https://doi.org/10.29321/MAJ.10.A03642

Potato Virus Y on Chilli (*Capsicum annuum* L.) in Tamil Nadu

by

R. JEYARAJAN[1] and K. RAMAKRISHNAN[2]

Introduction: Chilli (*Capsicum annuum* L.) is an important commercial crop of India cultivated in an area of 14,00,000 acres with an annual production of 4,00,000 tons of dry chilli. Among the 18 viruses which have been reported to occur naturally on this plant (Ramakrishnan, 1959, 1961) only Indian chilli mosaic virus (Mc Rae, 1924) leaf-curl virus (Husain, 1932; Vasudeva, 1954), potato virus Y (Joshi and Bhargava, 1962) tobacco mosaic virus (Kandaswamy *et al.* 1963) and potato virus X (Anon., 1964) have been reported to occur on chilli in India. A virus disease of chilli was found to occur over wide areas in Tamil Nadu causing considerable loss of crop. Collections of this virus were made from various parts of the State and cultures established in glass house. The symptoms produced by this virus have already been described (Jeyarajan and Ramakrishnan, 1961). The properties of four other isolates producing similar symptoms on chilli were studied in order to identify them and the results are presented in this paper.

Materials and Methods: An isolate of the chilli virus was collected from a field in Madukkarai village near Coimbatore. Four other isolates designated CH 29, 30, 32 and 33 which produced similar symptoms on chilli were obtained from the Plant Virologist, Agricultural College and Research Institute, Coimbatore. Seedlings of the chilli variety Sattur Samba *(C. annuum)* in the two-to-four leaf stage were used as test plants.

For insect transmission studies, virus-free colonies of aphids obtained by the multiplication of a single viviparous, wingless female were maintained on healthy, young host plants in an insect-proof cage. *Aphis gossypii* Glov. was maintained on *Gossypium hirsutum* L., *A. craccivora* Koch. on *Vigna sinensis* Endl., *Myzus persicae* Sulzer on *Nicotiana tabacum* L. and *Toxoptera citricidus* Kirk. on *Citrus aurantifolia* Swingle.

The adult apterous forms were used in transmission studies. They were first starved for an hour and transferred to young leaves of chilli plants showing clear symptoms of infection by the virus under study. They were then transferred to healthy chilli plants taking care not to injure the aphids. Aphids which did not feed on infected chilli plants were allowed to feed on another set of test plants to serve as control. At the end of the inoculation feeding period, the aphids were destroyed by spraying parathion and the plants were kept under observation for one month in the glasshouse taking precautions to avoid insect infestation.

1. Plant Pathologist (virus), Punjab Agricultural University, Abohar and 2. Dean and Additional Director of Agriculture, Agricultural College and Research Institute, Coimbatore-3.

Results: 1. *Varietal reaction:* With a view to study the type of symptoms produced by the present virus on different varieties of chilli under cultivation in various parts of India and at the same time to locate resistant varieties, 22 chilli varieties were inoculated with the infective sap. In each variety six plants were inoculated.

Of the 22 varieties tested, Kodakai 80-1, A-126, CA 743-3, X 33 d-1-1-2-1, G 2, B 72 A and Sattur Samba alone picked up infection. In all these varieties, the symptoms appeared after an incubation period of 15 to 18 days and were mostly similar to the symptoms on the test variety Sattur Samba already described.

The following 15 varieties did not show symptoms of infection by the virus: X 91-6-5, A 158, Warangal, S 32, Pandurana, CA 733-1-1-1-1, A 123 Gollaprodu, CA 766-1-3, A 125, A 126, CA 452-1, A 160, Rosagulla and C 60 A.

2. *Insect transmission:* Four species of aphids: *Aphis gossypii*, *A. craccivora*, *Myzus persicae* and *Toxoptera citricidus* were tested for their ability to transmit the disease. After ten minutes of acquisition feeding, the aphids were transferred to the test plants at the rate of five aphids per plant and allowed to feed for two hours. Only *A. gossypii* was able to transmit the virus. The symptoms appeared in 12–15 days.

Having found that *A. gossypii* transmitted the virus, the minimum number of this aphid required for transmission, acquisition feeding period were also determined using five infective aphids on each test plant. The results are presented in Table 1.

TABLE 1. *Transmission of Madukkarai isolate with A. gossypii*

Factor	Treatment	Plants inoculated	Plants infected
Number of aphids for transmission	1	6	1
	3	6	3
	5	6	3
Acquisition feeding period	1 Mnt.	6	3
	3 „	6	4
	5 „	6	3
	10 „	6	3
Inoculation feeding period	1 „	6	0
	3 „	6	0
	5 „	6	4
	10 „	6	3

It was found that even a single aphid was able to transmit the virus. The aphid acquired the virus in one minute of feeding. Inoculation feeding of five minutes was necessary.

3. *Identity of the virus isolates:* A careful scrutiny of the symptoms produced by the Madukkarai isolate and also four other chilli virus isolates designated CH 29, 30, 32 and 33 revealed similarity in disease symptoms produced on chilli. In order to find out whether these five isolates are one and the same virus, a comparative study of their physical properties was taken up. In the absence of local lesion host, chilli itself was used as the test plant.

i. *Dilution end point:* The sap was extracted from young, infected leaves by grinding in a glass mortar and squeezing through cheese cloth. Serial dilutions from 1 in 100 to 1 in 50,000 were made using phosphate buffer, pH 7.0 and each dilution of sap was inoculated on a set of ten chilli plants. The plants were observed for the production of symptoms. It was observed that all the five isolates had a low dilution end point of 1 in 100.

ii. *Thermal inactivation point:* The thermal inactivation point of all the five virus isolates was between 50° and 55°C.

iii. *Longevity in vitro:* The results of longevity *in vitro* studies on the Madukkarai isolate using filtered sap and sap centrifuged at 2500 rpm for 15 minutes are presented in Table 2.

TABLE 2. *Longevity in vitro of the Madukkarai isolate*

Age of sap	Filtered sap		Centrifuged sap	
	kept at 5°C	kept at 28°C	kept at 5°C	kept at 25-28°C
Fresh sap	—	8/12	—	6/12
1 day	5/12	4/12	5/12	3/12
2 days	3/12	2/12	6/12	3/12
3 days	0/12	0/12	2/12	2/12
4 days	0/12	0/12	0/12	0/12
5 days	0/12	0/12	0/12	0/12
6 days	0/12	0/12	0/12	0/12
7 days	0/12	0/12	0/12	0/12

Note: Numerator - Number of plants infected, Denominator - Number of plants inoculated.

In the filtered sap, the virus retained infectivity only for 48 hours both when stored in room temperatue and also at 5°C. In the case of centrifuged sap the longevity *in vitro* was found to be 72 hours at both temperatures.

iv. *Serological tests:* The five chilli isolates producing similar symptoms on the chilli variety Sattur Samba and resembling one another in their physical properties were tested against the antiserum for PVY by the tube precipation test. The results are present in Table 3.

TABLE 3. *Serological test for chilli virus isolates with PVY antiserum*

Sap tested	Dilutions of sap		
	1/2	1/4	1/8
CH 29	***	**	*
CH 30	***	**	*
CH 32	***	**	*
CH 33	***	**	*
Madukkarai isolate	***	**	*
PVY infected tobacco	***	**	*
Healthy chilli	–	–	–

Note :- Test negative, *, **, ***, denote intensity of precipitate.

All the five chilli virus isolates gave positive reaction with PVY antiserum thus indicating that they were strains of PVY.

v. *Host range of the virus:* Several plants belonging to Solanaceae and other families were inoculated with the Madukkarai isolate. The inoculations were made on the cotyledonary leaves, in legumes and on the true leaves in other plants. The extracted chilli sap as such and diluted 20 times with the phosphate buffer were used to inoculate plants other than chilli to overcome the inhibitory action of chilli sap on infection of other hosts.

Solanaceae: *Datura metal* L., *D. stramonium* L., *D. fastuosa* L., *Solanum melongena* L., *Nicotiana tabacum* var. White Burley, *N. glutinosa* L.

Leguminosae: *Sesbania speciosa* Taub. ex Engl., *S. aculeata* Poir, *Cyamopsis psoraboides* DC., *Dolichos lablab* L., *Vigna sinensis* Endl.

Compositae: *Zinnia elegans* Facq.

Malvaceae: *Althaea rosea* Cav.

Cucurbitaceae: *Cucurbita maxima* Duch., *Benincasa hispida* Cogn.

Chenopodiaceae: *Chenopodium amaranticolor* Coste and Reyn., *C. quinoa* Willd.

Umbelliferae: *Daucus carota* L.

Cruciferae: *Raphanus sativus* L., *Brassica oleracea* var. *bullata* DC., *B. oleracea* var. *caulorapa* Pasq.

Amaranthaceae: *Gomphrena globosa* L.

The virus did not pass on to any of these plants. Hence it was not possible to find a local lesion host to facilitate assay of the virus titre.

Discussion: The virus under study was transmissible by sap. The aphid which infects chilli crop commonly in Tamil Nadu is *Aphis gossypii*. The ability of even one aphid to transmit the virus, the short acquisition feeding

period and infection threshold necessary were all similar to the report made by Simons (1959 b) for a virus disease of chilli caused by PVY in Florida.

Identity of the virus: The present virus reacted positively with potato virus Y antiserum. Further, its transmissibility by sap and by the aphid *Aphis gossypii*, the low dilution end point of 1 : 100, thermal inactivation point of 50–55°C and longevity *in vitro* for just two days were all closely similar to those of PVY.

The symptoms of infection produced on chilli by the virus, however, were strikingly different from those described in literature. On inoculation of PVY to *C. annuum*, David and Stormer (1941) found indefinite flecks on leaves and slight swelling of the veins. Soon a finely divided intercostal flecking developed till the entire leaf had a dark green mottle. While older leaves had wavy margins they did not show curling and deformation. In Florida vein-banding was found to be the prominent symptom on *C. frutescens* upon infection by PVY (Anderson and Corbett, 1957) while in Bulgaria Kovacevasky (1942) reported vein-clearing and mosaic flecking of leaves to be the characteristic symptoms of this disease. From these differences in symptomatology found by workers in different countries, it is evident that the symptoms produced by PVY on chilli depend on the species of *Capsicum*, the variety of chilli plant infected, the strain of PVY and probably, the climatic factors also. As Anderson and Corbett (1957) pointed out, the identification of chilli viruses from symptoms alone is nearly impossible. Thus, the differences in symptoms noted in the presnt study may be considered to indicate that this is yet another strain of PVY.

Though Simons (1959 a, b) found PVY to be transmitted by *Myzus persicae* and *Aphis gossypii* from chilli to chilli, the present virus was transmitted only by *A. gossypii*. Though *M. persicae* is considered to be the universal vector of PVY, the inability of this aphid to transmit the present virus cannot be considered to indicate that this virus is not PVY. There are several recorded instances in which strains of a particular virus were not transmitted by the vector of the type virus. The non-transmissibility of potato virus C which is considered to be a strain of PVY by *M. persicae* and of the Argentine curly-top of sugar beet by *Eutettix tenellus* which is the vector of the North American curly-top virus may be cited as examples.

In the face of the information on the physical properties and serological reaction, the present virus is identified as a strain of PVY.

Summary: A virus disease of chilli prevalent over wide areas in Tamil Nadu was studied. Out of 22 chilli varieties tested for susceptibility seven picked up infection. It was transmitted by *Aphis gosspii*. Even a single aphid

was able to transmit the virus. The aphid acquired the virus in one minute of feeding and transmitted it in five minutes of inoculation feeding. The physical properties of an isolate collected from Madukkarai were compared with those of four other chilli virus isolates producing similar symptoms on chilli. All the isolates had the same dilution end point, thermal inactivation point and longevity *in vitro* and reacted positively to Potato virus Y antiserum. On the basis of these properties, the Madukkarai isolate is identified as a strain of Potato virus Y. The virus did not pass on to any other host than chilli when a wide range of hosts was inoculated by sap.

Acknowledgement: The senior author thanks the Indian Council of Agricultural Research, New Delhi for the award of a senior fellowship during the tenure of which the investigations were carried out and the University of Madras for according permission to publish his doctoral thesis.

REFERENCES

Anderson, C. W. and M. K. Corbett. 1957. Virus diseases of peppers in Central Florida. Survey results. *Plant Dis. Reptr.*, **41** : 143–7.

Anon. 1964. *Annual Progress Report of the Virology Section, Agricultural College and Research, Institute, Coimbatore for the year, 1963–64.*

David, E. and I. Stormer. 1941, *Capsicum annuum* als Testpflanze fur etnige Kartoffelviren. *Phytopath. Z.*, **13** : 532–8.

Husain, M. A. 1932. Leaf curl in cotton and other plants. *Nature, London.*, **130** : 312.

Jeyarajan, R. and K. Ramakrishnan. 1961. Studies on a virus disease of chilli *(Capsicum* sp.)' *South Indian Hort.*, **9** : 1–12.

Joshi, R. D. and K. S. Bhargava. 1962. A vein-banding mosaic virus disease of chilli *(Capsicum frutescens* L.). *Indian J. Microbiol.*, **2** : 29–34.

Kandaswamy, T. K., I. P. Janaki, K. Ramakrishnan, G. Thangamani, K. T. Subbaraja and S. Sellammal. 1963. A preliminary note on virus diseases of chilli in Madras State. *Madras agric. J.*, **50** : 110.

Kovacevsky, I. C. 1942. Die virus krankheiten der poprikapflanzen. *Arch. Bulg. Landw. Ges. Pflanzenbau.*, **1** : 25–102.

McRae, W. 1924. *Economic Botany, Part III. Mycology, Ann. Rept. Board. Sci. Advice India, 1922–23.* 31–5.

Ramakrishnan, K. 1959. Potato virus X on chilli *(Capsicum* spp.). *S. Indian Hort.*, **7** : 41–52.

———. 1961. Virus disease of pepper *(Capsicum* spp.). *J. Indian bot. Soc.*, **40** : 12–46.

Simons, J. N. 1959 a. Potato virus Y appears in additional areas of tomato and pepper production in South Florida. *Plant Dis. Reptr.*, **43** : 710–11.

———. 1959 b. Variations in efficiency of aphid transmission of southern cucumber mosaic virus and potato virus Y in pepper. *Virology*, **9** : 612–23.

Vasudeva, R. S. 1954. Report of the Division of Mycology and Plant Pathology. *Sci. Rept. Indian agric. Res. Inst., New Delhi, 1952-53* : 79–89.