C. annuum</i> Perennial — also resistant to CMV, PVY, PVMV, and leaf curl virus	
<i>C. annuum</i> Punjab Lal — also resistant to CMV, CVMV, and leaf curl virus	

Tobamoviruses

References

- C. annuum* Bangla Green (BG-1)
 — also resistant to CMV and leaf curl virus
 — partially resistant to PVY
- C. annuum* Lorai
 — also resistant to CMV, PVY, CVMV, and leaf curl virus
83. *C. annuum* Tam Veracruz
 (derived from *C. annuum*, AC 2207, Avelar, PI 264281, PI 342947, Jalapeño 1158, Jalapeño 100, and Jalapeño L.)
 — resistant to TMV
 — also resistant to CMV, PeMV, PVY, and TRSV
- C. annuum* Avelar
 — resistant to Texas isolate of TMV
 — also resistant to Texas isolates of PVY and TEV
- C. annuum* PI 342947
 — resistant to Texas isolate of TMV
 — also resistant to Texas isolates of PVY and TEV
84. *C. annuum* AVRDC Acc. C 05342
C. frutescens AVRDC Acc. C 05473
 — resistant to ToMV
 — also resistant to PVY
- C. annuum* AR 89, CNPH 703, G 3
C. frutescens Rawit Kutoarjo
C. baccatum var. *pendulum* PI 260571
 — resistant to ToMV and TMV
- C. annuum* AVRDC Acc. C 05050, C 05063, C 05092, C 05138
C. frutescens AVRDC Acc. C 05419, C 05552
 — resistant to ToMV
85. *C. annuum* PBC 473
 — resistant to ToMV
- C. annuum* PBC 137, PBC 365, PBC 417, PBC 621, C 04352, Fehrozan, Gregyo
 — resistant to TMV and ToMV
- Villalón et al. 1992
- AVRDC 1993
- AVRDC 1994

Tomato Spotted Wilt Virus**References**

- | | |
|---|---------------------------|
| 1. Several breeding lines | Reifschneider et al. 1986 |
| 2. <i>C. chinense</i> PI 152225, PI 159236 <ul style="list-style-type: none">— concentric necrotic local lesions only on inoculated leaves, no systemic infection | Black et al. 1991 |
| 3. <i>C. chinense</i> PI 159236 <ul style="list-style-type: none">— resistant to 8 Brazilian isolates (concentric necrotic local lesions on inoculated leaves)— susceptible to 3 other Brazilian isolates (systemic necrosis and stunting) | Boiteux and Nagata 1993 |

Unspecified Viruses**References**

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- | | |
|--|-------------------------|
| 1. PI 109252 | Dolan 1957 |
| 2. <i>C. annuum</i> Jwala
(derived from Puri Red and N.P. 46A)
— resistant to mosaic disease and leaf curl | Tewari 1977, 1982 |
| 3. Some varieties collected from Punjab (India)
— resistant to mosaic disease | Akhtar and Ibrahim 1979 |

Appendix 1. Viruses reported to infect peppers (Green and Kim 1991)

Taxonomic group	Virus	Particle size	Vector ¹	Geographical distribution	Host range
FILAMENTOUS VIRUSES					
Potyviruses	Chilli veinal mottle (CVMV)	750 x 12	A	Asia	<i>Capsicum</i> spp.
	Pepper mild mosaic	714	A	Venezuela	Solanaceae
	Pepper mottle (PeMV)	737	A	El Salvador, USA Thailand	Solanaceae
	Pepper severe mosaic (PeSMV)	761 x 13	A	Argentina	Solanaceae
	Pepper veinal mottle (PVMV)	770 x 12 850 x 12	A	West Africa (Ghana, Ivory Coast, Nigeria)	Solanaceae
	Peru tomato virus (PTV)	750 x 12	A	Peru	Solanaceae
	Potato virus Y (PVY)	730 x 11	A	Worldwide	Solanaceae
	Tobacco etch (TEV)	730 x 12-13	A	USA, Mexico, Sudan Nigeria, Venezuela	Dicotyledonae (mainly Solanaceae)
Carlaviruses	Potato virus M (PVM)	650 x 12	A	USSR, India	Solanaceae
	Potato virus S (PVS)	650 x 12	A	USSR, India	Solanaceae
Potexviruses	Potato aucuba mosaic ² (PAMV)	580 x 11-13	C	Worldwide	Solanaceae
	Potato virus X (PVX)	515 x 11-13	C, S	Worldwide	Solanaceae
ROD-SHAPED VIRUSES					
Tobamoviruses	Pepper mild mottle (PMMV)	312 x 18	C	North America, Australia, Japan, Europe (Denmark, France, Greece, Italy, the Netherlands, Spain)	<i>Capsicum</i> spp.
	Tobacco mosaic (TMV)	300 x 18	C, S	Worldwide	Wide
	Tomato mosaic (ToMV)	300 x 18	C	Worldwide	Wide
	Bell pepper mottle (BPemV)	300 x 18	C	Argentina	Solanaceae

continued

Appendix 1. Viruses reported to infect peppers (Green and Kim 1991)

Taxonomic group	Virus	Particle size	Vector ¹	Geographical distribution	Host range
	Tobacco mild green mosaic (TMGMV)	310 x 18	C	Worldwide (Germany, Hungary, Italy, USA, Brazil, North Africa, Spain, Canary Islands, Australia)	Solanaceae Umbelliferae Commelinaceae Gesneriaceae
	Dulcamara yellow fleck (DYFV)	300 x 19	C	Hungary	Solanaceae
Tobraviruses	Tobacco rattle (TRV)	2 components: 21-23 x 46-117 21-23 x 185-197	N	USA, Europe Brazil, Japan	Wide
ISOMETRIC VIRUSES					
Luteoviruses	Beet western yellows (BWYV)	26	A	Europe, USA, Japan	Wide; mainly Dicotyledonae, many vegetables and weeds
Tobacco necrosis and satellite viruses	Tobacco necrosis (TNV)	26-28	F	Worldwide	Wide
Tombusviruses	Tomato bushy stunt (TBSV)	30	S	USA, Europe, North Africa	Wide
	Moroccan pepper virus	30	S	Europe, North Africa	Solanaceae
Fabaviruses	Broad bean wilt (BBWV)	25	A	Argentina, Egypt Europe, Japan, Morocco	Wide; mainly Dicotyledonae
Nepoviruses	Tobacco ring spot (TBRV)	28	N	North America	Wide; woody, herbaceous, ornamentals
	Tomato ring spot (TomRV)	28	N	USA	Wide; ornamentals, woody, semiwoody plants
	Tomato black ring (TBRV)	30	N	Europe	Wide

continued

Appendix 1. Viruses reported to infect peppers (Green and Kim 1991)

Taxonomic group	Virus	Particle size	Vector ¹	Geographical distribution	Host range
Tymoviruses	Belladonna mottle (BMV)	27	B	Europe, USA	Solanaceae
Alfalfa mosaic virus group	Alfalfa mosaic (AMV)	5 components: 18 x 18 18 x 29 18 x 38 18 x 49 18 x 58	A	Worldwide	Wide (Dicotyledonae)
Cucumoviruses	Cucumber mosaic (CMV)	28	A	Worldwide	Wide
	Tomato aspermy (TAV)	30	A	USA, Europe New Zealand	Wide
Ilarviruses	Tobacco streak (TSV)	27-35	T	USA, New Zealand, Argentina, Europe, Japan	Wide
Cryptic viruses	Red pepper cryptic virus (RPCV)	30	—	Japan	<i>Capsicum annuum</i>
GEMINIVIRUSES³					
	Curly top (CTV)	18-20 x 32	L	North America, Turkey	Wide (Dicotyledonae)
	Tobacco leaf curl (TLCV)	15-20 x 25-30	W	Japan, India	Solanaceae Compositae Caprifoliae
	Pepper mild tigré (PMTV)	20 x 30	W	Mexico	<i>N. tabacum</i> <i>Datura stramonium</i>
	Chino del tomate (CdTV)	18 x 20	W	Mexico	Leguminosae Solanaceae <i>Cynanchum acutum</i> <i>Malva</i> sp.
	Serrano golden mosaic (SGMV)	20 x 30	W	Mexico, USA	<i>L. esculentum</i> <i>D. stramonium</i> <i>Capsicum</i> spp.
ENVELOPED VIRUSES					
Tomato spotted wilt virus	Tomato spotted wilt (TSWV)	70 - 90	T	Possibly worldwide (temperate/subtropical regions)	Wide

continued

Appendix 1. Viruses reported to infect peppers (Green and Kim 1991)

Taxonomic group	Virus	Particle size	Vector ¹	Geographical distribution	Host range
OTHER, NOT WELL CHARACTERIZED VIRUSES					
	Bell pepper dwarf mosaic	?	?	India	Solanaceae
	Brinjal mosaic	?	A	India	<i>Capsicum</i> spp.
	Chili leaf curl	?	W	Sri Lanka, India	Solanaceae
	Green veinbanding	?	A	Cuba	<i>Capsicum</i> spp.
	Launaea mosaic	?	A	India	<i>Capsicum</i> spp. <i>L. esculentum</i>
	Marigold mottle	?	N	India	<i>Capsicum</i> spp.
	Pepper vein banding	17 x 679	A	India	<i>Capsicum</i> spp.
	Pepper yellow vein mosaic	?	F	England, Hungary, Netherlands	<i>Capsicum</i> spp. <i>Lactuca sativa</i> <i>Solanum villosum</i>

¹ A = aphid; B = beetle; C = contact; F = fungus; L = leafhopper; N = nematode; T = thrips; W = whitefly; S = soil, no insect vector found; - = no vector; ? = particle size or vector not identified.

² Only infection by artificial inoculation has been reported.

³ For more information on geminiviruses, the reader is referred to the AVRDC Technical Bulletin No. 21: Leaf curl and yellowing viruses of pepper and tomato: an overview.

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