

## VIRAL/MLO DISEASES OF CUCURBITACEOUS CROPS IN INDIA, THEIR MANAGEMENT THROUGH CULTURAL PRACTICES AND FUTURE STRATEGIES

BY

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Cucurbits in India are attacked by twenty recognised viral/mlo diseases. Several of these viruses appeared to be widely distributed like pumpkin mosaic and cucumber mosaic in different parts of the country. Yield losses are substantially greater - though authentic data are not available. Salient features of the diseases have been given for the information of the reader. Keeping in mind the economic status of the small farmer and the environmental changes indicated by chemical treatment of crop, emphasis has been laid on non-chemical measures like good management practices which, if adopted, shall result in relief. Presently, little can be done to reduce virus infection in cucurbits. Suggestions have been made for establishment of integrated interdisciplinary teams for the purpose immediately since an effort is lacking at present. Breeding of resistant types is in the pipeline in the near future. Further research on the relationship between virus, the aphid vector, and the host is required. Till that time 'good management practices' is the answer for the small and cucurbit growers, at large, to minimise the viral/mlo disease losses.

### INTRODUCTION

Cucumbers, melons, pumpkins squashes and gourds belong to the family Cucurbitaceae. They are hot weather crops and are mostly trailers with the exception of bush varieties of squash. They are insect pollinated and the flowers are usually unisexual, both the kinds occurring ordinarily on the same plant with the exception of *parwal* (pointed gourd) where they occur on different plants. Pointed gourd and small gourd (*tondli*) are perennial and the rest are annuals.

The ripe fruits of muskmelon and watermelon are taken as desert whereas the unripe tender fruits of all these crops are cooked as vegetables. They are a good source of vitamins.

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These crops are grown all over India except pointed gourd and small gourd which are not grown in north-west India. Indian squash melon, watermelon and muskmelon are not usually grown in the hills. All these crops are propagated from seeds whereas pointed gourd and small gourd can also be propagated from cuttings. There are no standard varieties except the local types, because they are highly cross fertilized crops and one can never be sure of obtaining a distinct type from ordinary seeds grown in any part of the country.

#### DESCRIPTION OF DISEASES

Information gathered on various diseases has been presented in a descriptive manner for information.

The details of the diseases description have also been summarised in Table I for ready reference.

##### 1. Vegetable marrow (*Cucubita pepo*) Mosaic/Filiform :

*Virus* : Mosaic type - *Cucumis virus 1*  
 Filiform type - *Cucumis virus 3*

*Symptoms* : The mosaic and filiform type of symptoms are commonly met with and have been studied. The third type, the witches broom seen at a late stage of the crop, have only been recorded.

The mosaic symptoms consist of typical light and dark green patches on the leaves coupled with reduced leaves. In case of filiform type severe reduction in leaf size together with filiformy of the leaves is seen. In both the cases the flowering is delayed and the outer skin of the fruits exhibits chlorotic spots.

*Transmission* : Both the disease type are transmitted by sap inoculation. The mosaic type is transmitted by *A. gossypii* and *A. eraccivore* *A. evonymi* and *M. persicae*, while the filiform is transmitted by *M. persicae* only. The mosaic type syndrom is seed borne to the extent of 6.3%.

*Host Range* : The mosaic type infects both the cultivated cucurbits and others, while the filiform type infects only cultivated cucurbits.

*Properties* : These are as follows :

Mosaic type - T. I. P. - 52-55° C, D. E. P. - 1 : 200 : 1 : 300, longevity in vitro 12-18 hrs at room temprature.

Filiform type - T. I. P. - 55-60° C., D. E. P. - 1 : 500, longevity in vitro - 1 day at room temperature.

##### 2. Pumpkin (*Cucurbits moschata*) Mosaic :

*Virus* : It has close affinity with watermelon mosaic virus (MMV - 1).

*Symptoms* : The disease manifests itself as mosaic mottling on the young leaves. The leaf lamina is very often distorted and is reduced to narrow strips resulting in filiform shape. The affected plant very often does not bear any fruit.

*Transmission* : The virus is sap transmissible and is not seed borne. The vectors are *Myzus persicae* and *Sitabion rosaeformis*.

*Host range* : The host range is restricted to cultivated cucurbits only. *Cucumis sativus* is symptomless carrier.

*Properties* : T. I. P. - 50°C, D. E. P. - 1 : 500, longevity in vitro - 8 hrs. at room temperature Particle size : Flexuous rods 840 x 15 nm.

### 3 Pumpkin (*Cucurbita moschata*) yellow vein mosaic :

*Virus* Whitefly transmitted.

*Symptoms* : Faint vein yellowing develops initially in the young leaves of infected plants. With time the veinal yellowing and yellow patches become very distinct. Fruits are malformed and become very hard.

*Transmission* : The virus is not sap transmissible but is readily transmitted by whitefly *Bemisia tabaci* in a semi-persistent manner.

*Habitat* : Widely prevalent in Maharashtra State.

### 4 Bottle Gourd (*Lagenaria siceraria*) Mosaic and Smoke Gourd Mosaic.

*Virus* : Cucumber mosaic virus (*Cucumis virus 1*) strains.

*Symptoms* : The affected plants are characterised by the presence of well defined dark or light green mottle with elongated spots on the leaves. The diseased vines, with time, show retarded growth resulting in stunted plant growth with shortened internodes and leaves. The fruits especially of cucumber, bottle gourd, pumpkin and squash are often mottled malformed.

*Transmission* : The disease is sap transmissible and the virus passes through the seeds of muskmelon and pumpkin. The vectors are *Aphis gossypii*, *A. craccivora*, *A. evonymi* and *Myzus persicae*.

*Host range* : The virus has a very wide host range which includes solanaceous hosts, monocots and the cultivated cucurbits.

*Properties* : T. I. P. - 60 -70°C, D. E. P. - 1 : 10,000 and longevity in vitro 72-76 hours at room temperature,

Mosaic of snake gourd (*Trichosanthes anguina*), Mosaic of cucumber are caused by CMV-1 or its strain. ( Sr No. 10, Table-1 ).

5. Watermelon (*Citrullus lanatus*) Vein-banding Mosaic :

*Virus* : Serologically related to Cucumis Virus 2.

*Symptoms* : The infected vines show diffuse mottling on the leaves having light and dark green areas. In case of severe symptoms, blisters are seen on the older leaves. The vines when infected at early stage set few but small fruits and show much stunted growth.

*Transmission* : The virus is sap transmissible and is not aphid borne. The virus is not carried in the seed.

*Host range* : The virus remains confined to the cultivated cucurbits only but induced local lesions in *Chenopodium amaranticolor*. The bitter gourd is a symptomless carrier.

*Properties* : T.I.P. - 95-98°C, D.E.F., - 8 : 10,000 - 1 : 50,000 and longevity in vitro more than a year at room temperature.

*Particle size* : Flexuous rods - length 240 nm.

6. Watermelon (*Citrullus lanatus*) Leaf Mottle :

*Virus* : Corresponds to watermelon mosaic virus 1 strain and belongs to potato virus Y group.

*Symptoms* : The infected vines showed distinct mottling with narrowing and distortion of leaves resulting in stunted growth. In diseased vines the fruit size is reduced to one half as compared to those on the healthy ones. The fruits are deformed and the skin showed clear chlorotic patches. The disease incidence during the season was to the tune of 60-70%.

*Transmission* : The disease is sap-transmissible and is aphid borne. The aphids-*Aphis gossypii* and *Myzus persicae* transmitted the virus in a non-persistent manner. The virus is not seed borne.

*Host range* : The virus is apparently restricted to cultivated cucurbits and did not infect others. *Luffa acutangula* (T.W. Whitaker, U.S.A.) and poona strain; and muskmelon B-63-3 PI 180280, served as indicator host for the virus.

*Properties* : T.I.P. - 55-60°C, D.E.P. - 1 : 1000 : 1 : 10,000, longevity in vitro-36 hrs at room temperature.

*Particle size* : Flexuous rods length - 750 nm.

7. Muskmelon (*Cucumis melo*) Mosaic :

*Virus* : Related to bottlegourd mosaic virus (*Cucumis virus 2*).

*Symptoms* ; The disease is characterised by development of mosaic mottling of the leaves in the form of irregular chlorotic and green areas on the leaves without any leaf distortions.

*Transmission* : The virus is sap transmissible.

*Host range* : The virus infected cultivated cucurbit hosts only and induced local lesions on *Chenopodium amaranticolor*. Tobacco var. W. B. and *Nicotiana glutinosa* were not infected.

*Properties* : T. I. P. - 90°C, D. E. P. - 1 : 100,000 and longevity *in vitro* 60 days at room temperature.

*Particle size* : Rigid rods - 280 x 15 nm.

8. Muskmelon (*Cucumis melo*) Ringspot :

*Virus* : Related to tobacco ringspot group

*Symptoms* : The leaves of infected vines show mosaic mottling with chlorotic areas forming ringspot shape. The spots on the leaves consist of small yellowish brown coloured spots surrounded by bright yellow halo or margin.

*Transmission* : The virus infected cultivated cucurbits and others like tobacco var. W. B., *Nicotiana glutinosa*, *Petunia hybrida* and *Vigna sinensis* *Chenopodium amaranticolor*, reacted with local lesions. *Aphis craccivora*, *A. gossypii* and *Myzus persicae* failed to transmit the virus.

*Properties* : T. I. P. - 60°C - 70°C, D. E. P. - 1 : 1000 - 1 : 10,000 and longevity *in vitro* - 3 days at room temperature.

9. Ribbed Gourd (*Luffa acutangula*) : Mosaic :

*Virus* : *Cucumis virus* — 3.

*Symptoms* : The leaves of infected vines (*Luffa acutangula*) show distinct mosaic-mottling coupled with downward curling of the margins. In older leaves the chlorotic areas increase, become circular and turn yellow. The infected plants are stunted in growth and bear fewer flowers and fruits.

*Transmission* : The virus is sap transmissible and is not transmitted through seed and the aphids - *Myzus persicae*, *Aphis craccivara* *Thopalsium maidis* or the red pumpkin beetle *Rhipidopalpa feveicollis*.

*Host range* : The host range of the virus is restricted to family Cucurbitaceae only.

*Properties* : T. I. P. - 55°C - 60°C, D. E. P. - 1 : 1000, longevity *in vitro* - 4 to 6 days at room temperature.

10. Sponge Gourd (*Luffa cylindrica*) Ring Mosaic :

*Virus* : Tobacco ringspot strain.

*Symptoms* : The leaves of infected vines (*Luffa cylindrica*) show distinct mosaic symptoms with small yellow irregular spots distributed among inter-veinal areas. Apical growth is much reduced. The symptoms on the fruits are more

marked. They appear as dark yellow irregularly shaped blotched spots on the skin which becomes very hard. The fruit size is reduced to almost half as compared with healthy ones.

*Transmission* : The virus is sap-transmissible and seed borne. Aphid sp. - *A. gossypii*, *M. persicae* and *A. craccivora* failed to transmit.

*Host range* : Primary leaves of most of the cucurbits tested developed chlorotic local lesions followed by systemic disease. Muskmelon and *Cucumis sativus* were not infected. *Chenopodium amaranticolor* developed local lesions with chlorosis of veins.

*Properties* : T. I. P. - 50° - 55°C, D. E. P. - 1/5000, longevity *in vitro* at room temperature - 3 days.

#### 11. Sponge Gourd (*Luffa cylindrica*) Veinal Enation and Leaf Curl :

*Virus* : Strain of Nicotiana Virus 10 A.

*Symptoms* : The chief symptoms on the diseased vines (*Luffa cylindrica*) are curling, twisting and rolling of the young leaves. On the underside of the leaves well-defined hyperplastic growth along the veins developed into frills.

*Transmission* : The virus was easily transmitted by grafting and by the whitefly *Bemisia tabaci* but was not transmitted by sap inoculations.

*Host Range* : The virus infected chilli (*Capsicum annum*) tobacco Var W. B. tomato *Luffa acutangula*.

#### 12. Bitter Gourd (*Momordica charantia*) 'Leaf Distortion' :

*Virus* : Belongs to poty group.

*Symptoms* : The first sign of infection is a mild mottling of the leaves. Later the vein banding symptoms are common, The leaves are puckered and blistered. The growth of the plant is slowed down. The fruit size is reduced and fewer in number. The fruit colour is paler, having deformed shape and bears only few seeds.

*Transmission* : The virus is transmitted by sap inoculations. *A. gossypii* and *M. persicae* transmitted the virus in a non-persistent manner while *A. rumicis* failed to transmit the virus. The virus is not carried in the seed.

*Host range* : The host range of the virus was restricted to cucurbits only. Squash, pumpkin, white gourd and cucumber were not infected.

*Properties* : T. I. P. - 50°-55°C, D. E. P., - 1 : 100 - 1 : 500, longevity *in vitro* 24 hrs.

*Particle size* : Flexuous rods average length 690 - 705 nm. Very low concentration.

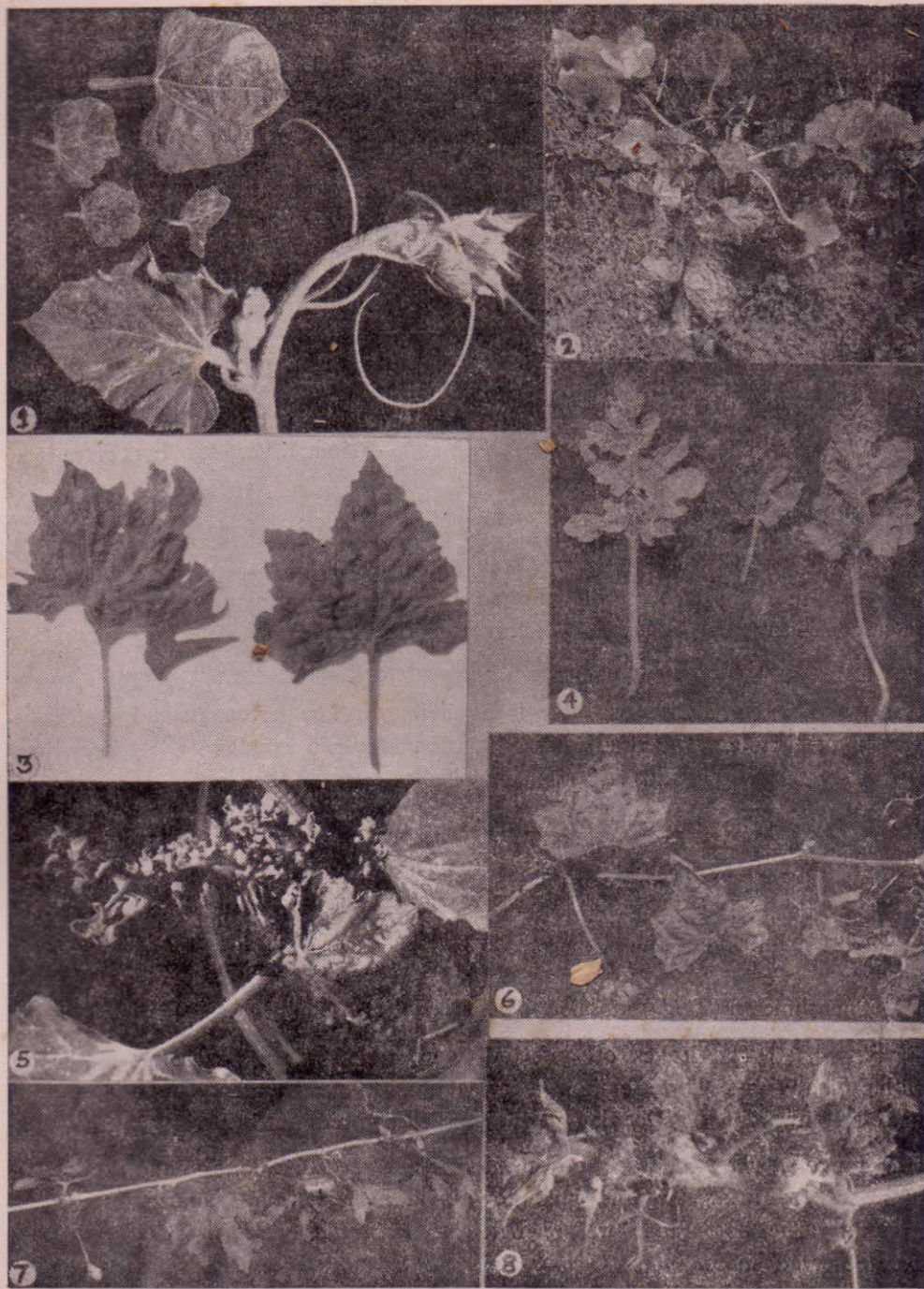


Fig. 1 : Bottle gourd (*Lagenaria siceraria*) mosaic disease. Fig. 2 : Muskmelon (*Cucumis melo*) mosaic disease. Fig. 3 : Bittergourd (*Momordica charantia*) leaf distortion. Fig. 4 : Watermelon (*Citrullus lanatus*) leaf mottle. Fig. 5 : Vegetable marrow dwarf disease of *Cucurbita pepo*. Fig. 6 : Spongy gourd (*Luffa cylindrica*) ring mosaic. Fig. 7 : Bottle gourd (*Lagenaria siceraria*) ring mosaic. Fig. 8 : Severe mosaic of *Benincasa hispida*.

13. Bitter Gourd (*Momordica charantia*) Yellow Vein and Ringspot :

*Virus* : Strain of Bitter Gourd leaf distortion virus.

*Symptoms* : The leaves of infected plants show intense yellowing of the veins with reduced leaf size. The leaves slightly curl downwards. The growth of the plant is not slowed down. Fruit size is not affected and appear normal.

*Transmission* : The virus is transmitted by sap inoculation. The virus is not transmitted by *A. gossypii* and *M. persicae*, while *A. rumicis* transmitted it in non-persistent manner. The virus is not carried in the seed.

*Host range* : The host range of the virus is restricted to cucurbits only. Squash, pumpkin, white gourd, cucumber and snake gourd were not infected.

*Properties* : T.I.P.—45-50°C, D.E.P.—1 : 100—1 : 300, longevity *in vitro*—less than 24 hours at room temperature.

*Particle size* : Flexuous rods average length 690—705nm. Very low concentration.

14. Bitter Gourd (*Momordica charantia*) Ring Mosaic :

*Virus* : Strain of tobacco ringspot.

*Symptoms* : The leaves of affected plants showed minute chlorotic rings interspersed in intervinal areas. As leaves mature the rings especially along the margins turned necrotic. The growth of the diseased plants were normal.

*Transmission* : The virus was sap-transmissible in low percentage and was easily graft transmissible. The virus was seed borne under field conditions. *A. cracivora*, *A. rumicis*, *A. gossypii* and *M. persicae* failed to transmit the virus.

*Host range* : The virus was not transmitted to any of the cucurbits tested except muskmelon.

*Properties* : T. I. P.—45—50°C, D. E. P. 1 : 100—1 : 200, longevity *in vitro* 6 hours at room temperature.

15. Squashmelon (*Tinda*) mosaic (*Citrullus vulgris* schrad. var. *fistulosus* SKS)

*Symptoms* : The leaves of infected vines show mosaic mottling to begin with. The younger leaves exhibit intervinal chlorosis with green vein-banding and these roll inwards. The leaf lamina is distorted and reduced in size.

*Host range* : The virus was sap transmissible and seed borne in tinda to the extent of 3%. *Myzus persicae* transmitted the virus in non-persistent manner from tinda to tinda. The host range was restricted to cucurbits only. Mosaic symptoms were observed in *C. pepo*, *Cucumis melo*, *Lagenaria siceraria*, *Luffa acutangula*, *Citrullus lanatus*, *Penincasa hispida* and *Trichosanthes anguina*, *Momordica charantia* and cucumber were symptomless carriers.

The virus had T. D. F.—50—50°C, D. E. P.— 1 : 500 longevity in vitro 8 hours at room temperature ( 32-38°C ) and 24 hours at 10°C.

*Seed transmission* : From commercial seed lot, 250 seeds were shown in the glass-house. Two hundred seeds germinated which were examined for foliar symptoms over 8 weeks. Only six plants exhibited the mosaic symptoms, thus indicating 3% seed transmission of the virus in commercial seed sample.

16. Petha ( *Benincasa hispida* Cong. ) severe mosaic :

*Symptoms* : The leaves of infected virus showed characteristic mosaic symptoms with considerable reduction in leaf size. Later on, the virus infected leaves were crowded together to give a bushy and stunted appearance. Severely infected leaves showed numerous dark green raised blisters on the upper surface.

*Transmission* : The virus was sap transmissible and was transmitted in a non-persistent manner by *A. gossypii* and *M. persicae*.

*Physical properties and host range.*

The virus had T. I. P.—54°C, D. E. P.—1 : 200—1 : 500, longevity in vitro 24 hours at 10 C and 8 hours at room temperature ( 26-28°C ).

The host range of the virus was restricted to cucurbits only. Typical mosaic symptoms observed in *Cucurbita pepo*, *Lagenaria vulgaris*, *Momordica charantia*, *Citrullus lanatus*, *Luffa acutangula* and *Cucumis melo*.

17. Vegetable marrow ( *Cucurbita pepo* ) "Dwarf"

*Symptoms* : The symptoms consisted of a dense tuft of shortened branches bearing severely reduced and malformed leaves. The malformed leaves with deformed lamina showed downward curling and cupping. The leaf lamina showed light and dark green areas. The petiole and the internodes were shortened resulting in "witches broom" type appearance of the diseased vines. The flowers were not set.

*Transmission* : The disease was not sap-transmissible but was readily transmitted by grafting within 30 days

The disease appears to be of MLO etiology and not reported so far. Responded to tetracycline spray treatment but recovery was reversed.

*Seed transmission* : The commercial seed lot when examined for seed transmission showed 1% seed transmission rate, proving its seed borne nature.

#### SOURCES OF INFECTION

(A) *Primary sources of infection* :

(1) Infected cucurbit culture of early sown crops like, squash, pumpkin, gourds, muskmelon, water melon and bitter gourd.

Table 1. Comparative study of Viruses / MLO naturally occurring in different cultivated cucurbits in India (1943-1987)

S.No.	Virus name	Natural host	Seed transmission	Vector, if any	Structural morphology	Virus Group relationship	Reference
1	2	3	4	5	6	7	8
(A) SAP TRANSMISSIBLE							
1.	Bottle Gourd Mosaic Virus/Green Cucumber Mosaic.	<i>Lagenaria siceraria</i>	—	—	—	Tobacco Virus/Cucumis virus-1 and strains	Vasudeva and Lal (1943) Vasudeva and Nariani (1952)
2.	Cucumber Mosaic Virus	<i>Cucumis sativus-Trichosanthes anguina</i> L <i>Cucurbita moschata</i> <i>Solanum melongena</i>	Pumpkin and Vegetable marrow.	<i>Aphis gossypii</i> <i>Myzus persicae</i> and others.	Spherical 25-30 nm	—	Shanker <i>et al</i> (1969) Mukhopadhyaya and Saha (1968) Sharma (1969)
3.	Watermelon Mosaic	<i>Citrullus lanatus</i> <i>Cucurbita pepo</i>	—	—	Flexuous rods 700-800 nm.	—	Bhargava & Joshi (1960) Raychaudhuri, M. (1973)
4.	Watermelon mottle	<i>Citrullus lanatus</i>	—	—	—	—	Shanker & Nariani (1974)
5.	Watermelon Leaf mottle	<i>Citrullus lanatus</i>	—	<i>Aphis gossypii</i> <i>Myzus persicae</i>	Flexuous rods 750 nm pin while structures present	Potato Y	Sharma & Pandey (1981)
6.	Muskmelon Mild mosaic	<i>Cucumis melo</i>	—	—	Rigid rods 280 x 15 nm	Cucumis virus 2C	Nariani <i>et al</i> (1977) Raychaudhuri <i>et al</i> (1950)
7.	Muskmelon Ring spot	—do—	—	—	—	—	Vishwanath <i>et al.</i> (1979)

Table 1 Contd

1	2	3	4	5	6	7	8
8. Ridge Gourd Mosaic	<i>Luffa acutangula</i>	—	—	—	—	Cucumis virus-3	Mitra & Nariani (1965)
9. Sponge Gourd ringspot	<i>Luffa cylindrica</i>	—	—	—	—	—	Sharma (1983a)
10. Snake Gourd Mosaic	<i>Trichosanthes anguina</i>	—	—	<i>A. gossypii</i> <i>M. persicae</i>	Spherical 29 nm	Cucumis virus-1	Dubey <i>et al</i> (1974)
11. Pumpkin Mosaic	<i>Cucurbita moschata</i>	—	—	—do—	Flexuous rods 84° nm	Cucumis Virus-3	Shankr <i>et al</i> (1972)
12. Vegetable marrow mosaic	<i>Cucurbita pepo</i>	—	Vegetable marrow 6.3%	—do—	Flexuous rods 740-800 nm	—do—	Reddy & Nariani (1963)
13. Bitter Gourd Leaf Distortion.	<i>Momordica charantia</i>	—	<i>M. charantia</i>	—	Flexuous rods	Potato Y	Sharma (1983a) 1985(a)
14. Bitter Gourd Yellow Vein and Ring spot	—do—	—	—	—	—do—	—do—	—do—
15. Bitter Gourd Ring Mosaic	—do—	—	<i>M. charantia</i>	—	—	—	—do—
16. Squash melon mosaic	<i>Citrullus vulgaris</i>	—	<i>C. vulgaris</i>	<i>M. persicae</i>	—	Potato Y	—
17. <i>Benincasa hispida</i> Severe Mosaic	<i>Benincasa hispida</i>	—	—	<i>A. gossypii</i>	—	—do—	Sharma, 1985(b)
(B) GRAFT TRANSMISSIBLE							
18. Pumpkin Yellow Vein Mosaic	<i>Cucurbita moschata</i>	—	—	<i>Bemisia tabaci</i> Genn.	—	—	Capoor & Ahmed (1974)
19. Sponge Gourd Leaf Enation & Curl.	<i>Luffa cylindrica</i>	—	—	—do—	—	Tomato leaf curl strain	Sharma (1983a)
20. Vegetable marrow 'Dwarfing'	<i>Cucurbita pepo</i>	—	<i>Cucurbita pepo</i>	—	—	Myeoplama like organism	Sharma (1983b) 1985(b)

(2) Late sown cucurbit crop receives infection from early sown cucurbit crop, weeds like *Amaranthus* Sp *Solanum nigrum*, *Portulaca oleracea* and *Lucas aspera* and through aphid vectors like *Aphis gossypii* and *Myzus persicae*.

(3) Self sown weeds - thrown off from infected seeds viz - *Amaranthus viridis* and *Solanum nigrum*.

(B) *Secondary spread of infection :*

Within the crop culture through aphid vectors like *Aphis gossypii*.

It is important to note that cucurbit cultivation both upland and riverbed has inter-culture of crops like, tamato, radish, brinjal, spinach, beet, beans and *Amaranthus*. These are all well known to harbour different aphid species and strains of cucumber virus and others. The pathogenic viruses go on spreading from one cucurbit species to other as available in the field. The entire cultivated area becomes an arena of viral infection at a very rapid rate and nothing could check it under the prevailing cultural practices of cultivation.

#### MANAGEMENT OF CUCURBIT VIRAL/MLO DISEASES AND THE FUTURE

As accepted commonly, no direct measures against a virus in an affected plant can be applied, indirect measure must rather be adopted. As will be seen from the account of the diseases studied in this country, it leads to conclude that efforts were made to identify the casual viruses and no data is available on the control aspect of the same.

At Delhi, riverbed cultivation of cucurbits is a family tradition for non-holding farmers and is their source of livelihood. This method is very popular and cheap coupled with popular customer demand for the fruit as it is believed to be very sweet. The self sown weeds and the early crop act as foci of infection for the mid and late crops as revealed by surveys. It is therefore recommended that sowing of early crop of cucurbits should be discouraged and in its place some suitable non-cucurbitaceous crop could be cultivated to avoid economic losses to the farmers. With this information at hand prevention of infection by eliminating or reducing the number of infection sources and of limiting the spread of viruses has to be rigorously adopted in the integrated management programmes (Sharma 1986).

At present it is not known which weeds in particular act as source of infection for the cucurbit viruses. Many cucurbitaceous, leguminous and malvaceous plants are found growing along the roads, drainage, waste lands and garbage heaps. However, information on this aspect will not be of much value since their elimination will be infeasible and uneconomical. Similarly combination plantings of crops with cucurbits is common and this tends to increase the pressure of aphid pests on each crop and the cucurbits suffer seriously as aphids act as vectors of many viruses.

Therefore, appropriate "Combination plantings" need be evolved which may help to reduce the pressure of major pests and diseases of each crop. Volunteer cucurbits, common in the fields, can easily act as sources of infection. Therefore, measures should be taken to prevent their growth.

Roguing of infected plants from a crop has been recommended for controlling several viral diseases. This is based solely on visual symptoms. Since seed transmission is known in some cases early roguing is recommended before virus spreads from infected to healthy plants within the crop through the vectors only since they are not contact-transmitted. Killing the aphid vectors before they enter the cucurbit crop from the 'mixed cropping' sources in the neighbourhood is worthwhile to try in order to reduce the primary infection of the crop plants. Killing vectors after their arrival has usually failed to decrease incidence of vectors carrying the stylletborn (non-persistent) cucurbit viruses and could infect a plant within a few seconds or minutes before being killed.

A rotation programme during which no plants susceptible to cucurbit virus are grown for a certain period may provide adequate control and is worth trial. Another important aspect is spread of these viruses by transporting infected seeds through seed supply pipeline agencies. The infected seeds do not show any external symptoms so that they cannot be detected in seed lots.

One of the most effective ways to control a virus disease in plant is breeding for field resistance or immunity. So far no such sources have been reported but work is in progress at many places in this behalf.

In order to devise management strategies for future control of these diseases of cucurbits joint efforts of scientists from several disciplines are needed to produce a sound programme to benefit the farmer. But such inter-disciplinary effort has been slow to develop in agriculture research. Till this happens cucurbit virus could be controlled effectively by non chemical methods like good management practices which include field sanitation disease free seed/cutting, crop rotation, isolation, mixed cropping etc. till the plant breeders breed varieties which are both palatable to human taste and are resistant to viral diseases in particular.

The results on aphid control through insecticides use for disease suppression are conflicting. Detailed studies on reflective mulches to repel aphids, oil sprays to reduce transmission and biological control are required on priority basis.

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